RSPO GHG Assessment for New Plantings, GRAINE Ndendé, SOTRADER

6/17/2016

This document is developed based on the HCV Assessment Report, appendix 7 High Carbon Stock Assessment (Proforest, June 2016) and chapter 5.4 of the ESIA (Terea, June 2016).It is not a public report for NPP consultation, report to be submitted to the RSPO secretariat.

Contents

1. Background

The revised P&C (2013) has a new criterion 7.8 requiring new plantation developments are designed to minimize net greenhouse gas (GHG) emissions. The indicators under this criterion include the identification and estimation of potential sources of emission and sinks of carbon associated with the new developments. Another indicator is that new developments must be designed to minimize GHG emission which takes into account avoidance of land areas with high carbon stocks and consideration of sequestration options.

1.1 GRAINE

On 22 December 2014, the Government of Republic of Gabon launched the national smallholders agricultural program i.e. GRAINE (*Gabon des Réalisations Agricoles et des Initiatives des Nationaux Engages*). To execute GRAINE, a company, SOTRADER was created as a joint venture between the Government of Gabon (51%) and Olam International (49%). Olam will develop and manage all development under GRAINE program.

The program aims to:

- Ensure food security through food cultivation (banana, manioc, chili, pepper, and palm).
- Reduce rural poverty and increase job opportunity
- Supporting economic development and diversification

Total 200,000 ha will be developed with 120,000 ha managed by smallholders' scheme/ cooperatives and 80,000 ha for industrial plantations (*70,000 ha for export crops i.e. palm; remaining area for domestic crops i.e. tomato, banana, pepper, cassava and banana*).

SOTRADER has registered and becomes a grower member of the RSPO since 10 July 2015 (RSPO membership number: 1-0187-15-000-00). All palm development under SOTRADER will comply with the RSPO system requirements including the New Planting Procedures and certification for schemed smallholders.

1.2 Gabon and National Commitment on Emission Reduction

Gabon is a country of Central Africa bordering Cameroon to the north, the republic of Congo to the east and the Atlantic Ocean to the west. The country covers 25.8 million hectare of land, with 88% of forest cover, and approximately 2.9 million ha or 11% of these terrestrial areas has been gazetted as National Parks.

Gabon has one of the lowest deforestation rates in Africa, estimated at 0.12% per year (average between 1990 and 2000). The country has a population of approximately 1.67 million people; more than 40% of the population is living in the capital city, Libreville. 26% or one out of four adults in Gabon is currently unemployed.

Gabon's economy is highly dependent on oil export, mining and timber. Oil export contributes 34.9% of the country's GDP while agriculture sector (including livestock and fishing) only contributes 2.9% of GDP in 2014.

80% of food consumed in Gabon is mainly imported from France, Cameroon and South Africa, and increasing food import bill is touching above USD500 million today (or 12% of Gabon total import bill).

Since 2009, the government has committed to diversify its economy via its sustainable development strategy referred as Gabon Emergent. This strategy is based on three pillars:

"Gabon Vert" (Green Gabon): 22 million ha of conserved forest, 1 million ha of arable land, 13 national parks and 800km of coastline allocated for timber industry, agricultural development and eco-tourism.

Gabon Industriel (Industrial Gabon): Promotion of the local transformational of primary materials and export of high value-added products.

Gabon des Services (Services Gabon): Develop Gabonese workforce with the goal of becoming a regional leader in financial services, ICT, green economy, higher education and health.

Through implementation of Green Gabon strategy, the government aims to create up to 50,000 jobs in agricultural sector, increase GDP from agricultural sector to 20% by year 2025 and increase local food security.

Under its 2015 Climate Action Plan for the UNFCCC[1], Gabon committed to reducing its Greenhouse Gas emissions at least by 50% in 2025 relative to its year 2000 baseline, the first African country to do so (April 2015). Achieving this reduction will depend on the rational use of Gabon's forest and agricultural land resources based on:

- The adoption of a new Forestry Code to prevent forest degradation
- The creation of 13 National Parks and other restrictions on land clearance
- The adoption of a National Land Use Plan that allocates land for different uses and explicitly excludes "intact forests, high conservation value forests and forests which are particularly rich in carbon".

Cumulative, Gabon's commitments should reduce GHG emissions over 1.5 million $GgCO_2$ between 2010 to 2025 or 65 % compared to the baseline scenario.

Today, the recently adopted Gabonese Republic Act No. 002/2014 on guiding Sustainable Development in the Gabonese Republic recognizes the need to control greenhouse gas emissions at national level. The National Climate Council is working on the development of a carbon diagnosis tool and develops a national carbon map that will enable companies to measure the impact of their activities in terms of GHG emissions[2].

[1] Gabon INDC

[2] Reducing Carbon Emissions from Forest Conversion for Oil Palm Agriculture in Gabon, Conservation Letter, C. Stewart *et. al*, 2016

1.3 NPP Site, Ndendé

The proposed agricultural concession area is located 5 km north of the town of Ndendé, straddling the Mouila-Ndendé main road (see map below) across the forest-savannah transition region of southern Gabon, in one of the two savannah fingers reaching northwards into Gabon from the Republic of Congo.

The site lies on the foothills of the Ikoundou plateau, in the plain extending on the eastern edge of the Ngounié syncline. The area is a savannah plain, across which run shallow valleys where forest corridors have developed. The plain lies over a limestone/shale bedrock typical of this area of Gabon, with residual karst formations to the West and an undulating relief more characteristic of eroded karst plateaux to the East. Numerous permanent or seasonal small lakes pepper the area, which have formed following the erosion of the parent material and the formation of shallow bowl-shaped depressions (“dolines”) plugged by clayey sediments.

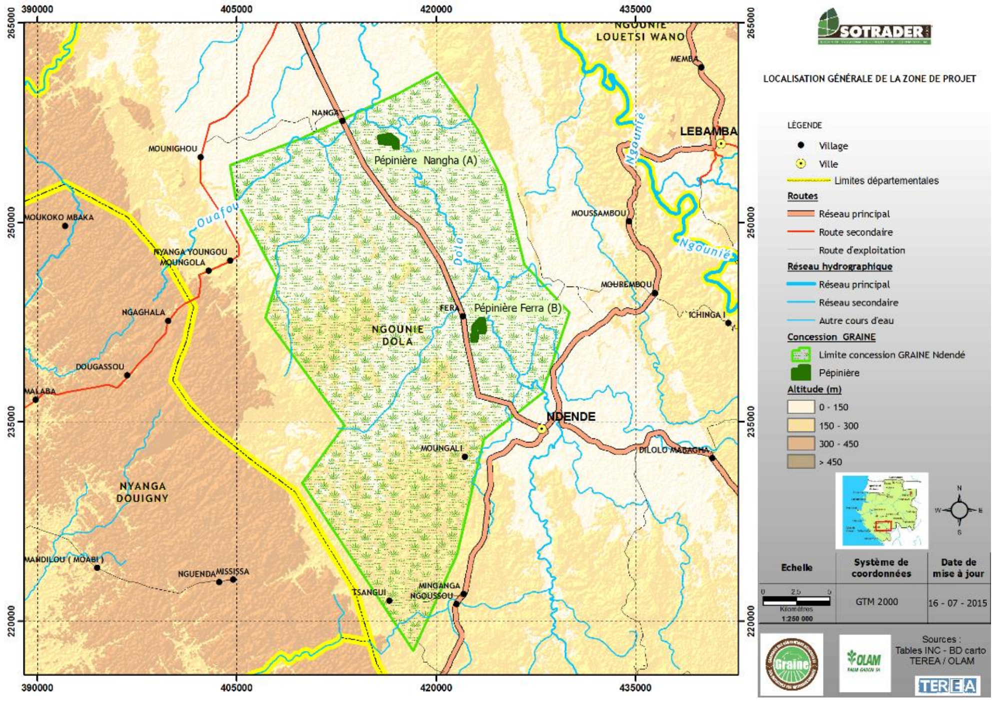

Figure 5: Location of SOTRADER's proposed Ndendé concession (Source: TEREA)

From a hydrological point of view, the entire concession is located within the catchment of the Dola River, a tributary of the Ngounié. The Dola joins with the Ngounié approximately 20 km from the northernmost concession boundary, and within the concession itself, the main tributaries of the Dola are the Ouafou River, the Rembo, the Douba and the Douengui. Many smaller streams and seasonal rivers can be traced from the geology, most of them are not named and often are seasonal.

2. Assessors and Credentials

Relevant experts are listed below. Carbon stock assessment was conducted as part of the HCV and ESIA assessment. Carbon assessment was coordinated by Proforest, led by Dr. Mike Senior with David Hoyle and Audrey Versteegen.

Name	ALS Licence	Organisation	Role	Expertise
Dr Audrey Versteegen audrey@proforest.net	ALS15032AV	Proforest	Lead Assessor	Biodiversity Conservation GIS
David Hoyle david@proforest.net	ALS15008DH	Proforest	Assessor	Biodiversity Conservation Social
Mike Senior mike@proforest.net		Proforest	Assessor	Carbon
Aubin Mboumba		TEREA	Team member	Environmental and social impacts
TEREA: Environmental and Social Impact Assessment				
Aubin MBOUMBA; Gustave NGUEMA;	TEREA			ESIA coordination
Geophysical and hydrological studies				
Jean-Charles MONTAUFIER	TEREA			Hydrology and hydrogeology
Dr Selliah Paramananthan	Param Agricultural Soil Surveys (Malaysia)			Soils
Vegetation and faunal studies				
Dr. Alfred NGOMANDA	Tropical Ecology Research Institute (IRET)			Fauna
Dr. Nestor ENGONE OBIANG	IRET and National Herbarium			Botany
Blaise MBOYE	IRAF at CENAREST			Fish and aquatic macro-invertebrates
Botanical Risk assessment				
Tariq Stévart	Herbier National de Belgique			Botany
Pete Lowry	Missouri Botanical Garden			
Socio-economic survey				

Dr Léon NGUIMBI	IRAF at CENAREST	Socio economic study
Guy-Roger MBATOUILA OBOLO	TEREA	Participatory mapping

3. Methods and Procedures Used for Conducting Carbon Stock and GHG Assessments

The scope of this assessment also included identification and mapping of high carbon stock (HCS) areas. It was initially agreed that HCS areas would be mapped according to the **HCS+** method as developed by the Sustainable Palm Oil Manifesto (SPOM) Science Study, rather than the **HCS Approach**, developed by Greenpeace, TFT, GAR. However, due to the growing interest of global stakeholders in the convergence of these two HCS methods and also the integration of the HCS and HCV tools, it was decided to use a hybrid of the HCS+, HCSA and HCV approaches.

Specifically, a combined methodology was used that allowed the identification of forest set-aside areas, that are both HCV and HCS, based on a combination of the **datasets, techniques and thresholds**, as laid out below. By using a combination of these approaches we were able to adopt best practice from each of the different approaches and to trial a combined methodology that could inform a refined and fully integrated HCV-HCS approach in the future.

3.1 Methods

3.1.1 Core datasets

- In line with HCS+, LiDAR-derived biomass maps (100 m resolution), as provided by SOTRADER, are used to map above-ground biomass and carbon.
- Field AGB plot data to ground-truth/verify LiDAR biomass estimates (in line with HCS+ and HCSA), as conducted by the contracted team of botanical experts from *l'Institut de Recherche en Ecologie Tropicale* in Gabon.
- Pedological maps and soil survey results, as contained in the Ndendé Physical Environment assessment conducted by TEREA.

3.1.2 Techniques and thresholds

As stated above, the methodology used combines aspects of both the HCSA and HCS+ methodologies. The key techniques and thresholds used are as follows:

- It was assumed that Young Regenerating Forest (YRF) was equivalent to forest of 35-75 tC/ha and Forest as forest >75 tC/ha,
- Maps of aboveground carbon are provided that include both HCSA and HCS+ carbon thresholds of 35 and 75 tC/ha,
- The HCSA patch analysis decision tree was used to determine the location of riparian forest HCS-HCV set aside areas. This allowed set-aside areas to be determined quantitatively based on patch viability,

- All forest patches with a *core area*[3] larger than 10 ha and >75 tC/ha were identified for protection
- Forest patches <10 ha in size were protected if connected to or <200m from forest patches >75 tC/ha and >100 ha in size
- Any forest patches between 10-100 hectares in size and considered to be at risk of encroachment (<2 km from villages/towns and <1km from roads) are slated for conservation with mitigation action to ensure adequate protection, unless they have <10 ha of forest >75 tc/ha in which case they are allocated for development.

Note: The outputs of this analysis do not include other HCV areas including dolines (sinkholes), savannah and community use areas, all of which were identified and demarcated for protection, as necessary, through the standard HCV identification and mapping processes.

3.1.3 Soil carbon

The HCS+ methodology requires soil carbon stocks to be quantified, and that any soils supporting >75tC/ha are protected, including both peat soils and other organic soils. Despite containing both mineral and organic components, organic soils with >20-35% of organic matter can contain as much carbon as pure peat.[4] **Therefore**, **as a precautionary indicator HCS+ recommends protecting all organic soils >15cm in depth.**

As part of their Physical Environmental assessment of the Ndendé concession, TEREA conducted soil surveys to supplement and ground-truth the existing 'Carte pedologique de Ndende a 1:200,000' developed by ORSTOM. The ORSTOM map identifies two main sub-regions in the Ndendé: 1) the Ndendé karst plain and 2) the Ikoundou piedmont plateau. Each of these sub-regions is further divided into three pedological sub-domains. Virtually all of these sub-regions are low-carbon, mineral soils.

The only partial exception is the sub-region 'Buttes gravillonnaires limitant les dolines et effondrements' (UC23), which is reported to contain 10-20% organic matter. However, this falls below the 20% threshold suggested by the HCS+ methodology and furthermore, the soil field surveys indicate that these soils are only found in low-lying depressions near wetland areas and in dolines . **These higher-carbon soil areas will be almost entirely protected within either wetland protective buffers or unplantable dolines/sinkholes, and so will be not be developed.**

Refer to annex 1, soil map.

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[3] Note that whenever patch size is referred to from here on in the document this refers to the core area, not total size of the patch. Core area is calculated as the area >100m from the patch edge.

[4] Part 2, Section 3.2, Page 31: The High Carbon Stock Study: Independent report from the Technical Committee

3.1.4 Above-ground carbon and biomass mapping

As stated above, above-ground biomass for the Ndendé concession was mapped based on LiDAR-derived biomass maps (100m resolution), as provided by Sotrader. Full details of the methodology used to develop this map can be found in HCS+ Gabon case study,[5] but a summary is provided here:

- Map derived from airborne LiDAR collected using a Leica ALS 60 sensor mounted on a Cessna 402 aeroplane,
- Canopy Height Model (CHM) developed based on LiDAR derived Digital Terrain Models and Digital Surface Models (spatial resolution of 2m),
- LiDAR outputs were calibrated based on georeferenced, forest inventory surveys conducted by the Gabon National Park Agency (ANPN), in a neighbouring, but biophysically similar forest-savannah area about 200 km to the northwest of the Ndendé concession. The inventories measured all trees with a DBH >10 cm,
- Field AGB values per tree were then correlated with the LiDAR point cloud using a point-density corrected, quadratic mean canopy profile height (QMCH) regression model. This was used to develop a 5m resolution AGB map that was generalised to a coarser 100m resolution AGB map by Sotrader.
- Carbon estimates, at 100m resolution, were then calculated from the AGB map based on the assumption that biomass has a carbon content of 50%.

The LiDAR derived biomass maps used here calculate all living above-ground biomass, but are calibrated based on field inventories of trees >10 cm DBH. Therefore, the map is considered to represent the above-ground biomass of all living biomass in trees >10 cm DBH, in line with requirements of both the HCSA and HCS+ approaches. This excludes biomass/carbon stored in small trees/saplings, which contributes a negligible amount to AGB in tropical forests,[6] and also deadwood, which is only considered to lead to differences in AGB in forests already above the 75 tC/ha threshold.[2]

3.1.5 Patch analysis

The HCSA patch analysis decision tree[7] was followed to determine which forest areas in the Ndendé concession should be set-aside for protection and from an HCS perspective can be considered for conversion to oil palm. This decision tree was designed as a systematic, evidence-based means of selected patches of viable forest for protection. It is based on core principles of conservation science such as patch size, vegetation quality, edge effects, connectivity and risk of encroachment.

The main thresholds used in the decision tree are stated in section 0 above. The only methodological deviation from the HCSA decision tree followed here for the Ndendé concession was in Step 7 'Risk Assessment', whereby proximity to rivers was *not* considered a risk factor in the Ndendé concession. This change was made in light of the unusual ecological context in the concession whereby virtually all trees are located in a riparian zone/gallery forest. Therefore, it can be argued that proximity to rivers actually increases rather than decreases forest protection. *This is a lesson that should be fed-*

[5] Part 3: Gabon Case Study, Section 5, Page 86: The High Carbon Stock Study: The HCS+ methodology tested on the ground
[6] Chapter four, page 60: The HCS Approach Toolkit: Forest Inventory and Estimation of Carbon Stock
[7] Chapter six, page 80: The HCS Approach Toolkit: HCS Forest Patch Analysis Decision Tree

back to the HCSA steering group as they continue with the planned toolkit revision, and seek to apply the toolkit to new geographic contexts outside of SE Asia.

3.1.6 Carbon accounting for carbon neutral development

The HCS+ methodology requires that oil palm development be carbon neutral or positive at a concession level, as averaged over the plantation lifecycle (25 years for one rotation). Therefore, HCS+ requires carbon accounting to be done for any development seeking to comply with HCS+. The accounting is required to estimate overall carbon balance for the concession across the lifecycle of the first plantation rotation, based on the following (and as shown in Figure 2):[8]

- Consideration only of GHG emissions directly associated with the land. This includes:
  - Carbon losses resulting from clearance of non-HCS forest (<75 tC/ha) or small HCS patches
  - Carbon gains resulting from carbon sequestered in growing oil palms over the plantation lifecycle
  - Carbon gains resulting from carbon accumulated in forest set-asides (HCV or HCS forest) over the plantation lifecycle.

- The baseline used under HCS+ is what is assumed to have occurred had there not been an oil palm plantation, which is assumed to be zero emissions. HCS+ considers this conservative on the assumption that most tropical forest landscapes are actually degrading over time.

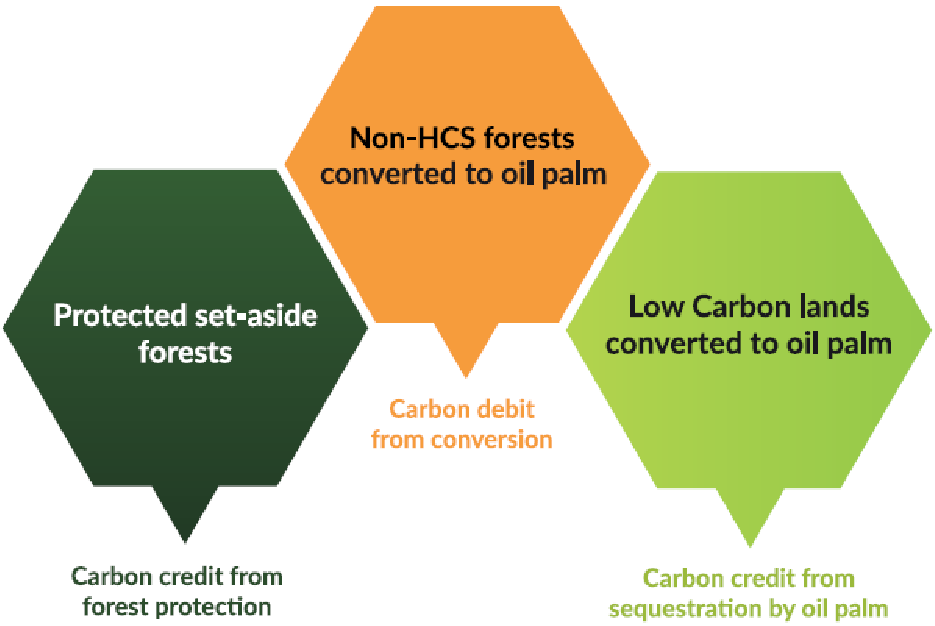

Figure 2: Schematic of carbon neutral development under HCS+ (source: HCS+ Independent Expert Report)

[8] Part 2, Section 3.4, Page 34: The High Carbon Stock Study: Independent report from the Technical Committee

In this assessment we followed the above as far as possible, based on the HCS+ Independent Expert Report and also the methodology used for the Gabon Case Study, for example, following aspects of the workflow used in the Gabon Case Study (Figure 12). Although HCS areas were identified following the HCS approach decision tree. Specific aspects of the accounting were as follows:

- Aboveground carbon stocks in existing vegetation prior to conversion were calculated based on the 100 m resolution AGB map outlined above. This map was used to calculate carbon losses resulting from conversion of non-HCS or non-viable patches,
- Carbon accumulation in oil palms was estimated to be 30 tC/ha over the plantation lifecycle, as outlined in the HCS+ report,
- Two different carbon accumulation rates ('High' and 'Medium') were used for set aside forests in line with the HCS+ study. The high rate used was 2.5 tC/ha/year (62.5 tC/ha/lifecycle) and the medium rate was 1.5 tC/ha/year (37.5 tC/ha/lifecycle),
- There was assumed to be no carbon accumulation in non-forest (savannah and doline) set-aside areas,
- As recommended in the HCS+ study it was estimated that plantation infrastructure would cover 2.9% of the proposed plantable area. These areas were assumed to result in negligible carbon losses as they are in non-forest locations and no carbon accumulation.

Based on the methodology outlined here we estimated the total carbon balance for the Ndendé concession and mapped areas of protected set-aside (accruing carbon), carbon debit (non-HCS converted to oil palm) and carbon credit (low carbon lands converted to oil palm).

4. Summary of Carbon Stock Assessment

We present here two maps to show firstly, aboveground biomass estimates across the concession and secondly, the final results of the HCS patch analysis, indicating areas for conservation versus development.

Figure 3 clearly illustrates that most above-ground biomass (AGB) in the concession is concentrated strongly in riparian and gallery forest. The majority of the concession consists of herbaceous savannah vegetation which has very low AGB (<10 tC/ha).

Table 1 shows the relative area across the concession in different AGB classes, showing clearly that ~44,000 ha consist of non-HCS forest of <35 tC/ha. Within the riparian and gallery forest there is some variation in aboveground biomass with some more degraded/open forest, particularly in the south-eastern area just north of Ndendé town. This is illustrated as the lightest green colour in Figure , consisting of forest of 35-75 tC/ha and is assumed to represent YRF under the HCS approach and covers 4,491 ha.

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AGB (tC/ha)	Area (ha)
<10	40,964.9
10-35	3,175.7
35-75	4,491.5
75-150	8,648.4
>150	893.4
Total	**58,173.9**

Table 1. Area (ha) of vegetation in different AGB classes, based on 100m resolution biomass map

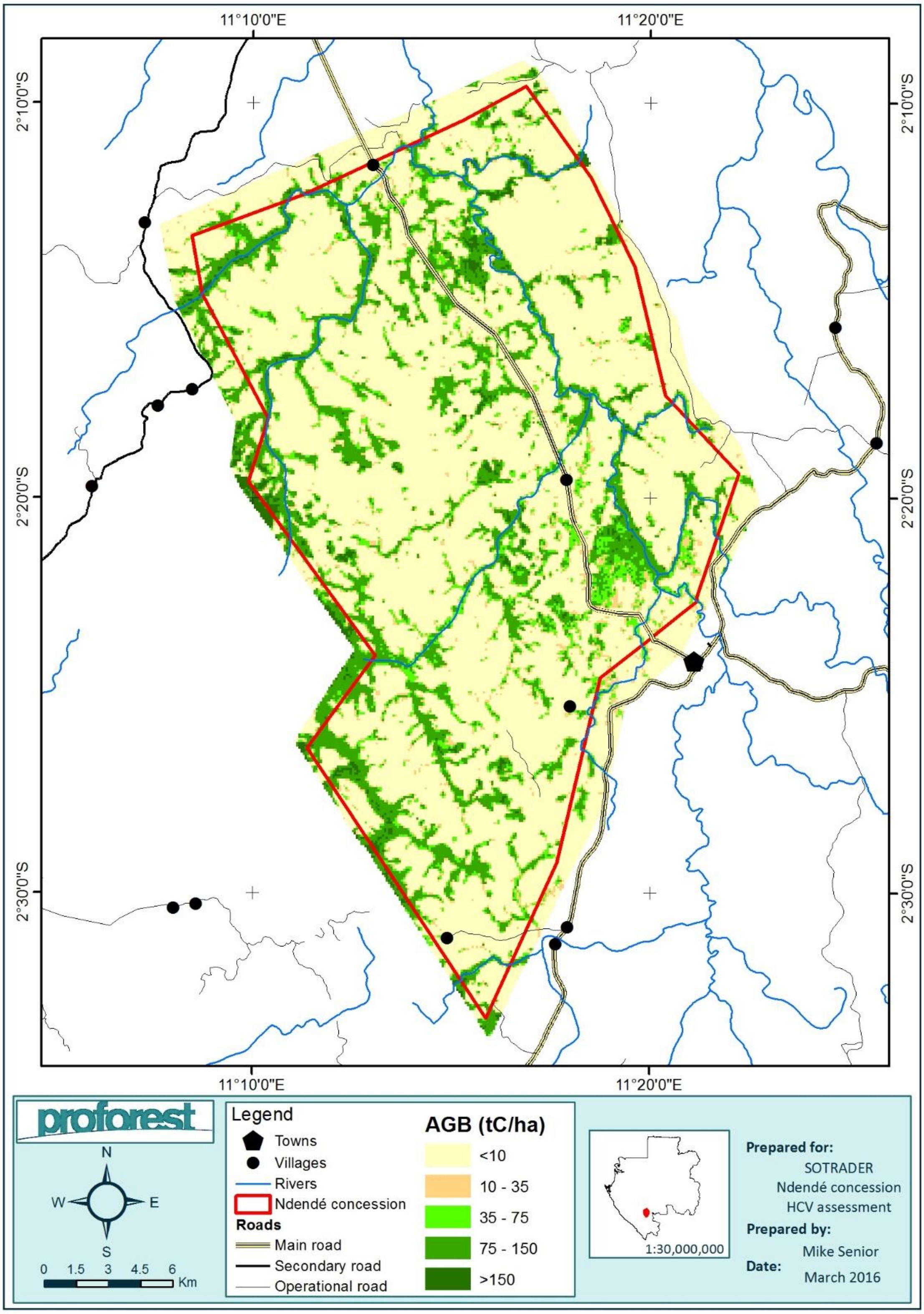

Figure 3. Above-ground biomass map for the Ndendé concession, with biomass shown in tonnes of Carbon per hectare at 100m resolution.

The AGB map shown in Figure was used as the basis for the HCS patch analysis, the results of which are shown in Figure 4. The patch analysis splits HCS forest into 3 clear categories as shown in the map, these are:

- ***HCS areas for conservation ('Conserve')***,
- ***HCS areas for conservation in need of targeted mitigation action ('Conserve with mitigation')***. These areas consist of viable HCS areas that occur within close proximity to towns/villages or roads and hence are considered at high risk of encroachment. Therefore, their protection is considered to be contingent on adequate mitigation measures to prevent encroachment, and
- ***Non-HCS areas for development ('Develop')***

The patch analysis determined that the majority of the riparian and gallery forest in the Ndendé concession should be set aside for conservation, and indeed the majority of this forest (shown in green in Figure 4) is connected, suggesting that it has considerable value for conservation. The areas shown in red ('Develop') consist of small or isolated (non-viable) HCS patches that are allotted for conversion due to their negligible conservation value and viability over time.

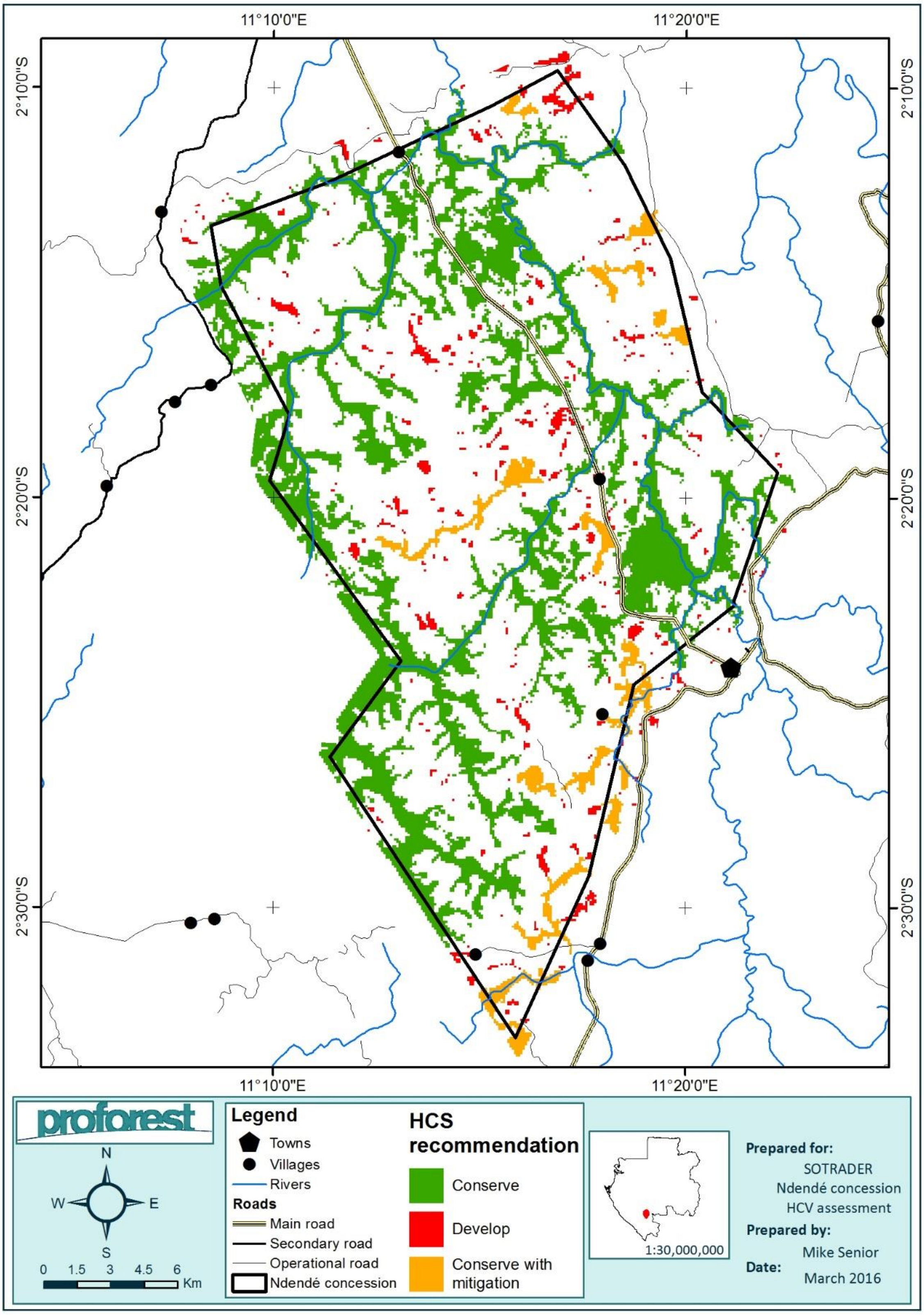

Figure 4. Map of final results of the HCS patch analysis. Only forest areas are coloured on the map, any background white areas are savannah areas open for development unless identified for protection or non-conversion elsewhere (e.g. as HCVs, community land). Of the mapped forest areas, red areas are proposed for development whilst orange and green for protection.

5. Summary of GHG Emission

5.1 Emission from landuse change

The results of the HCS+ carbon accounting estimate that the concession will be highly carbon positive over the course of the plantation lifecycle. These results are illustrated below in Table 2 and Figure 5. This highly carbon positive result occurs when using both the high (2.5 tC/ha/yr) and medium (1.5 tC/ha/yr) carbon accumulation rates.

The highly positive result is explained by the fact that virtually all of the proposed plantable area is on non-forested savannah which currently stores close to zero carbon. Oil palm planting on these areas therefore results in huge carbon gains as a result of carbon accrued in oil palm biomass. There is also estimated to be a substantial carbon gain in the forested set-aside areas, as these areas sequester carbon and regenerate towards later successional status.

	Area (ha)	**Carbon gains (+) and losses (-) [t C]**	
Carbon accumulation rate (tC/ha/yr)		**2.5**	**1.5**
Plantable	*38,671.3 (66.3%)*		
Carbon loss	737.1	-31,319.1	
Carbon gain	36,812.7	+1,090,573.8	
Infrastructure*	1,121.5		
Carbon balance from planting		+1,059,254.7	
Not plantable/set-asides	*19,646.4 (33.7%)*		
HCS or HCV forest	13,410.9	+838,182.0	+502,909.2
Non-forest HCV (mostly savannah)	6,235.5		
Total	**58,317.7**	**+1,897,436.7**	**+1,562,163.9**

**Infrastructure development is expected to occur on savannah areas and hence no carbon losses are assumed.*

Table 2. Summary of carbon losses and gains for the Ndendé concession.

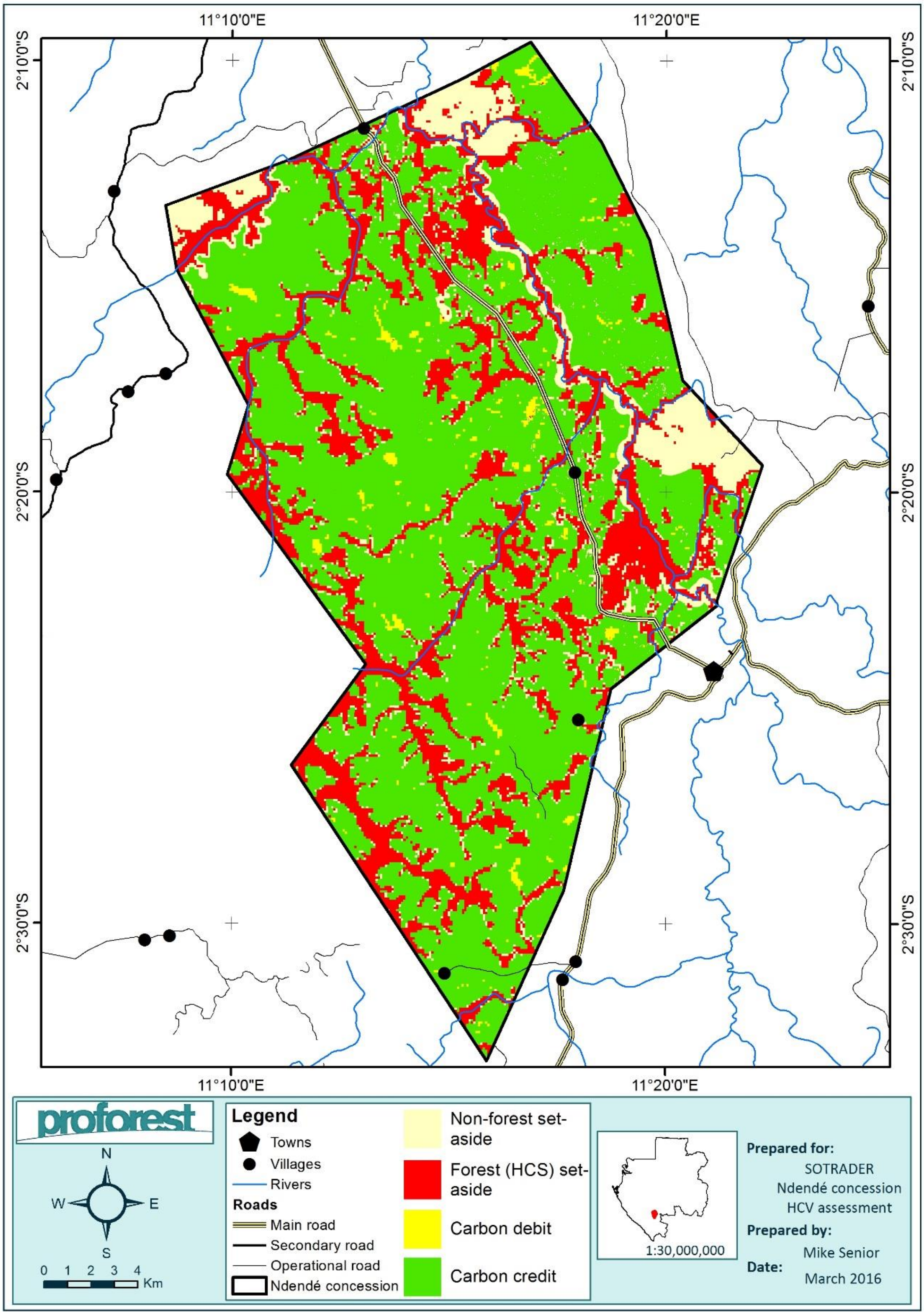

Figure 5. Carbon balance of the Ndendé concession based on HCV and HCS set-asides (excludes HCV 5-6 set asides and community use areas). The pale beige and red areas are set-asides, whereby red areas represent forest (HCS) areas that are expected to accumulate carbon of the plantation life-cycle (according to the HCS+ methodology) but the beige areas are non-forest set-asides, such as savannahs, that are not expected to accrue any carbon. Yellow and green areas consist of the plantable areas (prior to negotiation of HCV5 & 6 areas), with yellow areas those where there will be net carbon losses over the plantation life-cycle (where small, non-viable forest patches will be cleared for planting) and green where there will be net carbon gains over the plantation life-cycle (non-forest areas cleared for planting).

5.2 Emissions from energy use for site preparation operations

38,000 ha has been identified as plantable area, but SOTRADER is targeting to plant up to 30,000 ha in this concessions. The emission calculations from operational activities were made as below:

Project Phase	Source	Quantity	Unit	Emission Factor	Unit	Reference	Total tCO_2eq	Total tC
Land preparation								
Fossil Fuel Use	Road construction	1,260,000	L	83,053	kgCO2eq / TJ	IPCC2006	3,807	1,038
	Planting machineries	1,500,000	L	83,053	kgCO2eq / TJ	IPCC2006	4,532	1,236
	Workers' transport	300,000	L	83,053	kgCO2eq / TJ	IPCC2006	906	247
	Nursery operation	912,500	L	83,053	kgCO2eq / TJ	IPCC2006	752	752
Plantation Maintenance and Harvesting								
Fossil fuel use	Harvesting machineries/ maintenance	15,225,000	L	83,053	kgCO2eq / TJ	IPCC2006	46,002	12,546
	Generator sets	27,375,000	L	74,349	kgCO2eq / TJ	IPCC2006	74,004	20,194
Fertilizer Inputs	NPK (12/12/17)	681,458	T	0.228	tC/t	Ademe, 2012	569,698	155,372
Total Emissions								**191,386**

Fuel the following requirements have been estimated by SOTRADER to the ground and planting preparation phase:

Land Preparation:

- 700 L fuel / km of road is required for road construction or 1, 260, 000 L is estimated for 1800 km

Plantations (30 000 ha planted):
- 50 liters / ha for heavy machines or 1.5 million L in total
- 10 liters / ha for the transportation of personnel or 300 000 L in total

Operation of the nursery:
- 500 liters/day for up to 5 years (using 2 motor pumps for irrigation, 365 days/yr) or 912,500 L

Energy requirements for ground preparation and planting operations were estimated by the company at a total of 3,972,500 L to cover the needs of the project.

Considering an emission factor for combustion "mobile" of diesel of 83,053 kgCO2eq / TJ (IPCC, 2006), a heating value of 0.0428 TJ / t and a density of 0.85 t / m3, we can estimate emissions GHG of this position 12,003t CO2eq (3,273tC).

Plantation Maintenance and Harvesting:

Fuel requirements for the plantation operation were estimated at 20.3 L/ha/ year for plantation maintenance and collection of products is 15,225 million litres for the whole project over 25 years. Regarding the operation of infrastructures, electricity will be supplied by five generators with a capacity of 250 kVA each, or 1250 kVA in total. These generators have a total estimated consumption of 250 l.h-1 diesel, an annual total of 27,375,000 liters of diesel, considering a power generation 12 hours per day. Thus the total consumption is estimated at 25 years to 42.6 million liters.

Considering an emission factor for combustion "mobile" of diesel of 83,053 kgCO2eq / TJ for combustion "stationary" of diesel, 74,349 of kgCO2eq / TJ (IPCC, 2006), emissions can be estimated at 120 046 tCO2eq or 32 740 tC over 25 years.

The inputs used to value the carbon balance are nitrogen fertilizers namely NPK (12.12.17) for nurseries and plantation. The use of other inputs is ignored here because of low volumes and GHG impact potential. The emission factors used for this estimate are those proposed by ADEME (2012) is 1,445 tC / t N; 0.256 tC / t P and 0.139 tC / tK2O. The table below summarizes the expected GHG emissions in the project area on a 25 years rotation.

Thus, the total emission estimated from fertilizer input is 569,698 tCO2eq or 155,372tC during the project duration.

6. Conclusion

The total GHG sequestration related to the project is estimated at **1.13 million tCO_{2eq}** or 45,351 tCO_{2eq}/year average over a rotation of 25 years. Net sequestration of GHG is due to the land selection that prioritizes low carbon stock area and sequestration from HCV/ HCS set aside.

	Area (ha)	**Carbon Gain (+) or Carbon Loss (-)**	
Carbon accumulation (tC/ha/yr)		2.5	1.5
Plantable	30,000		
Carbon loss	737.1	-31,319.1	
Carbon Gain	28,812.7	+853,574.3	
Not Plantable	27,646.4		
HCS or HCV	13,410.9	+838,182.0	+502,909.2
Non forest HCV (mostly savannah)	62,35.5	0	0
Community set aside	8,000	0	0
Subtotal from landuse		**+1,660,437.2**	**+1,325,164.4**

Project Phase	Source	Quantity	Unit	Emission Factor	Unit	Reference	Total tCO_2eq	Total tC
Land preparation								
Fossil Fuel Use	Road construction	1,260,000	L	83,053	kgCO2eq / TJ	IPCC2006	3,807	1,038
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Fossil fuel use	Harvesting machineries/ maintenance	15,225,000	L	83,053	kgCO2eq / TJ	IPCC2006	46,002	12,546
	Generator sets	27,375,000	L	74,349	kgCO2eq / TJ	IPCC2006	74,004	20,194
Fertilizer Inputs	NPK (12/12/17)	681,458	T	0.228	tC/t	Ademe, 2012	569,698	155,372
Subtotal from operations								**191,386**
Total emission/ sequestration from development							**1,469,051.2 *(estimate 2.5 tC/ha/yr from sequestration)***	**1,133,778.4 *(estimate 1.5 tC/ha/yr from sequestration)***

7. Management and Mitigation Plans

Due to site selection, Ndende will be a net sequestration project. In general, Olam has committed **NOT to develop on peatlands and high carbon stock fores**t determined through a multistakeholder process in key origins.

Other measures will be implemented to limit emissions of certain factors (complementing the compensation made by plantations):

i. To limit site preparation to an absolute minimum, promote site restoration in highly degraded areas and to avoid swampy areas as far as possible;

ii. To quickly re-use the biomass residues (energy biomass, timber, etc.);

iii. Limit consumption of generators operating the site. An alternative being studied by Olam Palm Gabon to limit such emissions is to connect to the electricity distribution network;

iv. Avoid losses and unnecessary consumption by ensuring regular maintenance of equipment and optimizing travel;

v. To rehabilitate the infrastructure areas to allow for restoration of the natural environment at the end of the project.

vi. Continue to measure, disclose, manage greenhouse gas emissions reductions through Carbon Disclosure Project (CDP).

8. Internal Responsibility

Summary of planning and management of Ndende, including mitigation of emission impacts has been signed off by respective person in-charge and it is submitted as part of the NPP notification.

Organizational information and personnel involved in planning and implementation are presented below:

Contact Persons	Position	Entity
Supramaniam Ramasamy	President, Global Head of Plantation	Olam International Ltd
Gagan Gupta	Country Head	Olam Gabon
Faizal Mohd	Head of Sotrader	Sotrader
Christopher Stewart	Head, Environment and Sustainable Development	Olam Gabon
Quentin Meunier	ESIA Manager	Sotrader
Olivier Desmet	CRS Manager	Olam Gabon
Audrey Lee	Sustainability Manager	Outspan Malaysia Sdn. Bhd.

The plantations management is structured according to various roles and functions to ensure implementation of best agronomic, environmental, social practices and monitoring of ESMP, HCV management, social contract etc. Each of these divisions/ unit is managed by a manager, and assisted by assistant managers or executives.

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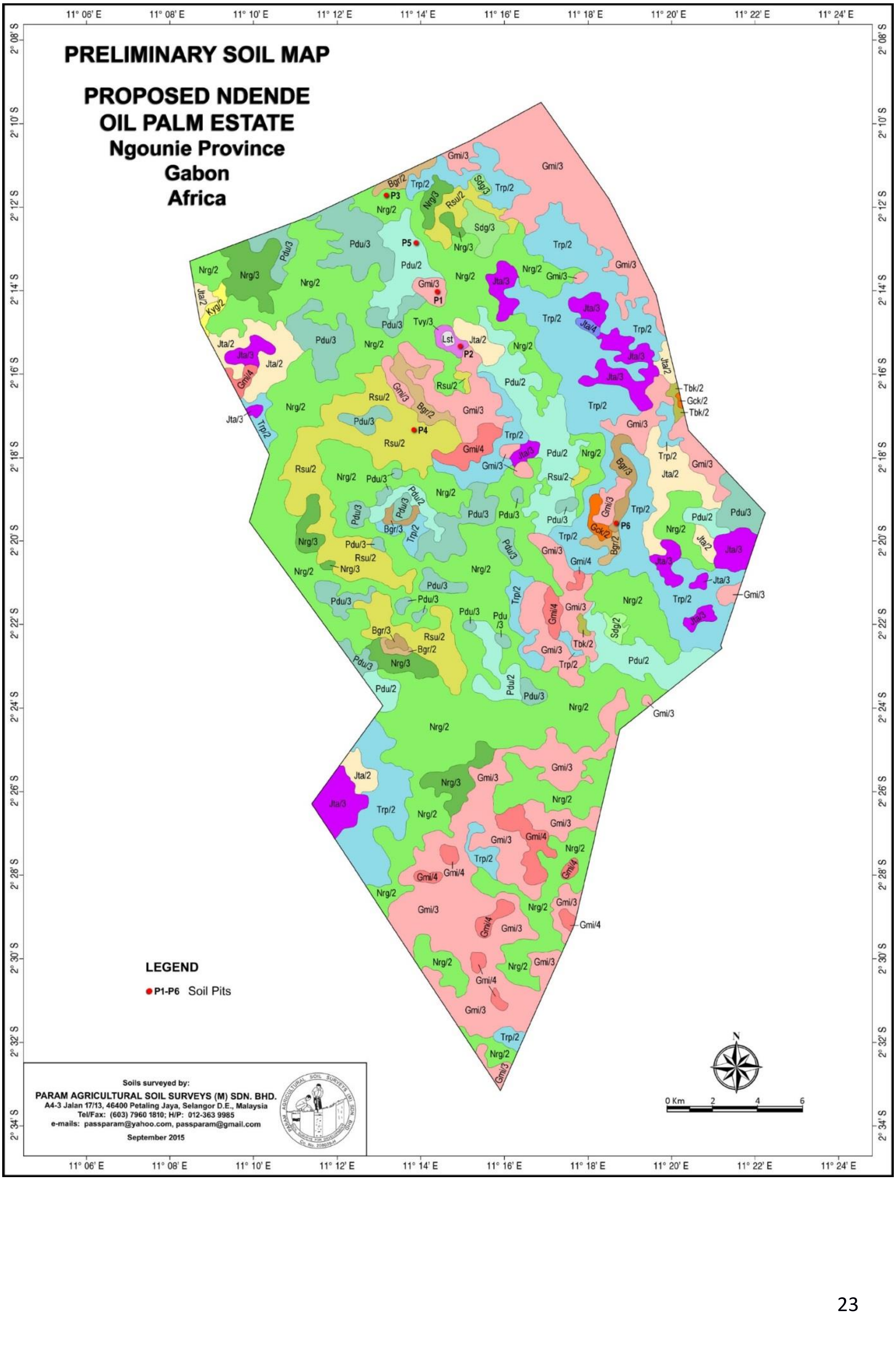
Annex 1 Soil Map



PRELIMINARY SOIL MAP LEGEND

PROPOSED NDENDE OIL PALM ESTATE

Ngounie Province, Republic of Gabon, Africa

Parent Material	Map Symbol	Soil Series	Slope Class (%)	Description	Extent	
					Ha	%
Sedimentary rocks	Bgr/2	Bungor	Undulating (4-12)	Deep (>100 cm) yellowish brown to strong brown fine sandy clay. Moderate medium subangular blocky; friable to firm. Patchy clayskins (kandic). Well drained. Soils developed over sedimentary rocks.	563.2	1.0
	Bgr/3		Rolling (12-24)		336.1	0.6
	Sdg/2	Serdang	Undulating (4-12)	Deep (>100 cm) brownish yellow fine sandy clay loam. Weak fine and medium subangular blocky; friable. Thin patchy clayskins (kandic). Well drained. Soils developed over sedimentary rocks.	102.3	0.2
	Sdg/3		Rolling (12-24)		327.3	0.6
Pediments	Gmi/3	Gajah Mati	Rolling (12-24)	Shallow (<50 cm) gravelly clay. Yellowish brown to strong brown; weak medium subangular blocky; friable. Patchy clayskins. Stones consist of subangular petroplinthite gravels. Well drained. Soils developed over pediments (P) surface. Larger boulders may be present on the soil surface.	2,303.7	3.9
	Gmi/4		Hiily (24-38)		140.7	0.2
	Tvy/3	Tavy	Rolling (12-24)	Moderately deep (50-100 cm) yellowish fine sandy clay over gravelly clay below 50 cm depth. Moderate medium subangular blocky; friable. Patchy clayskins. Gravels consist of subangular petroplinthite gravels and stones. Well drained. Soils developed over pediment (P).	97.0	0.2
	Jta/2	Jitra	Undulating (4-12)	Shallow (<50 cm) gravelly clay. Strong brown to brownish yellow; weak medium subangular blocky; friable. Patchy clayskins. Stones consist of	2,059.0	3.5

Parent Material	Map Symbol	Soil Series	Slope Class (%)	Description	Extent	
					Ha	%
	Jta/3		Rolling (12-24)	subrounded petroplinthite gravels. Well drained. Soils developed over pediments (P_3) surface.	10,758.2	18.4
	Jta/4		Hiily (24-38)		1,222.6	2.1
	Trp/2	Terap	Rolling (12-24)	Moderately deep (50-100 cm) yellowish brown to strong brown. Fine sandy clay to 70 cm over stony clay. Moderate medium subangular blocky; friable. Patchy clayskins. Stones consist of subrounded petroplinthite (lateritic) gravels. Well drained. Soils over Pediments (P3).	8,178.3	14.0
	Pdu/2	Pedu	Undulating (4-12)	Shallow (<50 cm) gravelly loam. Strong brown to brownish yellow; weak medium subangular blocky structures; friable. Patchy clayskins. Stones consist of subrounded petroplinthite gravels. Well drained. Soils developed over pediments (P3) surface.	3,709.1	6.4
	Pdu/3		Rolling (12-24)		3,882.0	6.6
	Nrg/2	Nerang	Undulating (4-12)	Moderately deep (50-100 cm) brownish yellow to strong brown fine sandy loam to over 50 cm overlying a dense thick (>25 cm) gravelly clay. Gravels consist of rounded and subrounded petroplinthic gravels. Weak medium to fine structure; friable; patchy clayskins. Within 100 cm soil is variegated. Moderately well drained soil on Pediment (P_3) surfaces.	19,007.0	32.5
	Nrg/3		Rolling (12-24)		1,624.7	2.8

Annex 2 HCV Map