Review of the *Pterocarpus erinaceus* NDF of Ghana, Mali and Sierra Leone, based on the elements of Module 10 of CITES

Module 10

1. What is in this module?
2. Forest management principles relevant to NDFs for CITES-listed tree species
3. Formulating NDFs for CITES-listed tree species
4. References

Annex 1: Supporting information sources for formulating NDFs for tree species

Annex 2: Historical background on formulation of NDFs for tree species in the context of CITES

Module 10

1. What is in this module?
2. Forest management principles relevant to NDFs for CITES-listed tree species
3. Formulating NDFs for CITES-listed tree species
4. References
Annex 1: Supporting information sources for formulating NDFs for tree species
Annex 2: Historical background on formulation of NDFs for tree species in the context of CITES

1. Forest Management Plan (FMP): (i) **The strategical or long-term plan**, (ii) **The tactical management plan**, (iii) **The operational plan**
2. Forest Inventory: (i) **National forest inventories**, (ii) **FMU level inventory**, (iii) **Annual cutting plot inventory**
3. Class distribution of tree species populations
4. Regeneration of tree species populations
5. Minimum Felling Diameter (MFD)
6. Rotation cycle
7. Annual Allowable Cut (AAC)
8. Silviculture
9. Harvest techniques
10. Conversion of standing tree volume to timber specimens or wood product

Module 10

1. What is in this module?
2. Forest management principles relevant to NDFs for CITES-listed tree species
3. Formulating NDFs for CITES-listed tree species
4. References
Annex 1: Supporting information sources for formulating NDFs for tree species
Annex 2: Historical background on formulation of NDFs for tree species in the context of CITES

The formulation of an NDF for a CITES-listed **tree species requires as a minimum**:

1. **Inventory data** for the species

2. **Management** of the **area** from **where the species is harvested for export**: demonstrating provisions for **sustainable management** as a **prerequisite for determining that export will be non-detrimental**

3. **Monitoring** of **species harvesting** and **timber** and other wood product exports

Ghana's NDF on *Pterocaprus erinaceus* Module 10 of CITES

Module 10: Linking NDFs to SFM components (Ghana NDF)

Mark boundary and Map ~~concession~~ area

- Define area for which an NDF is applied
  - Describe the physical features of the entire ~~concession~~ area.
  - Define the distribution and amount of timber and other wood product that can be sustainably harvested.

Module 10: Linking NDFs to SFM components (Gha

Mark boundary and Map ~~concession~~ area

- Define area for which an NDF is applied
  - Describe the physical features of the entire ~~concession~~ area.
  - Define the distribution and amount of timber and other wood product that can be sustainably harvested.

✓ A total of **twenty-six political districts** were selected for the field assessment, based on a review of **past inventories and interviews with the district forestry staff**

✓ The selected **districts were mapped** by the Mapping and GIS Unit at the Resource Management Support Centre **to assist field teams in distributing sampling plots** (DF-PC27-15-03).

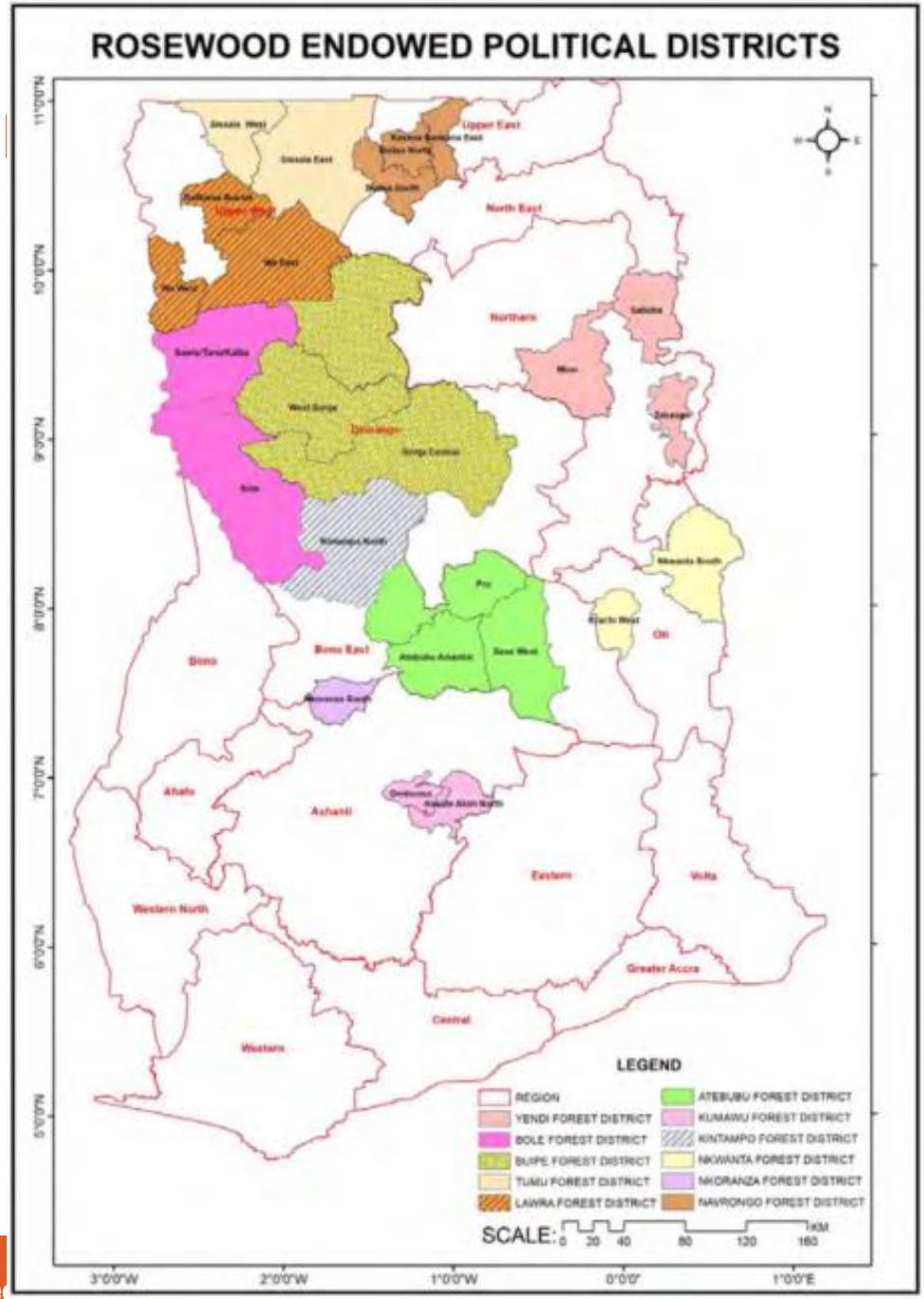


Figure 5 Spatial distribution of rosewood endemic districts

Module 10: Linking NDFs to SFM components (Ghana NDF)

Transparent tenure and access rights

- Factor in reducing illegality & the risk of land conversion, which are considerations in NDF development
  - An important condition for sustainable forestry is maintaining the integrity of the forest estate by protecting the area from incursion and conversion

Not explicitly mentioned in the NDF but there was : a Ban on rosewood exploitation in 2019

➔ **harvesting, transporting and export of Rosewood except stocks of salvage and confiscated**
rosewood auctioned

➔ The forest act requires a **management plan** which shall **identifying appropriate management zones including zones to be devoted to protection**

Module 10: Linking NDFs to SFM components (Ghana NDF)

Inventory forest and environment

- Essential for species for which NDF is required.
  - Forest inventory must be completed before full-scale harvesting is approved. Environmental inventory allows for the protection and management of the entire area and its resources.

Sampling procedures (4.4 page 10) describes the plot size and shape, the sampling intensity, the plot location and demarcation and enumeration (page 10-11)

Module 10: Linking NDFs to SFM components (Ghana NDF)

Inventory forest and environment

- Essential for species for which NDF is required.
  - Forest inventory must be completed before full-scale harvesting is approved. Environmental inventory allows for the protection and management of the entire area and its resources.

Sampling procedures (4.4 page 10) describes the plot size and shape, the sampling intensity, the plot location and demarcation and enumeration (page 10-11)

National inventories

- New inventory (August 2022) involving desk studies (reports, maps and field measurements)
- 40m x1000m rectangular plots in rosewood endemic areas across 36 political districts (Figure n°1)
- Trees over 10cm in diameter were measured
- Sapling between 2 to 9,9cm were also recorded.

Forest management inventories

- Describing the area, specifying boundaries, ownership of the land, and the status of forest and wildlife resources

Annual cutting plot inventories

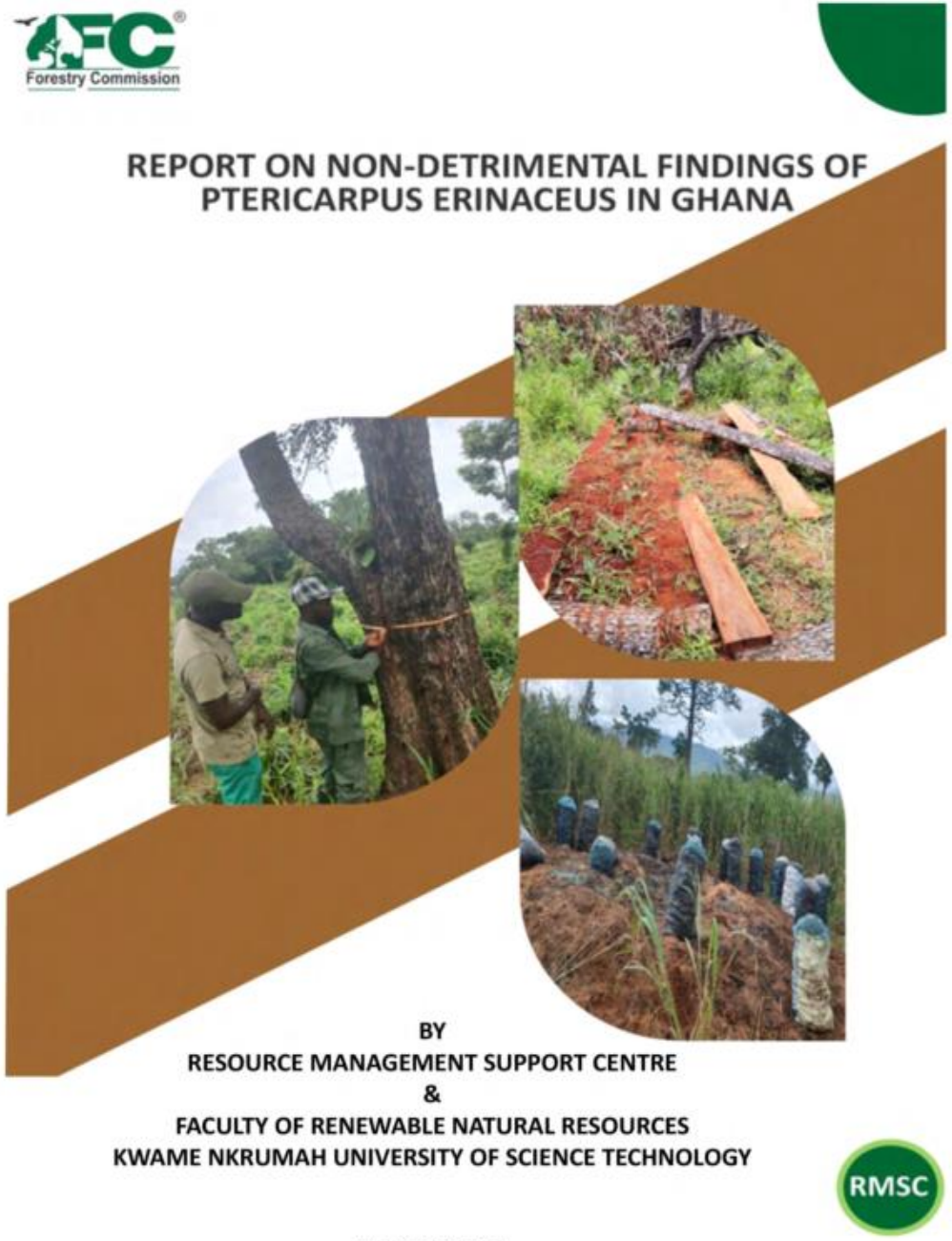
- Marking trees with number in accordance with the logging manual (Timber resource management and legality licensing regulations, 2017 and Trees and Timber Act, 1974).

Module 10: Linking NDFs to SFM components (G

Develop forest management plan

- Important for sustainability of species and maintenance of its role in the ecosystem
  - Management plan can be considered a major source for making an NDF. The better the forest management plan, the easier it will be to formulate an NDF.

Chapter 7 & 8 mention the restoration and plantation program, but the silvicultural methods were not described.



Module 10: Linking NDFs to SFM components (Gh

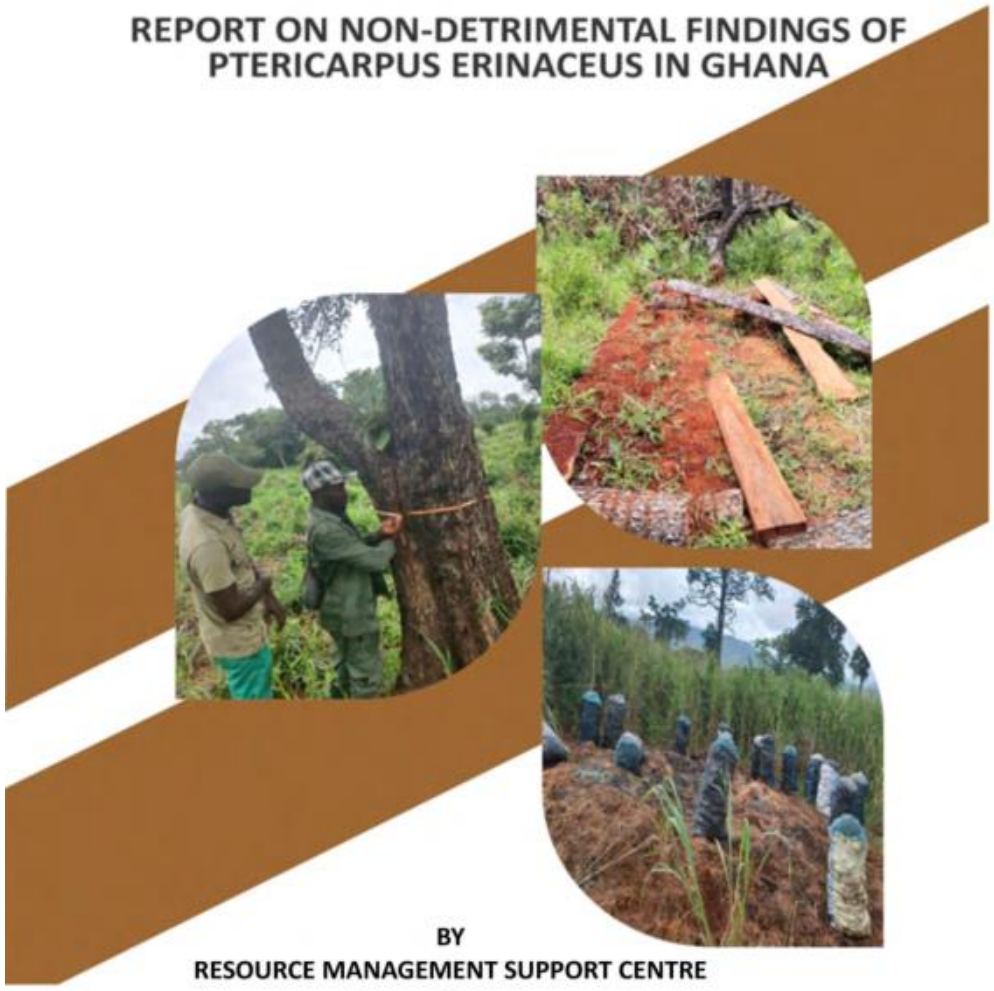
Plan transport infrastructure

- Relevant for maintenance of the role of the species in the ecosystem.

Persisting infrastructure improves access and by this increases the risk of illegal logging activities but improves the likeliness that proposed silvicultural measures planned over years and post-harvest monitoring takes place.

Not mentioned in NDF but normally, included in the Timber Utilization Contract (TUC), a strategic plan within a time framework of **20 years** and the tactical management approved for **5 years**

➔ Specific to concession model



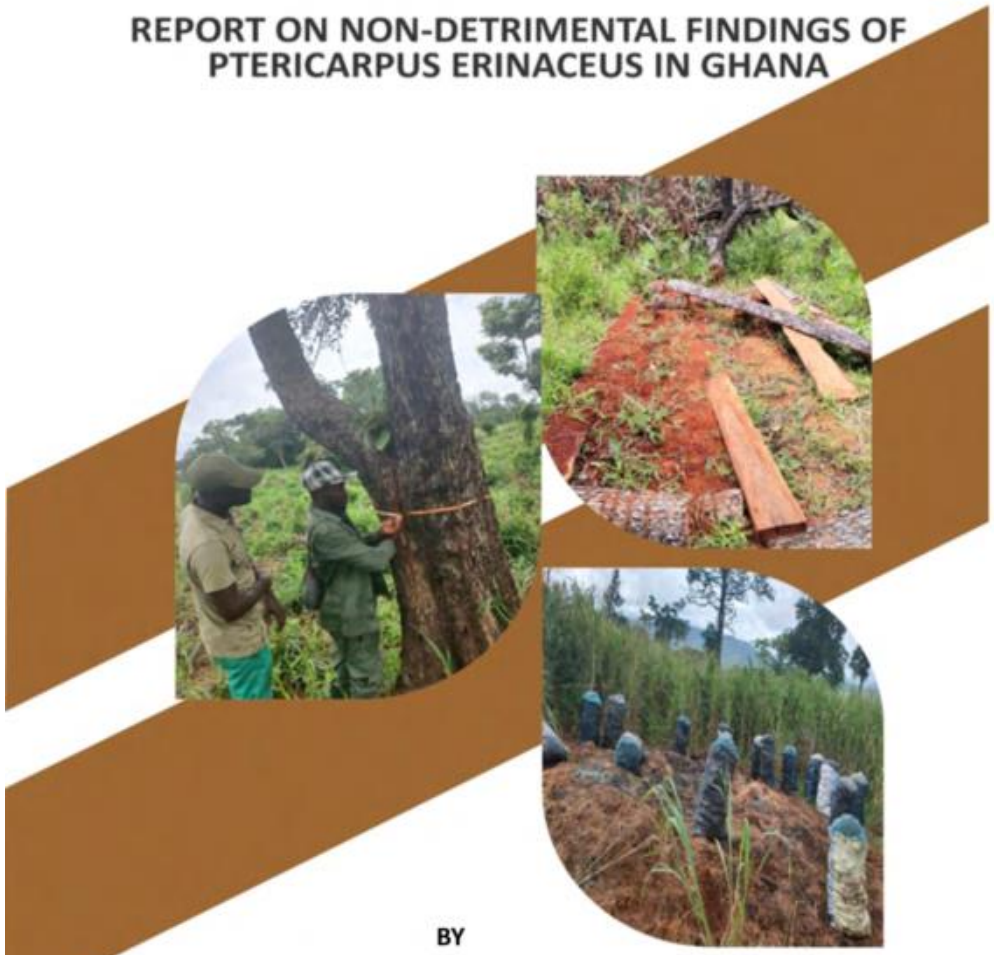
Module 10: Linking NDFs to SFM components (Gh

Develop forest use plan

- Important in relation to wood conversion and to likelihood of fraud

Not mentioned in NDF but normally, included in the Timber Utilization Contract (TUC), a strategic plan within a time framework of **20 years** and the tactical management approved for **5 years**

➔ Specific to concession model



Module 10: Linking NDFs to SFM components (Gh

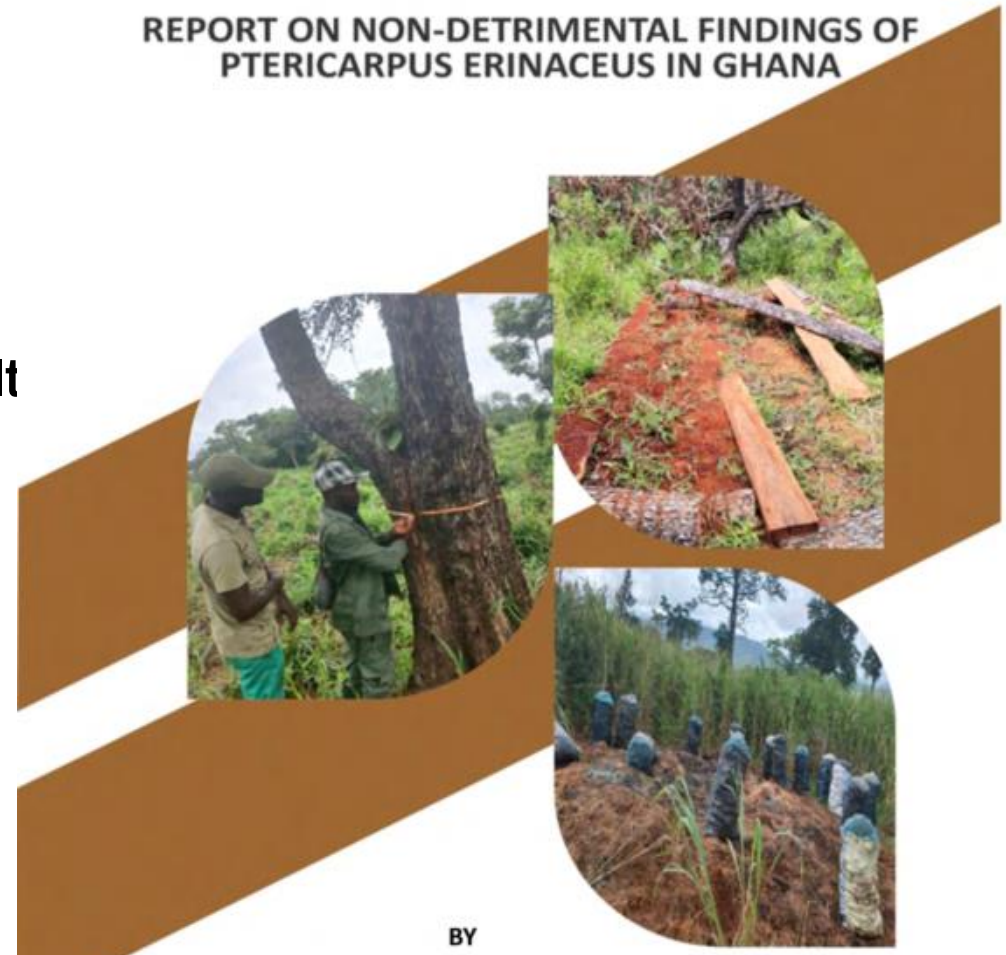
Create social and community development plan

- Incorporation of local and traditional knowledge and participatory species monitoring

The plan should document commitments on the part of the concession holder to community and social development. It is also linked to the forest utilization plan

Not mentioned in the NDF but the social responsibility agreement is a key component of the TUC process which requires a pact between the landowner and communities to honor the rights and respects the social and cultural values

➔ Specific to concession model



Module 10: Linking NDFs to SFM components (Gh

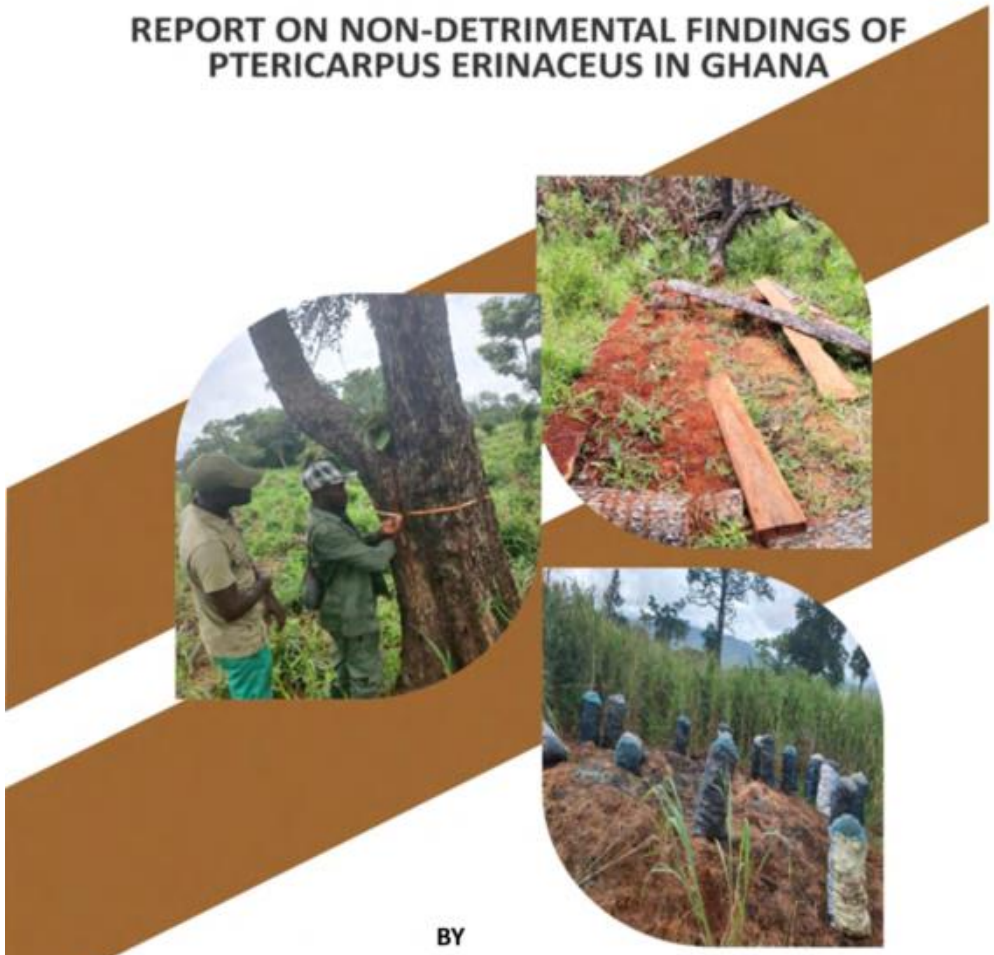
Develop initial annual operating area plan

- Harvesting plan essential for NDF formulation

The initial operating area plan should include a logging plan layout on the ground and marking of trees. After these are completed and approved by the forest administration, harvesting can begin.

Not mentioned in the NDF but an harvesting plan exists and shall be drawn up with the logging manual (Timber resource management and legality licensing regulations).

➔ Specific to concession model



Module 10: Linking NDFs to SFM components (Gh

Annual harvesting and postharvest silviculture

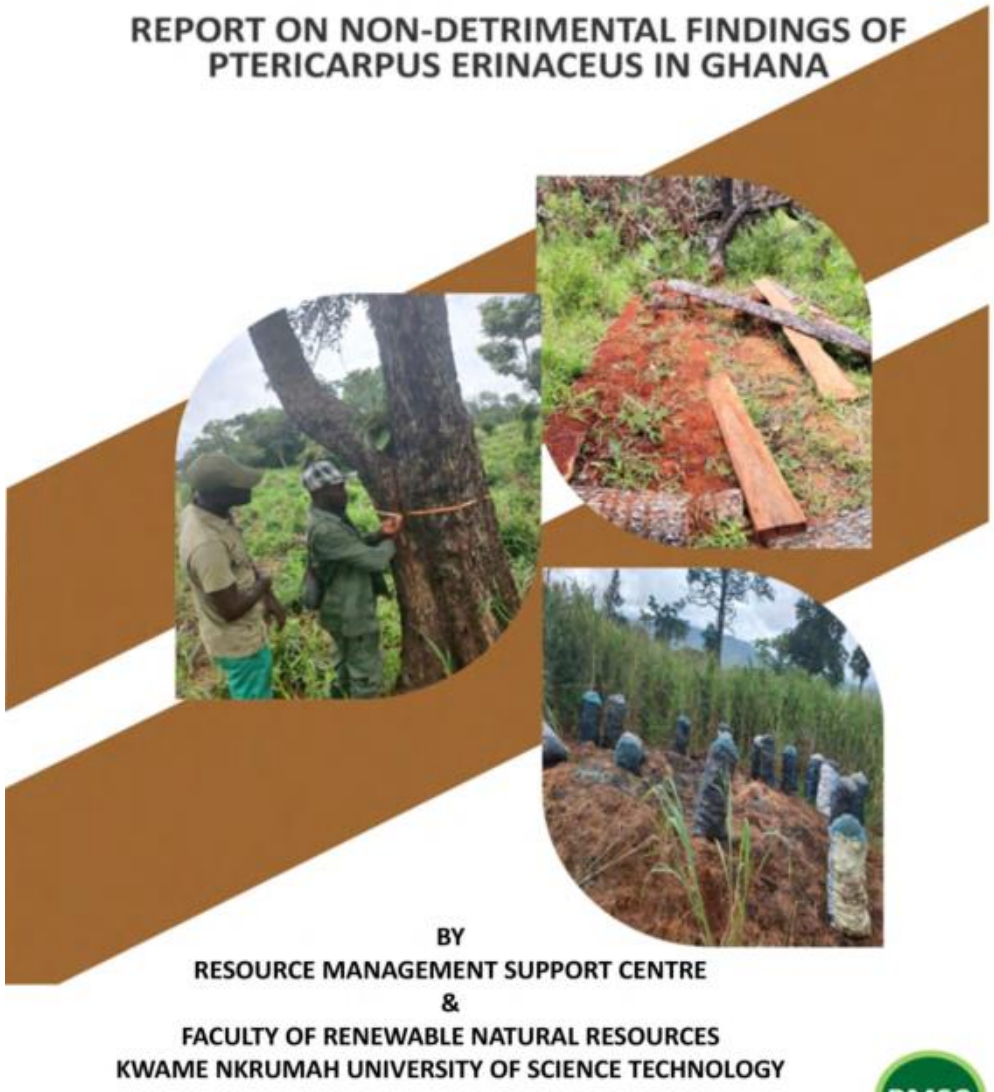
- Actual harvested volume on an annual basis is essential for NDF formulation.

~~Concession~~ holder develops annually operating area plans that, when approved, allow annual harvesting of areas.

~~Concession~~ holder also conducts required post-harvest silviculture

Not mentioned in the NDF but an harvesting plan exists and shall be drawn up with the logging manual (Timber resource management and legality licensing regulations).

➔ Specific to concession model



Module 10: Forest management principles in Ghana NDF

Class distribution and regeneration of tree species population

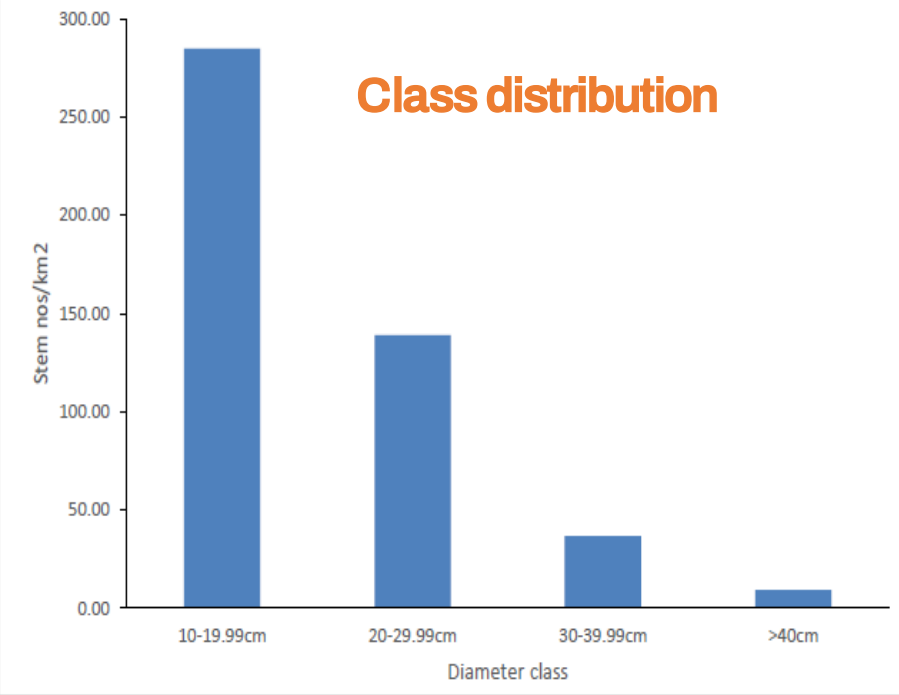


Figure 7 Mean stem number per km2 diameter class distribution for all the political

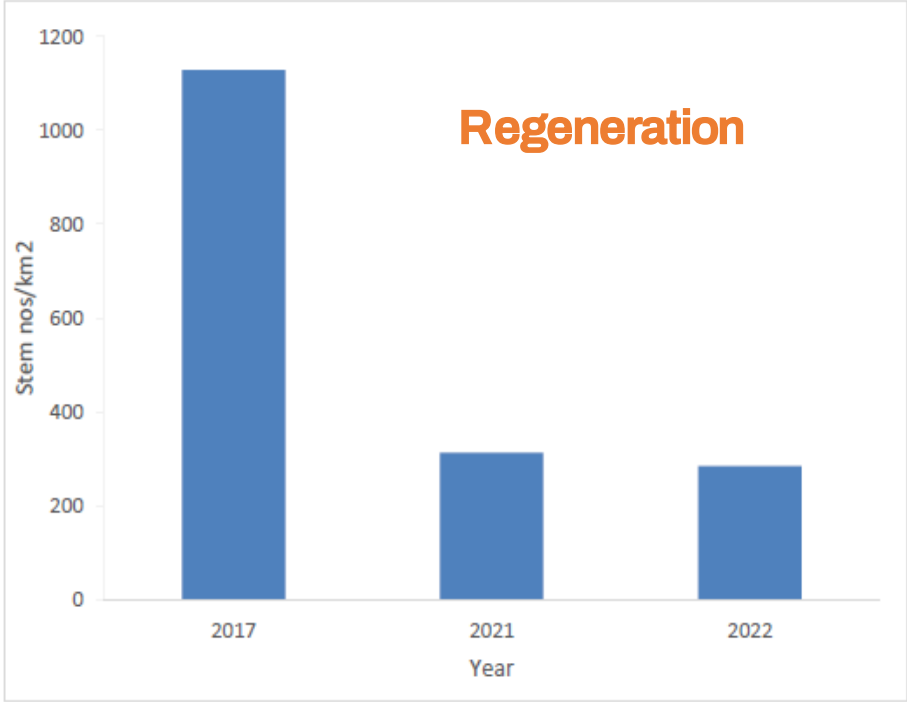


Figure 8 Natural regeneration per km2 across all the districts

A typical negative exponential curve
Most recorded trees were belowcm dbh, with % of trees in the 10-19,9cm diameter class

Good regeneration, with estimates below 70 stems per km² . A decline rate reduction from 72% (2017-2021) to 9% (2021-2022), indicating the positive impact of conservation measures

Module 10: Forest management principles in Ghana NDF

Recovery rate

Not explicitly stated (NDF-PC27-15-03).

Mortality rate: Not available (NDF-PC27-15-03).

Growth rate: "Additional permanent sample plots should be established to monitor the dynamics of the species and other species of economic importance" (NDF-PC27-15-03).

Module 10: Forest management principles in Ghana NDF

Minimum Diameter of Exploitation (MED) and Rotation Cycle

MED >= 20-29.9cm dbh

Rotation cycle (3 scenarios) :

50,40 and 30 years

Module 10: Forest management principles in Ghana NDF

Annual Allowable Cut

Test Rotation cycle ➡ Adoption 50 years

Table 3 First five Political Districts with the highest proposed felling quota per annum

No.	Political district	Scenario 1 (50years)		Scenario 2(40years)		Scenario 3(30years)	
		Stem nos.	Vol (m^3)	Stem nos	Vol (m^3)	Stem nos	Vol (m^3)
1	East Gonja	4,712.90	2,597.06	5,891.13	3,246.32	7,854.84	4,328.43
2	West Gonja	4,673.10	2,575.12	5,841.38	3,218.91	7,788.51	4,291.87
3	Central Gonja	4,104.03	2,261.53	5,130.03	2,826.92	6,840.04	3,769.22
4	Bole	2,895.95	1,595.82	3,619.94	1,994.77	4,826.58	2,659.70
5	Kintampo North	2,435.82	1,342.27	3,044.78	1,677.83	4,059.70	2,237.11

Conservative annual quota : 23,207.97m^3

Underwater rosewood (Volta Lake)

16 years and felling quota of 40,000m^3 par annum aligning with Revised National Transport Policy (2020), the Volta Lake Strategic Plan (2010 – 2014) and the Draft Volta Lake Master Plan 2014

➡ Total Annual Quota: 63,207.97m^3

Module 10: Forest management principles in Ghana NDF

Sylviculture and harvest technique (2.9 and 2.10)

Enrichment planting

Increasing the population in off-reserve areas by expanding plantation trials in Ghana's savanna and transition zones

Soil treatment

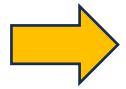
Not explicitly stated (NDF)

Protective measures for single trees

Not explicitly stated (NDF)

Reduced-impact logging

Including detailed mapping of transportation routes and infrastructure



Reducing soil erosion, habitat fragmentation and the overall ecological footprint of the logging operations (TimberTradePortal)

Module 10: Forest management principles in Ghana NDF

Conversion of standing tree volume to timber specimens or wood products

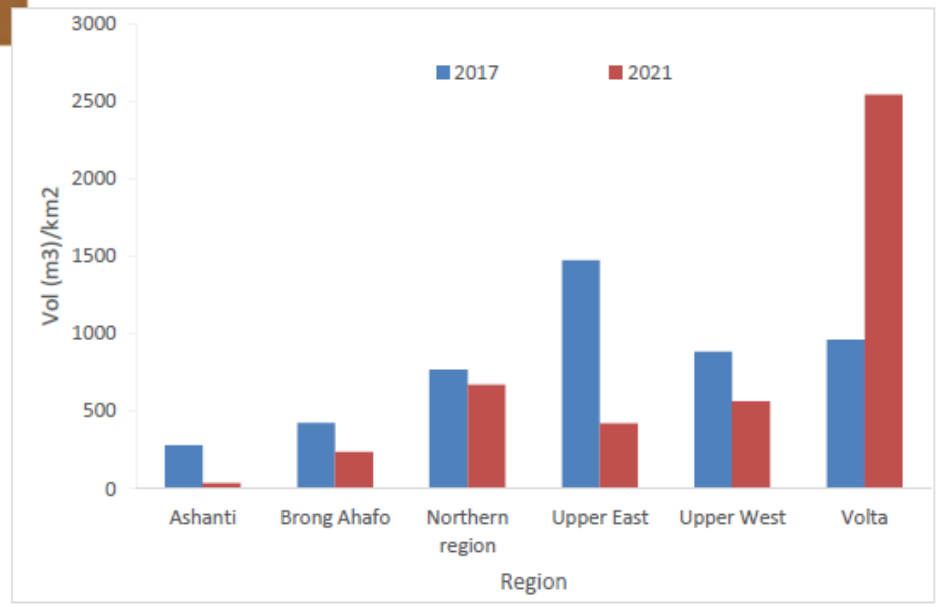


Figure 10 Comparison of volume per km2 of rosewood in 2017 and 2021 for six regions in Ghana

Declining of volume

Total stems (>=20cm dbh)= **5,264,465** stems

A standing volume= **2,900,996.00** m^3

40% of the total stems/volume above the felling limit was retained per Political District **+ 20%** reserved for charcoal production

Module 10: Forest management principles in Ghana NDF

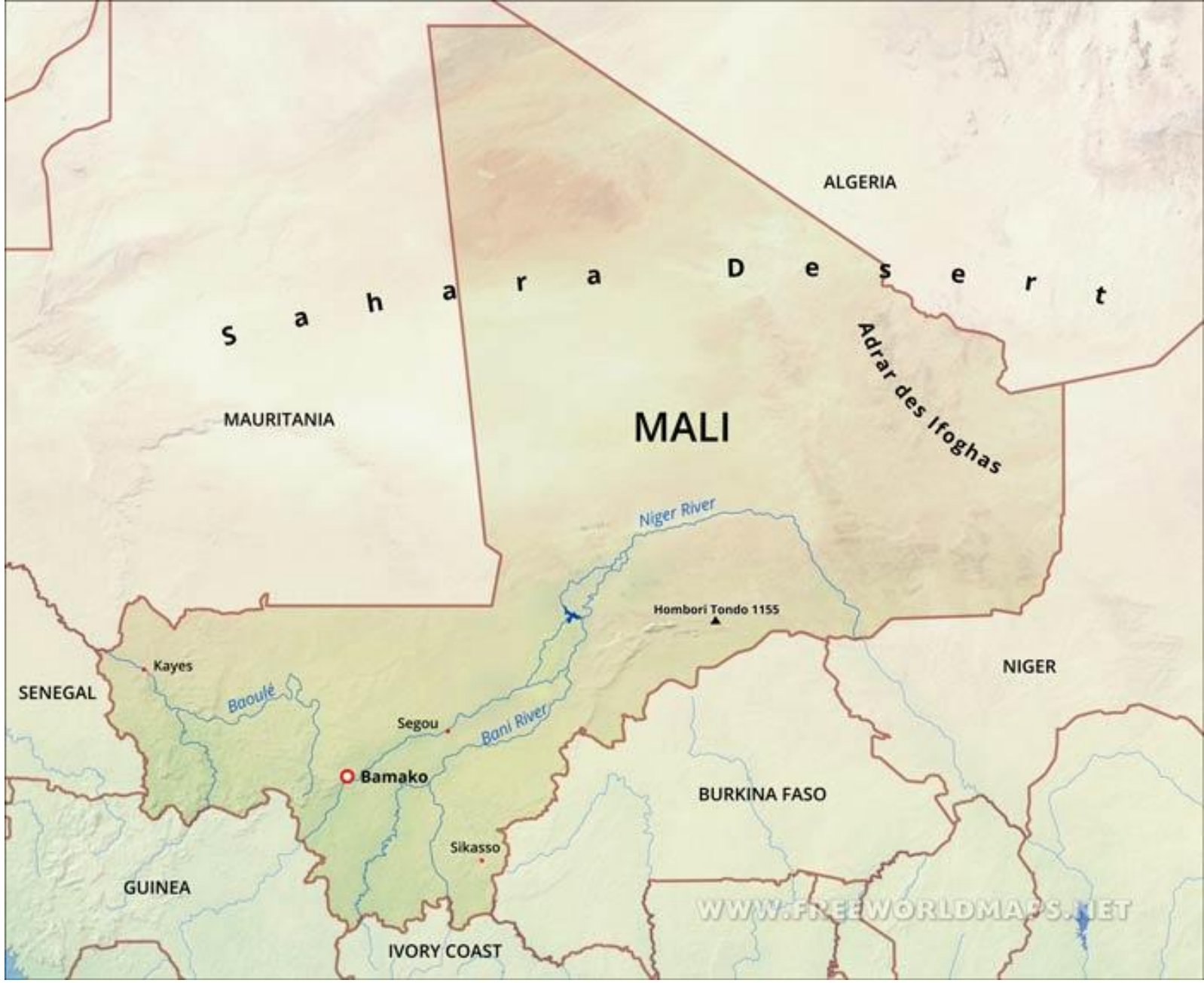
Criteria		
2.2 Forest management plan		
The strategical or long-term plan	The tactical management plan	The operational plan
2.3 Forest inventories		
National forest inventories	FMU level inventory	Annual cutting plot inventory
2.4 Class distribution of tree species populations		
2.5 Regeneration of tree species populations		
2.6 Minimum Felling Diameter (MFD)		
2.7 Rotation cycle		
2.8 Annual Allowable Cut (AAC)		
2.9 Silviculture		
2.10 Harvest techniques		
2.11 Conversion of standing tree volume to timber specimens or wood products		

Module 10: Forest management principles in Ghana NDF

The formulation of an NDF for a CITES-listed tree species requires as a minimum

- ✓**Inventory data** for the **species**
- ✓**Management** of the **area** from where the **species** is **harvested** for export: **demonstrating provisions for sustainable management** as a prerequisite for determining that export will be non-detrimental
- ✓**Monitoring of species harvesting** and timber and other wood product exports

Mali's NDF on *Pterocaprus erinaceus* Module 10 of CITES



Module 10: Linking NDFs to SFM components (Mali NDF)

Mark boundary and Map ~~concession~~ area

- Define area for which an NDF is applied
  - Describe the physical features of the entire ~~concession~~ area.
  - Define the distribution and amount of timber and other wood product that can be sustainably harvested.

Module 10: Linking NDFs to SFM components (Mali NDF)

Mark boundary and Map ~~concession~~ area

- Define area for which an NDF is applied
  - Describe the physical features of the entire ~~concession~~ area.
  - Define the distribution and amount of timber and other wood product that can be sustainably harvested.

Not presented in the NDF

✓ But data were collected in **102 out of 148 forest** areas where managements plans were available

Module 10: Linking NDFs to SFM components (Mali NDF)

Transparent tenure and access rights

- Factor in reducing illegality & the risk of land conversion, which are considerations in NDF development
  - An important condition for sustainable forestry is maintaining the integrity of the forest estate by protecting the area from incursion and conversion

Not explicitly mentioned in the NDF

Decree No 2021-0071 setting out the models for forest management plan which need to include a socioeconomic analysis and an analysis of the flora and fauna.

<u>But the duration of the plan, it's only between 5 and 10 years.</u>

Module 10: Linking NDFs to SFM components (Mali NDF)

Inventory forest and environment

- Essential for species for which NDF is required.
  - Forest inventory must be completed before full-scale harvesting is approved. Environmental inventory allows for the protection and management of the entire area and its resources.

Management inventories were conducted in 148 forest areas with management plans. But the NDF does not present more details.

Module 10: Linking NDFs to SFM components (Mali NDF)

Inventory forest and environment

- Essential for species for which NDF is required.
  - Forest inventory must be completed before full-scale harvesting is approved. Environmental inventory allows for the protection and management of the entire area and its resources.

Management inventories were conducted in 148 forest areas with management plans. But the NDF does not present more details.

National inventories

Inventory conducted in 2014, over 25 years after the reference from the PIRL

669 ha of forest across a total area of 12 108km^3 (with a sampling rate of 1,95 per 1000

Forest management inventories

Inventories in protected areas using systematic sampling
Diameter>= 10cm collected in circular plots with a 20-meter radius
Across 148 forest areas with management plans

Annual cutting plot inventories

"In the recommendations, a geo-referenced logging inventory is demanded to carry out before any logging takes place" (NDF-PC26-16-04).

Module 10: Linking NDFs to SFM components (Mali

Develop forest management plan

- Important for sustainability of species and maintenance of its role in the ecosystem
  - Management plan can be considered a major source for making an NDF. The better the forest management plan, the easier it will be to formulate an NDF.

AVIS DE COMMERCE NON PREJUDICIABLE DE *PTEROCARPUS ERINACEUS* AU MALI

Prof Jean Lagarde BETTI,

+ 237 6 77 30 32 72

Law No 10 states that local authority areas must have a management plan to any exploitation, including economic analysis.
However,
The 22 articles of the decree regulating the exploitation mentions a duration, between 5 and 10 years. It implies a practical plan rather a strategic plan.

Module 10: Linking NDFs to SFM components (Mali

Plan transport infrastructure

- Relevant for maintenance of the role of the species in the ecosystem.

Persisting infrastructure improves access and by this increases the risk of illegal logging activities but improves the likeliness that proposed silvicultural measures planned over years and post-harvest monitoring takes place.

AVIS DE COMMERCE NON PREJUDICIABLE DE *PTEROCARPUS ERINACEUS* AU MALI

Prof Jean Lagarde BETTI,

+ 237 6 77 30 32 72

Not mentioned in NDF but normally, included in the management plans of the area

➔ Specific to concession model

Module 10: Linking NDFs to SFM components (Mali

Develop forest use plan

- Important in relation to wood conversion and to likelihood of fraud

AVIS DE COMMERCE NON PREJUDICIABLE DE *PTEROCARPUS ERINACEUS* AU MALI

Prof Jean Lagarde BETTI,

+ 237 6 77 30 32 72

Not mentioned in NDF but normally, included in the management plans of the area.

However, in the NDF, the 6th recommendations ask to follow the efficiency of management plan which must be elaborated.

➔ Specific to concession model

Module 10: Linking NDFs to SFM components (Mali

Create social and community development plan

- Incorporation of local and traditional knowledge and participatory species monitoring

The plan should document commitments on the part of the concession holder to community and social development. It is also linked to the forest utilization plan

AVIS DE COMMERCE NON PREJUDICIABLE DE *PTEROCARPUS ERINACEUS* AU MALI

Prof Jean Lagarde BETTI,

+ 237 6 77 30 32 72

Not mentioned in the NDF but the Law No 10 mentions a socioeconomic analysis for management plan. However, the NDF does not mention any social impacts or measures.

➔ Specific to concession model

Module 10: Linking NDFs to SFM components (Mali

Develop initial annual operating area plan

- Harvesting plan essential for NDF formulation

The initial operating area plan should include a logging plan layout on the ground and marking of trees. After these are completed and approved by the forest administration, harvesting can begin.

AVIS DE COMMERCE NON PREJUDICIABLE DE *PTEROCARPUS ERINACEUS* AU MALI

Prof Jean Lagarde BETTI,

+ 237 6 77 30 32 72

Not mentioned in the NDF but in the recommendations, a geo-referenced logging inventory is demanded to carry out before any logging takes place.

➔ Specific to concession model

Module 10: Linking NDFs to SFM components (Mali

Annual harvesting and postharvest silviculture

- Actual harvested volume on an annual basis is essential for NDF formulation.

~~Concession~~ holder develops annually operating area plans that, when approved, allow annual harvesting of areas.

~~Concession~~ holder also conducts required post-harvest silviculture

Not mentioned in the NDF but Article 10, Law No10 refers to the obligation to have logging permits, authorizations and certificates of origin.

➔ Specific to concession model

AVIS DE COMMERCE NON PREJUDICIABLE DE *PTEROCARPUS ERINACEUS* AU MALI

Prof Jean Lagarde BETTI,

+ 237 6 77 30 32 72

Module 10: Forest management principles in Mali NDF

Class distribution and regeneration of tree species population

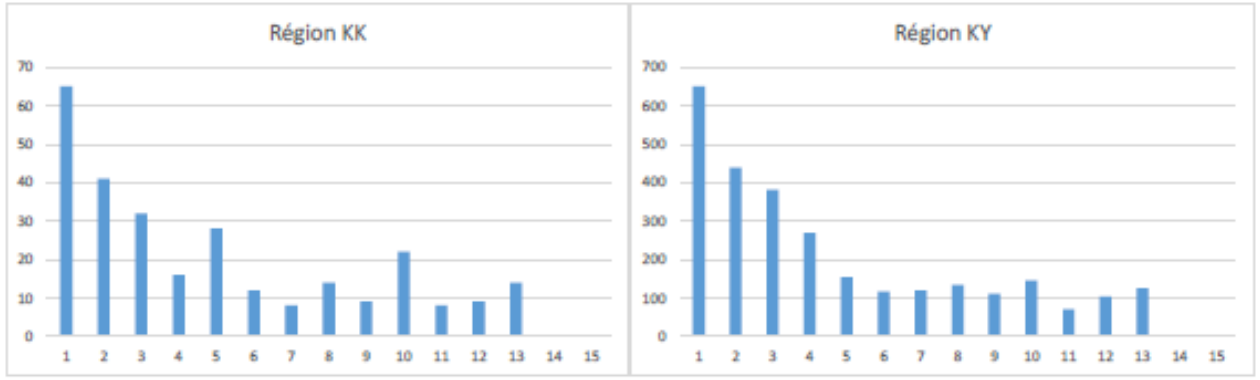


Figure 4a : Structure diamétrique à Koulikoro

Figure 4b : Structure diamétrique à Kayes

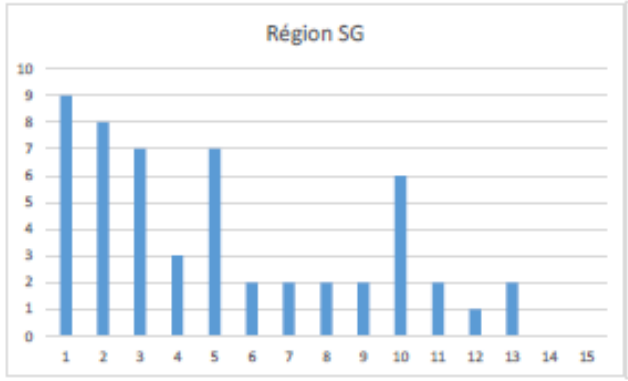


Figure 4c : Structure diamétrique à Ségou

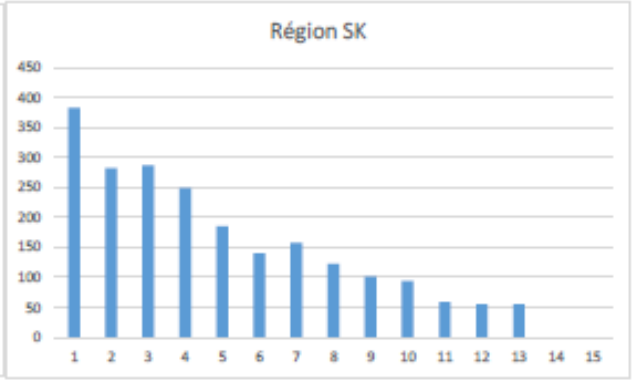


Figure 4. D : Structure diamétrique à Sikasso

Class distribution national inventory 2014

Module 10: Forest management principles in Mali NDF

Class distribution and regeneration of tree species population

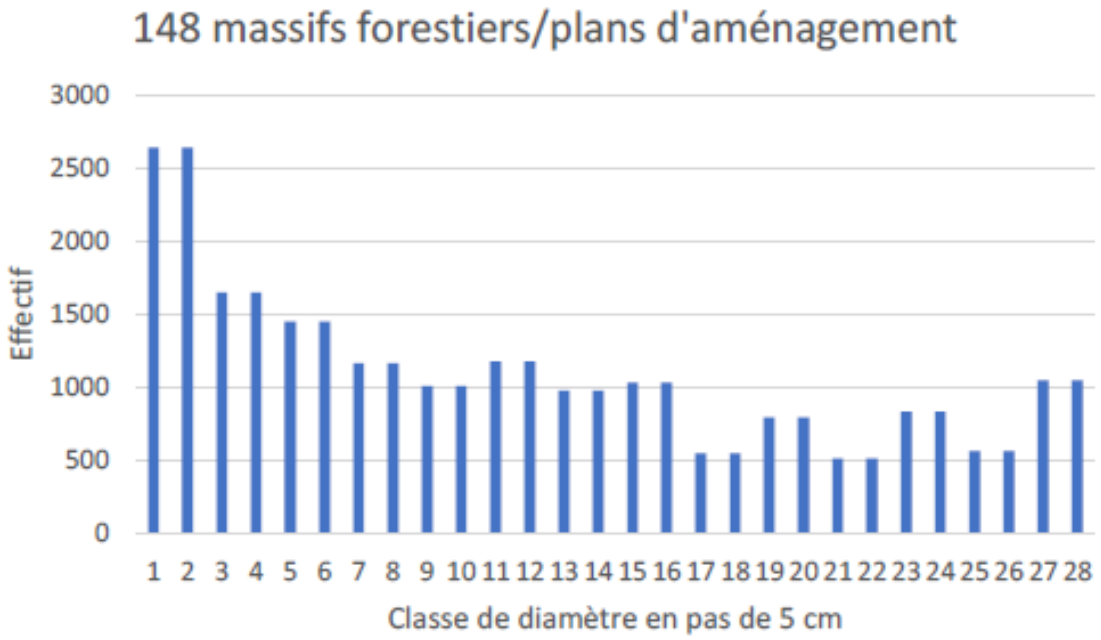


Figure 5. Structure diamétrique de *P. erinaceus* dans 148 massifs forestiers

Class distribution managmented forests

Regeneration well-supported, with an average of 23.6 stems per hectare across the 148 forest

Module 10: Forest management principles in Mali NDF

Recovery rate

"The stems that can be harvested are those between the DMA determined + 3 classes immediately above this diameter. The rest of the stems with a diameter above the DMA+3 are kept as seed trees or seed carriers.

According to Madron (1998), the recovery rate (% Re) is given by :

- **% Re = 100 [No (1- Δ) (1- α)] T/Np . Where: % Re: Percentage recovery of the number of stems harvested**
- **No : Number of trees reconstituted after the rotation time**
- **Δ = Logging damage rate**
- **α = is the mortality rate.**
- **T = Rotation"**

Mortality rate: Fixed at 1% for all diameter classes
Growth rate: 0,4cm/year (No reference).

Module 10: Forest management principles in Mali NDF

Minimum Diameter of Exploitation (MED) and Rotation Cycle

MED >= 25 cm dbh but DFR=25cm

AND

Rotation cycle = from **6 to 10** years

Need to increase the rotation cycle to **12,5 years** and **DMA>=50cm** to estimate the quota

Module 10: Forest management principles in Mali NDF

Annual Allowable Cut

Based on a 12.5-year rotation and a minimum management diameter (MMD) of over 50 cm, the annual harvest quota for the 1032 stands is 65 302.4 m^3, with a quota of 55 384.8 m^3 for wooden planks.

Module 10: Forest management principles in Mali NDF

Sylviculture and harvest technique (2.9 and 2.10)

Enrichment planting	Not explicitly stated.
Soil treatment	Not explicitly stated.
Protective measures for single trees	Not explicitly stated.
Reduced-impact logging	Not explicitly stated.

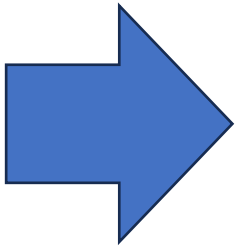
Module 10: Forest management principles in Mali NDF

Conversion of standing tree volume to timber specimens or wood products

STEMS

VOLUMES

SIFOR global tarif
1 foot of timber=0,72m³



An average material yield of 80% was applied, based on field data from concessionaires

Module 10: Forest management principles in Mali NDF

Criteria		
2.2 Forest management plan		
The strategical or long-term plan	**The tactical management plan**	**The operational plan**
2.3 Forest inventories		
National forest inventories	**FMU level inventory**	Annual cutting plot inventory
2.4 Class distribution of tree species populations		
2.5 Regeneration of tree species populations		
2.6 Minimum Felling Diameter (MFD)		
2.7 Rotation cycle		
2.8 Annual Allowable Cut (AAC)		
2.9 Silviculture		
2.10 Harvest techniques		
2.11 Conversion of standing tree volume to timber specimens or wood products		

Module 10: Forest management principles in Mali NDF

The formulation of an NDF for a CITES-listed tree species requires as a minimum

- ✓**Inventory data** for the **species**
- ✓**Management** of the **area** from where the **species** is **harvested** for export: **demonstrating provisions for sustainable management** as a prerequisite for determining that export will be non-detrimental
- ✓Monitoring of species harvesting and timber and other wood product exports

Sierra Leone's NDF on *Pterocaprus erinaceus* Module 10 of CITES

Module 10: Linking NDFs to SFM components (Sierra Leone NDF)

Mark boundary and Map ~~concession~~ area

- Define area for which an NDF is applied
  - Describe the physical features of the entire ~~concession~~ area.
  - Define the distribution and amount of timber and other wood product that can be sustainably harvested.

Module 10: Linking NDFs to SFM components (Sierra Leone NDF)

Mark boundary and Map ~~concession~~ area

- Define area for which an NDF is applied
  - Describe the physical features of the entire ~~concession~~ area.
  - Define the distribution and amount of timber and other wood product that can be sustainably harvested.
- Drone data and GIS mapping. The GIS analysis identified viable and non-viable quantities of the species using a **vegetation index tool (machine learning analysis).**

✓ The supervised **random forest (RF)** algorithm predicted the population size and distribution of *Pterocarpus erinaceus* by learning from known locations and **predicting its presence** in other areas (NDF- PC27-15-03).

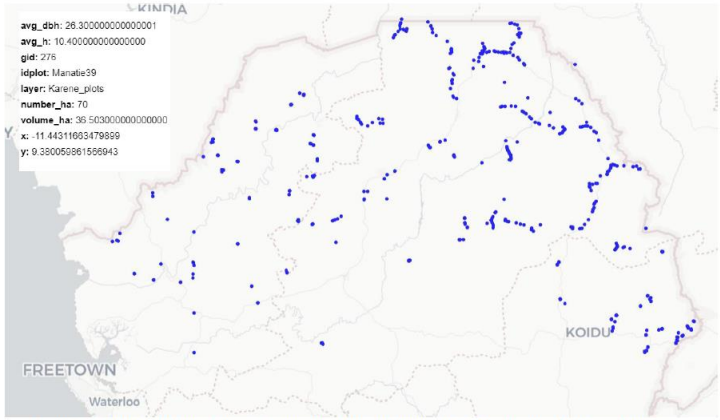


Figure 5.5. Distribution of plot and dependent variables inside each plot used for prediction

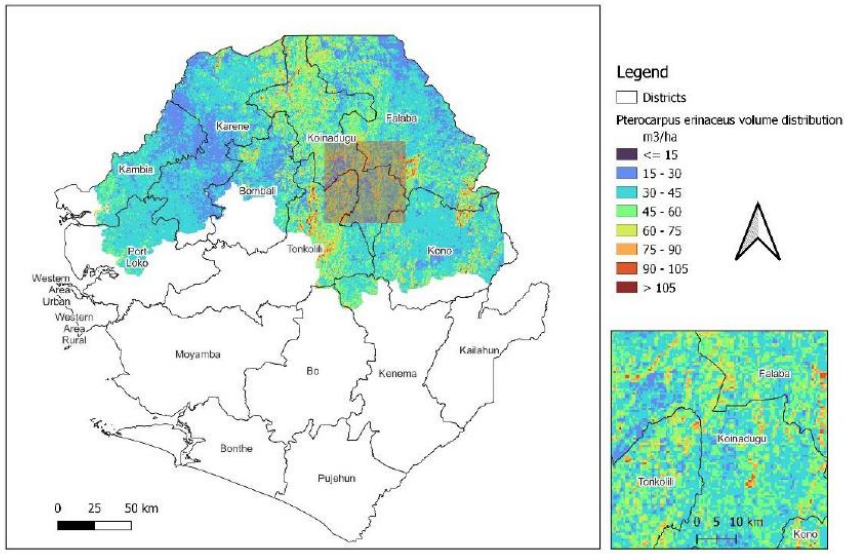


Figure 5.7. National distribution expressed in standing volume as m^3/ha produced from machine learning regression based on field plots

Module 10: Linking NDFs to SFM components (Sierra Leone NDF)

Transparent tenure and access rights

- Factor in reducing illegality & the risk of land conversion, which are considerations in NDF development
  - An important condition for sustainable forestry is maintaining the integrity of the forest estate by protecting the area from incursion and conversion

Not explicitly mentioned in the NDF but there was the imposition of the zero-quota export in 2022

In Section 8, Part II of the Forestry Act requires that the management plan shall describe the area and other rights affecting it (Forestry Act)

Module 10: Linking NDFs to SFM components (Sierra Leone NDF)

Inventory forest and environment

- Essential for species for which NDF is required.
  - Forest inventory must be completed before full-scale harvesting is approved. Environmental inventory allows for the protection and management of the entire area and its resources.

There hasn't been any National Forest Inventory carried out since the Forestry Act in 1988.

Module 10: Linking NDFs to SFM components (Sierra Leone NDF)

Inventory forest and environment

- **Essential for species for which NDF is required.**
  - **Forest inventory must be completed before full-scale harvesting is approved. Environmental inventory allows for the protection and management of the entire area and its resources.**

There hasn't been any National Forest Inventory carried out since the Forestry Act in 1988.

National inventories

Mapping study in all Regions, Districts and Chiefdoms to assess species distribution (10hrs across all sites).

Four Regions visited, comprising 8 Districts and 54 Chiefdoms

Sampling unit= a belt transect of 20mx50m with measurement of trees (**DBH ≥10cm**) AND the number of saplings (**DBH <10cm)**

Forest management inventories

Rmq: The study is based on a range-wide inventory, and does not specify whether the points are within forest concessions.

Annual cutting plot inventories

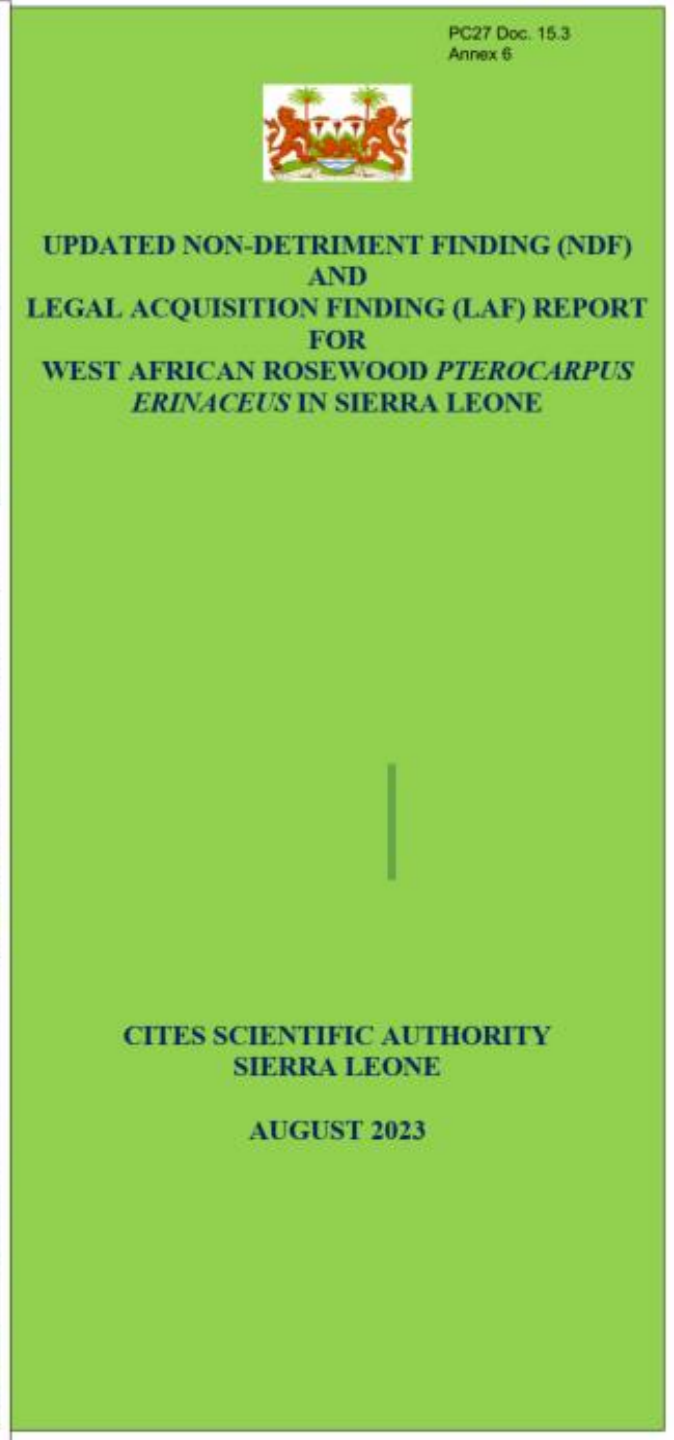
Currently, operators only provide generic maps with blocks and compartments, without detailed points of exploited trees (NDF-PC27-15-03)).

Module 10: Linking NDFs to SFM components (Sie

Develop forest management plan

- Important for sustainability of species and maintenance of its role in the ecosystem
  - Management plan can be considered a major source for making an NDF. The better the forest management plan, the easier it will be to formulate an NDF.

The NDF recommend to set up management plan for harvesting, regeneration and conservation. Currently, it is not clear (STEP 8)



Module 10: Linking NDFs to SFM components (Sie

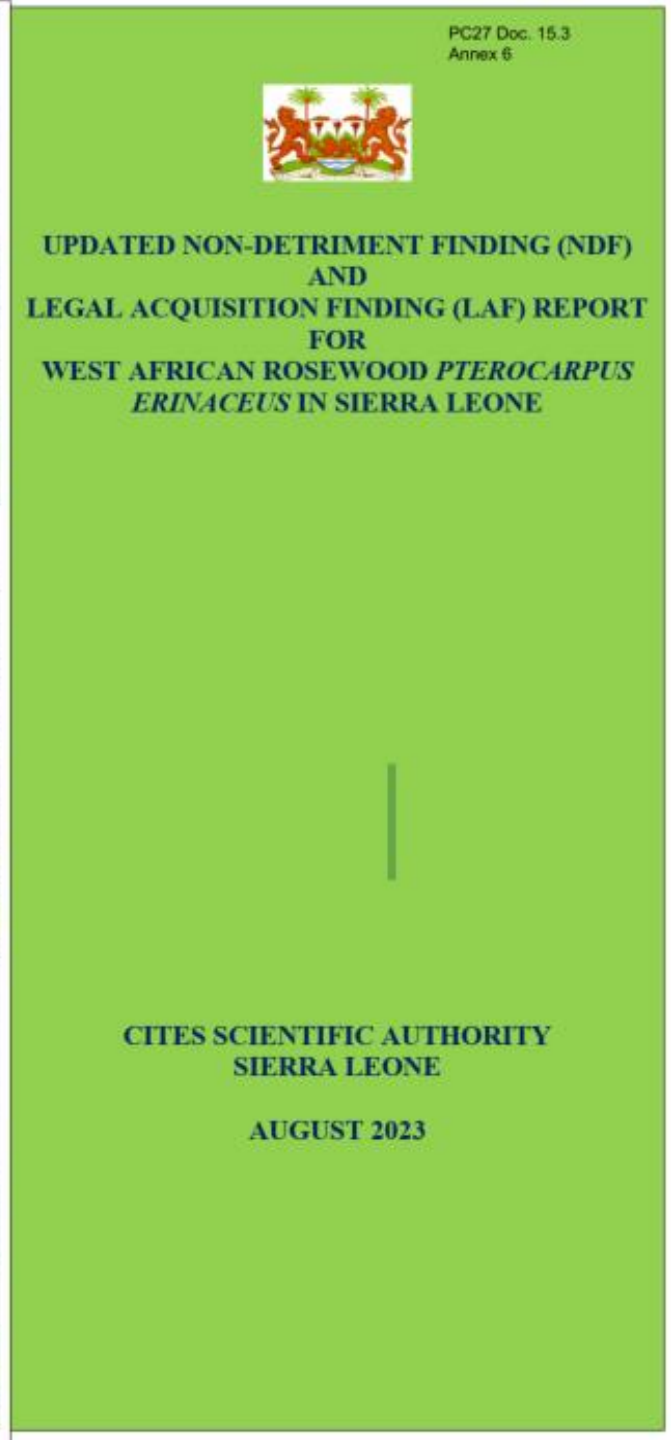
Plan transport infrastructure

- Relevant for maintenance of the role of the species in the ecosystem.

Persisting infrastructure improves access and by this increases the risk of illegal logging activities but improves the likeliness that proposed silvicultural measures planned over years and post-harvest monitoring takes place.

Not mentioned in NDF. No other informations

➔ Specific to concession model



Module 10: Linking NDFs to SFM components (Sie

Develop forest use plan

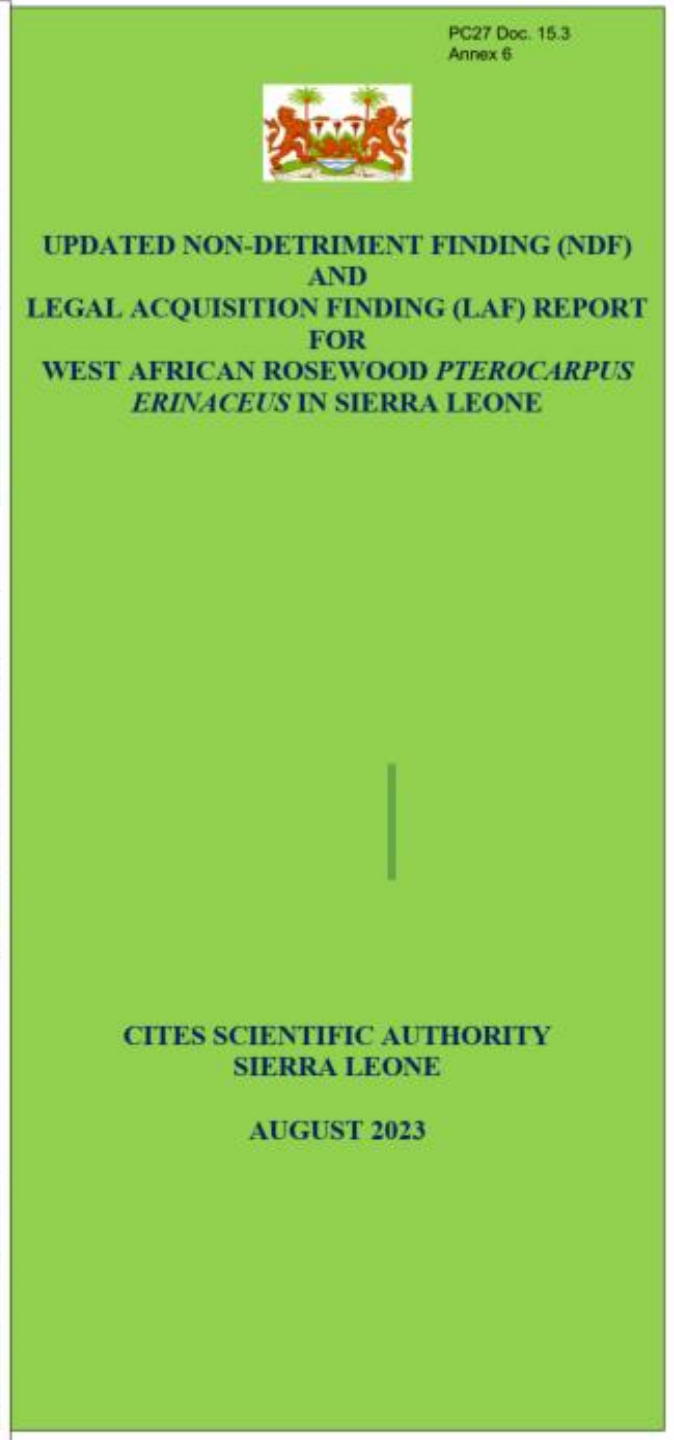
- Important in relation to wood conversion and to likelihood of fraud

Not mentioned in NDF

There are management plan with information, maps showing details of harvested sections points with harvesting areas, lists of harvested trees and lists of logs resulting from harvesting (NDF).

Currently, operators provide generic maps without detailed points of exploited trees.

➔ Specific to concession model



Module 10: Linking NDFs to SFM components (Sie

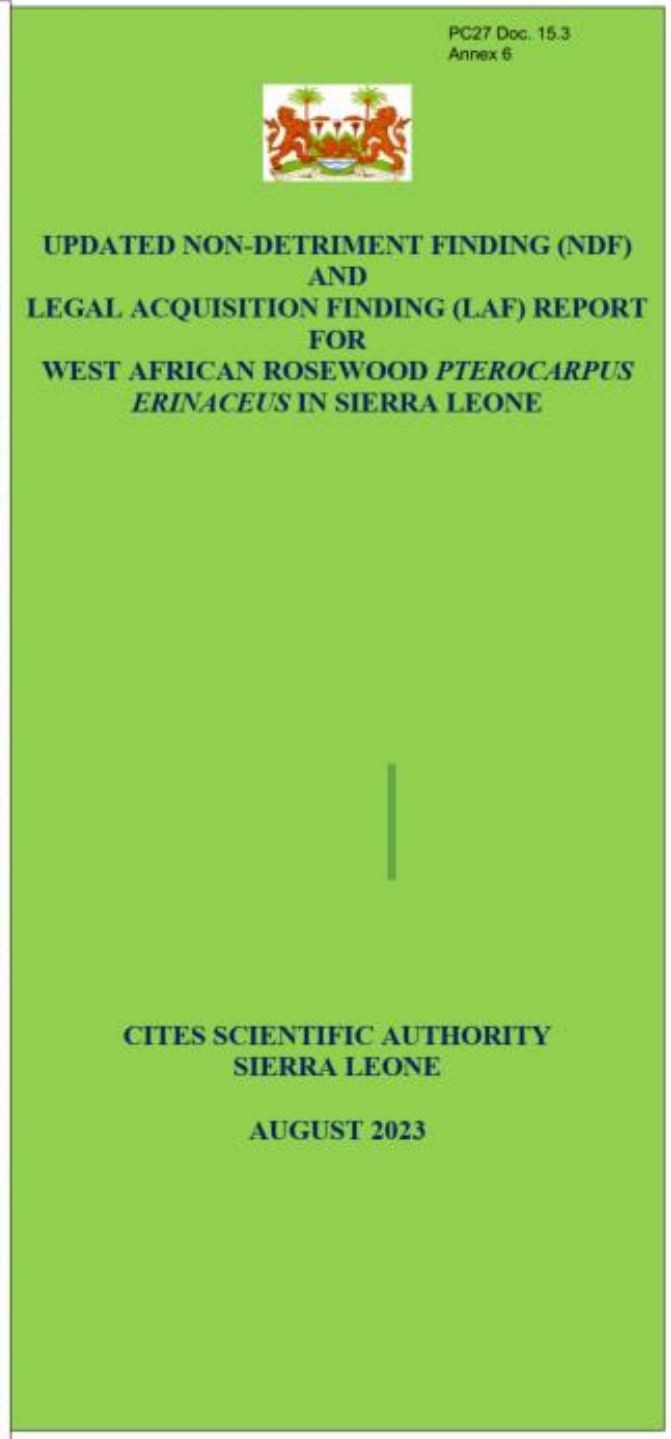
Create social and community development plan

- Incorporation of local and traditional knowledge and participatory species monitoring

The plan should document commitments on the part of the concession holder to community and social development. I is also linked to the forest utilization plan

Future developments in improving the management measures mentions the social needs of sustainable exploitation, but currently, it is not a priority.

➔ Specific to concession model



Module 10: Linking NDFs to SFM components (Sie

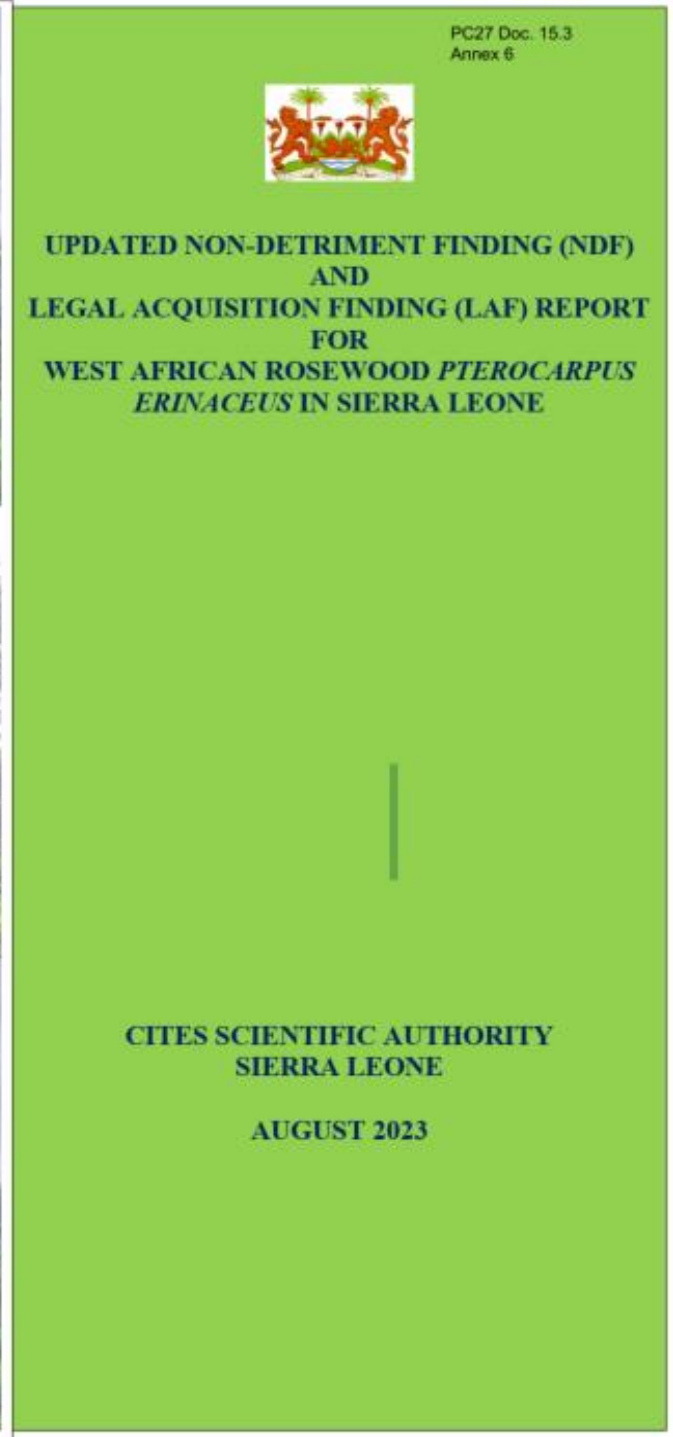
Develop initial annual operating area plan

- Harvesting plan essential for NDF formulation

The initial operating area plan should include a logging plan layout on the ground and marking of trees. After these are completed and approved by the forest administration, harvesting can begin.

Not mentioned in the NDF but the Forest Regulations require to provide annually information on the total area exploited during the preceding year with a map.

➔ Specific to concession model



Module 10: Linking NDFs to SFM components (Sie

Annual harvesting and postharvest silviculture

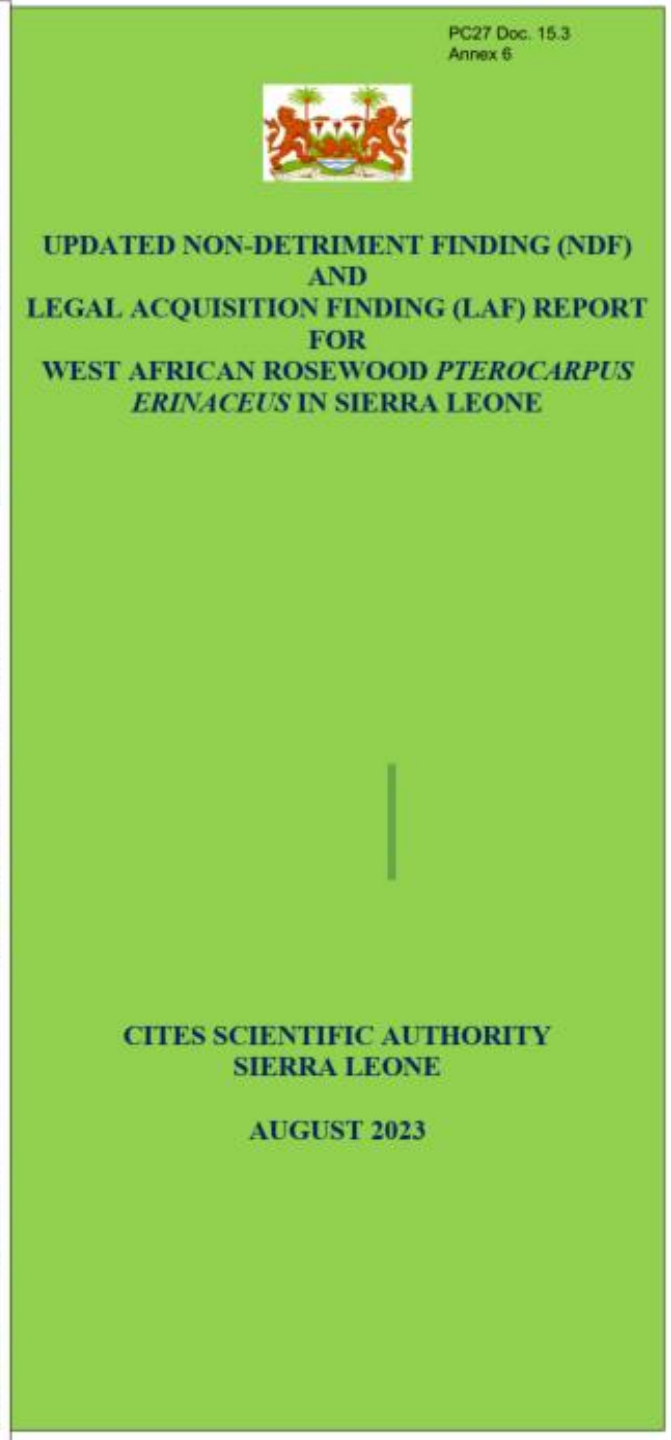
- Actual harvested volume on an annual basis is essential for NDF formulation.

~~Concession~~ holder develops annually operating area plans that, when approved, allow annual harvesting of areas.

~~Concession~~ holder also conducts required post-harvest silviculture

Not mentioned in the NDF but an harvesting plan exists and shall be drawn up with the logging manual (Timber resource management and legality licensing regulations).

➔ Specific to concession model



Module 10: Forest management principles in Sierra Leone NDF

Class distribution and regeneration of tree species population

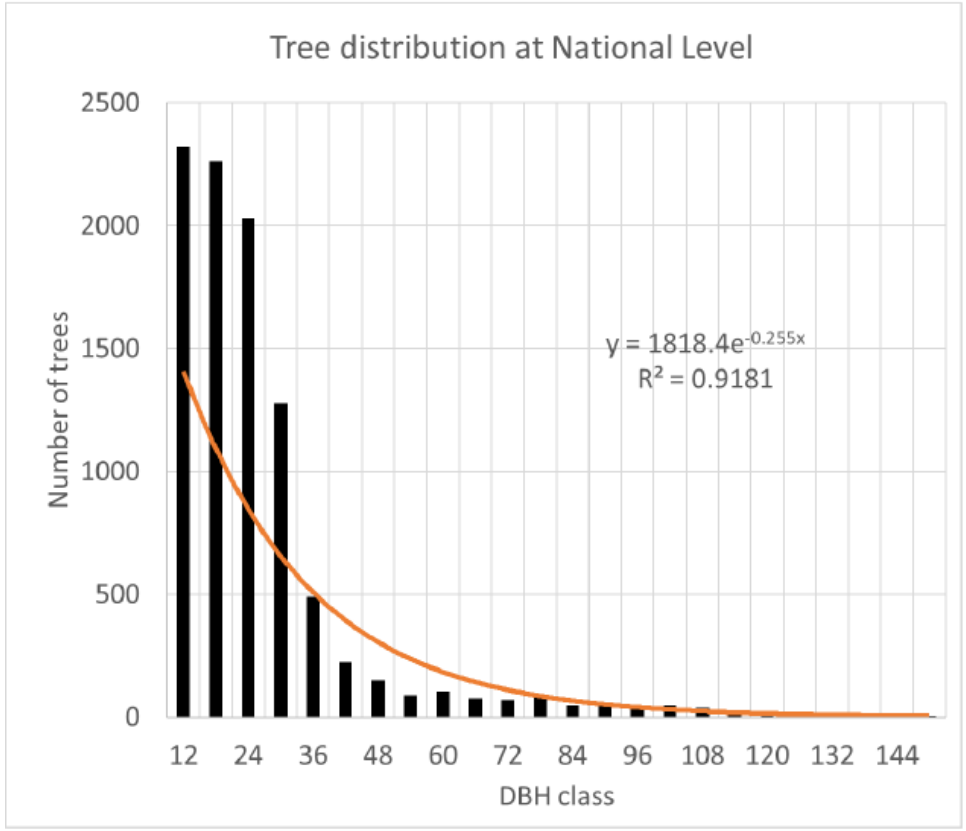


Figure 5.8. Size structure of *Pterocarpus erinaceus* at national level

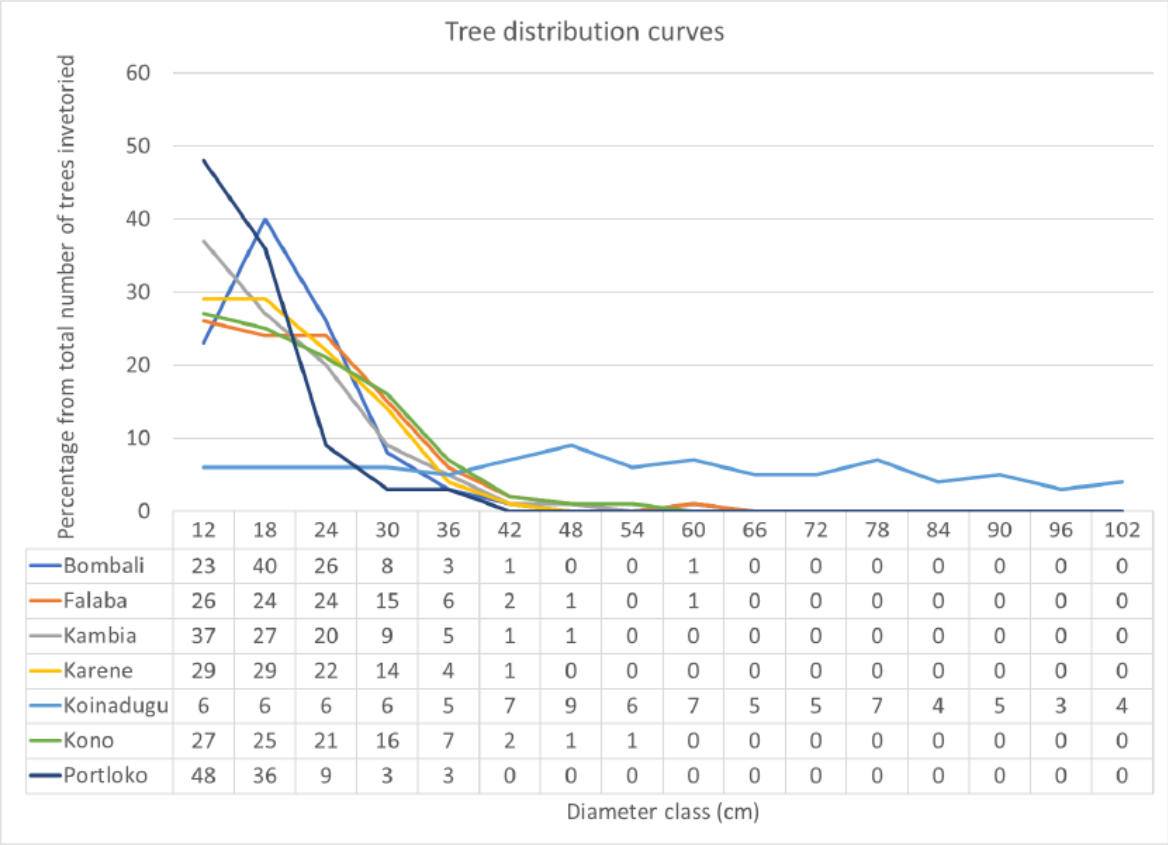
A reverse J-shaped curve, with a high number of small trees and a decreasing number of trees with increasing size. This is evident from the field plots, which show that the majority of trees have a DBH (diameter at breast height) of less than 24 cm. The R2 value of 0.9181 indicates that the reverse J-shaped curve is a good fit for the data, meaning that the majority of the trees are accurately represented by the curve.

Regeneration rate

In each 20x50 meter transect, the number of actively coppicing stumps was counted to assess future stock potential and the impact if coppicing is limited. Seedlings and saplings, along with their heights, were also enumerated in each plot (NDF-PC26-16-04).

Module 10: Forest management principles in Sierra Leone NDF

Class distribution and regeneration of tree species population



	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102
Bombali	23	40	26	8	3	1	0	0	1	0	0	0	0	0	0	0
Falaba	26	24	24	15	6	2	1	0	1	0	0	0	0	0	0	0
Kambia	37	27	20	9	5	1	1	0	0	0	0	0	0	0	0	0
Karene	29	29	22	14	4	1	0	0	0	0	0	0	0	0	0	0
Koinadugu	6	6	6	6	5	7	9	6	7	5	5	7	4	5	3	4
Kono	27	25	21	16	7	2	1	1	0	0	0	0	0	0	0	0
Portloko	48	36	9	3	3	0	0	0	0	0	0	0	0	0	0	0

Figure 6.3. Size class distribution of the trees showing different exponential curves , the numbers represent the DBH classes in cm.

Class distribution at district level

Prevalence of a reverse J-shaped curve in most Districts indicates according the NDF a degree of resilience within the *Pterocarpus erinaceus* populations in these areas.

Module 10: Forest management principles in Sierra Leone NDF

Recovery rate

$$P = \frac{[(G_0\ (1-\Delta)](1-\propto)^T}{G_p} \times 100$$

Where:
P is the restoration percentage of the number of trees initially exploited.
G0 is the basal area of the diameter classes immediately below the MDE,
Gp is the exploitable basal area, alpha represents the annual mortality rate, and delta is the damage rate due to exploitation (NDF - PC27-15-03).

Mortality rate: Not used in the past but included in the guiding principles and objectives (NDF- PC26-16-04).
Growth rate: Not used in the past but included in the guiding principles and objectives (NDF-PC26-16-04).

Module 10: Forest management principles in Sierra Leone NDF

Minimum Diameter of Exploitation (MED) and Rotation Cycle

Optimal MED >= 30 cm dbh estimated to ensures the restoration percentage over 50%

	MDE 25		MDE 30		MDE 35	
	P%	T	P%	T	P%	T
BOMBALI	30.7	22.8	90.8	32.8	221	42.8
FALABA	10	30	24	40	46.2	50
KAMBIA	26	30	57.2	40	108	50
KARENE	25.1	20	59.9	30	158	40
KOINADUGU	0.371	30	0.848	40	1.18	50
KONO	12.4	38	28.2	48	58.5	58
PORTLOKO	92.5	20	141	30	385	40

Rotation cycle = 20 years

$$T = \frac{MDE - D_{bi}}{AAM}$$

Here, T represents the transition time in years, MDE is the Minimum Diameter of Exploitation, Dbi is the diameter of the lower bound of the relevant class, and AAM is the average annual growth.

Module 10: Forest management principles in Sierra Leone NDF

Annual Allowable Cut

District	Total quota m^3/year	Precautionary Export quota for standing volume m^3/ year
Bombali	6,753	3,376.5
Falaba	43,021	21,510.5
Kambia	10,753	5,376.5
Karene	21,552	10,776
Koinadugu	25,950	12,975
Kono	43,072	21,536
Portloko	1,547	773.5
Total	**152,649**	**76,324.5**

Sierra Leone has determined an **annual harvestable quota** of standing volume of **152,649 cubic meters per year**.

Because this is the first NDF completed, Sierra Leone is taking a **precautionary position** and submitting to the CITES Secretariat an annual harvestable export quota of standing volume of **76,324.5 cubic** (NDF-PC27-15-03).

Module 10: Forest management principles in Sierra Leone NDF

Sylviculture and harvest technique (2.9 and 2.10)

Enrichment planting

The country has a reforestation program including *Pterocarpus erinaceus*, which should be part of a **National Reforestation Plan** within a **National Forest Management Plan** to target affected areas effectively (Forestry Act 1988, Part IV: 16.1 & Part IV-17.1).

Soil treatment

Not explicitly stated (NDF)

Protective measures for single trees

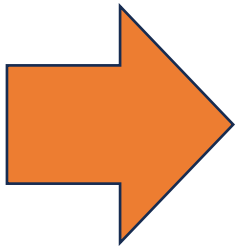
Not explicitly stated (NDF)

Reduced-impact logging

Not explicitly stated (NDF)

Module 10: Forest management principles in Sierra Leone NDF

Conversion of standing tree volume to timber specimens or wood products



Not explicitly stated

Module 10: Forest management principles in Sierra Leone NDF

Criteria		
2.2 Forest management plan		
The strategical or long-term plan	The tactical management plan	**The operational plan**
2.3 Forest inventories		
National forest inventories	FMU level inventory	Annual cutting plot inventory
2.4 Class distribution of tree species populations		
2.5 Regeneration of tree species populations		
2.6 Minimum Felling Diameter (MFD)		
2.7 Rotation cycle		
2.8 Annual Allowable Cut (AAC)		
2.9 Silviculture		
2.10 Harvest techniques		
2.11 Conversion of standing tree volume to timber specimens or wood products		

Module 10: Forest management principles in Sierra Leone NDF

The formulation of an NDF for a CITES-listed tree species requires as a minimum

- ✓**Inventory data** for the **species**
- ✓**Management** of the **area** from where the **species** is **harvested** for export: **demonstrating provisions for sustainable management** as a prerequisite for determining that export will be non-detrimental
- ✓Monitoring of species harvesting and timber and other wood product exports