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CHEMONICS INTERNATIONAL INC.

# VOLUME II
# TECHNICAL MANAGEMENT PLAN FOR THE NIALAMA FOREST RESERVE
# GUINEA NATURAL RESOURCES MANAGEMENT PROJECT

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## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| CIRAD | Centre de Coopération Internationale en Recherche Agronomique pour le Développement |
| CRD | Communautés Rurales de Developpement |
| DNFF | Direction Nationale des Forêts et de la Faune |
| FG | Guinean franc (1$ = 1000 FG; September, 1996) |
| GPS | Global Positioning System |
| MAEF | Ministère de l'Agriculture de l'Elevage et des Forêts |
| NRM | Natural Resources Management |
| PGRN | Project de Gestion des Ressources Naturelles |
| SPFF | La Section Prefectorale des Forêts et de la Faune |
| stere | stacked cubic meter; approximately 0.66 $m^3$ solid volume |
| TR&D | Tropical Research & Development, Inc. |
| UGVD | Union Guinéen de Volontaires de Développment |
| USAID | United States Agency for International Development |

# SECTION I
# BACKGROUND

## A. Forest Description

### A1. Status

Nialama Forest, with a declared area of approximately 10,000 hectares (ha), was reserved as a state forest in 1943 by order of the governor-general of French West Africa. The boundaries, which extend for about 48 kilometers, were defined by 14 points (A - N). The first three points (A - C) were described in terms of recognizable physical features; the others were identified by east and west bearings (0 -180 degrees) relative to true north. The reservation document also defines the limits of the enclave area of 150 ha set aside for the two villages of Kagnégandé and Diawbhé (see Annex A, Legislative Orders and Directives, and Annex B, Documents Relating to the Reservation of the Nialama Forest).

As a result of the reservation, Nialama Forest lies between latitudes 11'40" and 11'50" north, and between longitudes 12'40" and 12'49" west. Administratively, Nialama Forest is situated within the prefecture of Lélouma, sous-préfecture of Linsan Saran. It is bordered on the west by the Prefecture of Gaoual. Forest cover extends in some directions beyond the boundaries, and significant areas of nearby forest lie outside the state domain.

A recent exercise in 1996 used a Global Positioning System (GPS) to resurvey the recognized boundary. This revealed some discrepancies compared to the original boundary points specified in the reservation document. The reason for these discrepancies is not clear, but they are likely to have come from difficulties encountered by the colonial authorities in locating the prescribed boundary points (D - N) on the ground. Consequently, disparities exist between the currently recognized boundary and the legal boundary specified in the reservation document (see Annex C, Forest Boundaries).

### A2. Principal Geophysical Formations

Five principal geophysical formations are found in the forest: (1) areas consisting of *bowal*, (2) promontories and escarpments, (3) a plateau consisting of regular hills, (4) a lower plain with undulations, and (5) valley bottoms with hydromorphic soils (*bas-fonds*). The *bas-fonds* and the plain are situated between 250 to 300 meters above mean sea level The *bowal* and the summits of most hills lie at an average altitude of about 500 meters.

### A3. Climate

The annual rainfall is estimated to be 1,415 millimeters, with a single rainy season and a dry season lasting about six months from November to April. Average annual temperature is 26.5 degrees Celsius, with an average maximum of 39.2 degrees Celsius in April the hottest month, and an average minimum of 16.4 degrees Celsius in January the coldest month, based on information for Gaoual.

### A4. The Koundou Watershed

About 60 percent of the forest lies in the Koundou water catchment area. The two principal water courses are the tributaries Kansuma and Koundou, which flow into the Komba River. Several smaller streams feed these two water courses. Forty-nine have been identified, but few flow throughout the year. The other cease flowing several months before the onset of the rainy season.[1]

### A5. Forest Type Classification

According to the United Nations Educational, Scientific, and Cultural Organization vegetation map of Africa, Nialama Forest comes within zone XI (*Zone de transition régionale guinéo-congolaise/soudanienne)*. More precisely, it is situated in mapping unit 11a (*Mosaïque de forêt guinéo-congolaise et de formation herbeuse secondaire)*.[2]

The vegetative cover of Nialama may be described as dry deciduous (*forêt sèche*) with islands and isolated areas of gallery forest along water courses and areas of herbaceous grassland on the *bowal* areas. Table I-1 contains the classification used in forest mapping and inventory assessment of Nialama, with four major formations and minor sub-divisions.

**Table I-1. Forest Vegetation Classification**

| Vegetation Class | Code |
|---|---|
| 1: Forêt Galerie | FG |
| 2: Savanna: | SA |
| 2a: S. arborée dense | Sad |
| 2b: S. arborée claire | Sac |
| 2c: S. arbustive | Saa |
| 2d: S. de Bowé | Saw |
| 3: Bowal | BW |
| 4: Culture: | CU |
| 4a: Jeune Jachère | Cuj |
| 4b: Tapade | Cut |
| 4c: Défrichement | Cud |
| 4d: Bas-fonds (rizières) | Cur |

### A6. Forest History

Before classification of Nialama Forest in 1943, the area now occupied by the forest belonged to the village of Linsan Foulbhé but was controlled by satellite villages (*fulasso*) that owed allegiance to Linsan Foulbhé. The forest land was managed communally by each *fulasso* according to African custom and Islamic code. Families and individuals enjoyed forest usufruct rights, and landless people could obtain land for cultivation on payment of rent in kind (*farilla*)

[1] Sources of information concerning the number of year-round streams often conflict; some estimates refer to 33. See Erdmann (1994) and Fischer (1993).

[2] The United Nations Educational, Scientific, and Cultural Organization classification is described in White (1986). For a summary of the phyto-classifications applicable to Nialama Forest, see Bourque (1995).

(Fischer, 1994; MacLain, 1994; and Bourque, 1995). The village of Nialama, after which the forest is named, lies just outside the northern boundary of the forest.

At the time of classification, few people inhabited the forest. Only two villages (Kagnégandé and Diawbhé) lay within the reservation limits. Initially, it had been intended to permit these two villages to continue cultivating land in the forest around the villages. But, owing to the incompatibility of cultivation, fire, and habitation with the status of Nialama as a classified forest, an enclave amounting to 150 ha of unclassified land was set aside for the two villages.

In the early years after independence in 1958, the government adopted a hands-off policy toward forest management. Only in the late 1960s did the government initiate attempts to control bush fires, culminating in strict legislation with severe penalties in 1972. The first major encroachments into Nialama Forest occurred in the mid-1970s in response to the introduction of taxes in kind, levied per capita on farmers. A second major encroachment occurred during the 1980s. At the same time, Labé experienced an economic boom that created a demand for construction wood, especially for Rônier (*Borassus aethiopum*), in Nialama Forest.

In 1994, the Direction Nationale des Forêt et Chasse issued a directive calling for the eviction from classified forests of all illegal occupants and farmers. This was applied in Nialama Forest, although the Director of Forests and Water approved exceptions for influential local leaders on an unofficial basis. In the short term (until the present time), local people have accepted the interdict and, consequently, there has been minimal farming activity within Nialama Forest.

Under the auspices of the Natural Resources Management Project, a process of sensitization and preparation for co-management of Nialama Forest has been undertaken.

### A7. Forest Influences

The reservation documents note that "the forest cover, although open, was sufficiently dense to permit rapid natural regeneration," and that "wild fires occurred every year." This is an indication that traditional agriculture (slash and burn cultivation) was being practiced within the area before reservation.

The annual occurrence of fire may condition an ecosystem in favor of fire-resistant species and inhibit the regeneration of younger and smaller trees. Such a process may allow the invasion of grasses which, in turn, exacerbates the annual fires. The end result of such a process is degradation of *savane arborée dense* into *savane arborée claire*, and then into *savane arbustive*.

However, the long-term exclusion of fire leads inevitably to an accumulation of fuel load within the forest. If, or when, a fire does eventually occur, the effects on vegetation, soil, and fauna may prove catastrophic. In general, the lesser of two evils (annual or periodic catastrophic fires) is to exclude fire selectively for a few years in discrete parts of the forest, but otherwise encourage the ignition of fires early in the dry season when flammability is reduced. In this way, regeneration may be encouraged from time to time, while limiting fuel loads.

The recent encroachments into the forest for cultivation have progressively diluted forest cover in Nialama, which, when accompanied by annual burning, have led to the invasion of razor grasses and have inhibited forest regeneration. However, if cultivation were managed according

to location, area, duration, and fire control, then the deleterious effects on forest ecology would be minimal, and the social benefits would be advantageous.

Although domestic livestock grazing is banned in the forest under the reservation conditions, graziers are obliged to water their stock within the forest during the dry season. Although regeneration is often selectively grazed as a result, the fuel load of grasses is also reduced if they are browsed early in the season.

The demand for timber products has, in the past, depleted the stock and variety of economically valuable timber species in Nialama Forest. As a result, the current demands on the forest are much reduced. Although the biological diversity of the forest at the species level may have been adversely affected, there has been no discernable effect at the ecological level.

## B. Institutional Factors

### B1. Forest Policy

**Tropical Forestry Action Plan of 1988.** The principles of Guinea's decentralized forest policy were laid down in the Tropical Forestry Action Plan for 1988-1993, which enunciated the following principles determining the role of co-management of classified forests in Guinea:

- The existing state forest domain should be protected and maintained.
- Classified forests should contribute to economic and social development
- Nonstate entities should be permitted to enter into contracts with the state for the management of state classified forests

**Lettre Politique du Développement Agricole of 1991.** This policy statement articulates Guinea's decentralization policy toward forest management. In particular, the ministry responsible, Ministère de l'Agriculture de l'Elevage et des Forêts (MAEF):

- Will seek to safeguard natural forest resources by conserving the forest domain
- Will ensure that the classified forest domain not be diminished
- Takes a village land use management approach that includes local involvement in management decisions
- Anticipates reducing the number of forestry staff and transforming foresters from a regulatory enforcement service to a technical assistance service

### B2. Forest-Related Legislation

See Annex A, Legislative Orders and Directives, for forest-related legislation.

**Colonial Forest Code 1935.** The French colonial authorities introduced a comprehensive forest code (Décret du 4 juillet 1935) regulating the harvest of forest products and authorizing the establishment of classified forests. Fifty-two classified forests were established between 1936 and 1958, when Guinea became independent.

**Revised Forest Code 1989**

A new forest code was introduced in 1989 (Ordonnance 081/PRG/SGG/89 and decree 227 of December 20, 1989). This code:

- Allows two kinds of classified forest domain—state and collective.
- Allows state forest domain to be managed either by the state or under a management contract by any private or public entity with a *personalité morale*. In such a case, the management plan forms the basis of the contract, and the contract must conform to the classification conditions.
- Provides for the establishment and implementation of a National Forest Fund, a portion of which can be used to provide loans to *Communautés Rurales de Développement* (CRDs) for reforestation.
- Confirms customary use rights.

The forest code stipulates that a management plan should include (1) a description of the management unit boundaries; (2) a map showing forest infrastructure, natural protection zones, and zones where agriculture and livestock are permitted; and (3) a description of the reforestation and silvicultural program to be followed.

**Customary use rights.** Customary use rights were first recognized in the colonial forest code of 1935, and were reconfirmed in the revised forest code of 1989.

The customary use rights are those which the local populations living within or close to a forest reserve may exercise to satisfy their needs for forest products. In specific terms, they include: (1) collecting dead wood, (2) harvesting wild fruit and plants for food, (3) collecting medicinal plants, and (4) cutting trees for constructing houses and animal shelters and making agricultural implements. Grazing and the passage of domesticated livestock is also permitted within the provisions of the revised forest code, but not according to the conditions of reservation of Nialama Forest Reserve.

The exercise of all these rights is strictly limited to the satisfaction of family and domestic needs. They cannot lead to commercial transactions or be transferred to third parties. The rights cannot be exercised in areas that are legally protected, and use rights may be suspended if forest conditions so dictate.

**Other related forest legislation.** An order (*Arrêté Conjoint*) was passed in 1992 concerning the distribution of forest taxes and fees. This order sets out the principle that CRDs should receive 40 percent of revenues from cutting permit fees and reforestation taxes. Clearing fees go into the National Forestry Fund.[3] This was followed by a decree in 1993 that CRDs should receive a percentage of the National Forest Fund.[4]

Also in 1992, an order was made under the *Code Foncier et Domanial* that permits non-state entities to manage the classified public domain.[5]

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[3] Arrêté Conjoint A/92/3809/MARA/MPF, 1992.

[4] Décret D/93/110 of 10 June 1993.

[5] Ordonnance 092/019 of 30 March 1992.



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### B3. Reservation Document Conditions

Nialama Forest was reserved in July 1943.[6] Articles 1 and 2 of the document define the limits of the forest boundary and of the enclaves of Kagnégandé and Diawbhé, respectively. Article 3 defines the use rights of local people as those listed in article 14 of the decree of July 4, 1935, with these additional conditions:[7]

- Cultivation of rice is authorized within the forest reserve in suitable areas.
- Passage of herds of cows is forbidden outside of the tracks through and across the forest.

As noted previously, grazing of domesticated animals is permitted under the revised forest code, even though it is not allowed by the forest reservation document.

### B4. Forest Administration

The national forest service, *La Direction Nationale des Forêts et de la Faune* (DNFF), is mandated under the forest code to:

- Ensure the sustainable management of the state forest domain
- Provide technical assistance to the management of the decentralized collective forest domain and exercise technical supervision
- Ensure compliance with the provisions of forestry legislation
- Fulfill a regulatory function, in conjunction with the police and judicial authorities
- Ensure a steady supply of seeds, plants, cuttings and other proven genetic material
- Safeguard the genetic resources of the national forest
- Take appropriate measures to control fires and protect soils from erosion
- To take necessary measures for the protection and development of Guinean forests, in accordance with forest policy and its legislative provisions

At a decentralized level, the forest service comprises *la Section Préfectorale des Forêts et de la Faune* (SPFF) at Lélouma, and one *Cantonnement Forestier* at Linsan Saran. The local administration of forests and receipt of forest revenues is becoming more closely linked with the CRDs.

### B5. Forest Finances

Fees or taxes for permits or licences are payable for tree felling, firewood gathering, and small game hunting. Table I-2 contains forest tax rates.

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[6] Courmarie, P.1943: Arrêté no.2667/SE/F du 23 juillet 1943. The classement document and other relevant documents are contained in annex A.

[7] Ordonnance 092/019 of 30 March 1992.



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**Table I-2. Forest Tax Rates**

| Forest Product | Unit of Measure | Tax Rate (FG) |
|---|---|---|
| Timber (Class "A") | cubic meter | 16,000 |
| Firewood | stere | 50 |
| Bamboo | 1000 poles | 5,000 |
| Rônier Palm | tree | 4000 |
| **Note:** Timber also taxed at 20,000 FG per tree. | | |

Forest revenues are currently collected by the *cantonnement forestier* in respect of any taxable activities in Nialama Forest. In principle, there should be very few occasions on which taxes are levied owing to traditional use rights and the prohibition of commercial activities. The main revenue categories are (1) permits for tree cutting, firewood collecting, and small game hunting; and (2) fines and penalties for transgressions. Local people are generally reluctant to pay taxes or fines directly to the *cantonnement forestier*.

### B6. Management Planning

**Forest management planning in Guinea.** There are few operational management plans for reserved forests in Guinea, and most apply to areas richer in forest resources than Nialama Forest. Although some management plans elsewhere in Guinea envisage peoples' participation, these do not include co-management contracts for state forest domain.[8]

Recognizing that a step-by-step approach toward management planning may solve some immediate problems facing various forest reserves, "intervention plans" have been prepared for 16 forest reserves in the prefecture of Mamou. The forests concerned are much smaller than Nialama; nevertheless, their forest types and problems are similar. Proponents of the intervention plan approach stress that they are a pre-condition for a management plan, but not a substitute (CIRAD, 1996).

**Forestry Action Plan for the Préfecture of Lélouma.** The SPFF of the Préfecture of Lélouma has prepared a document entitled *Démarches pour un Plan d'Action*, which contains objectives, activities, outputs, and indicators for various program areas. The objective is stated as the "Protection of the Environment" and the immediate objective as the "Management of Natural Resources with the Population." The program areas include:

- Wildfire management
- Cultivation control
- Rational tree cutting
- Hunting control
- Protection of water sources and reforestation
- Soil enrichment and conservation

[8] Management plans have been prepared in April 1995 for Ziama and Decke Forest Reserves for 1996-2015. A management plan is also being developed for Dubreka Forest Reserve by DNFF in collaboration with surrounding villages and with GTZ technical and financial support.

The management plan for Nialama Forest should reflect the priorities that have been determined at the prefecture level.

**Nialama Action Plan.** The proposal for an action plan was prepared as a step in the process leading to a co-management agreement for Nialama Forest Reserve and indicated many of the priority areas and interventions to be addressed by the project's technical management plan.

The proposal contained four main components:

- A contract between the DNFF and the local population, represented by the forest committee
- The introduction of a taungya[9] system on a temporary basis, focused on degraded areas in which planting would be necessary to re-establish forest cover
- The formalization of contracts between DNFF and villagers for cultivation in the existing flooded rice zones (*bas-fonds*)
- The limited extraction of economic products for revenue generation for the local population, including Bani timber, bamboo, and firewood

On the management of Nialama Forest, the action plan proposed interventions in the following areas:

- Fire management
- Reforestation
- Selective cutting of Bani trees under a system designed to ensure natural regeneration
- The extraction of other products, such as bamboo, from the forest
- The protection of gallery forests and biological diversity
- The control of grazing by domesticated animals

The action plan also addressed the personnel implications for DNFF of the management proposals and set out a three-stage time frame for the management plan:

- Short-term (years 1-3)
- Medium-term (years 4-9)
- Long-term years (10-30)

### B7. Environmental Assessment

In May 1996, A USAID team carried out an environmental assessment of the proposal for an action plan for the management of Nialama Forest. This assessment preceded the formulation of the preliminary management plan and could not, therefore, address all relevant issues. There were no recommendations concerning the principle of productive harvesting or the practice of

[9] Taungya is an agroforestry system that combines the temporary cultivation of agricultural crops on under-used land with the establishment of permanent tree cover. Tree establishment under taungya has usually featured planted exotic species. When the trees have been successfully established (typically in 2 to 4 years), cultivation is no longer feasible and farmers must abandon those plots.



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rotational fallow as a form of agroforestry taungya. Also, some recommendations in the environmental assessment lay outside the scope of a technical management plan. The following paragraphs describe the main implications for the management plan of the environmental assessment.

**Chimpanzee habitat and food sources.** The management plan should not permit any destructive harvesting within the identified chimpanzee habitat areas. One such area, which lies partially in the unclassified enclave, is currently identified. This should not preclude the identification of other areas in due course.

The management plan should not permit the cutting of any identified food source for humans or chimpanzees (e.g., *Parkia biglobosa, Spondias mombin,* or *Ficus* spp.). Any other food source trees identified should be noted.

**Protected areas.** The management plan should (1) identify all *bas-fond* rice areas and restrict their expansion, (2) recognize the need to maintain vegetation in the gallery forest areas and around stream heads, (3) restrict agriculture on steep slopes (over 30 degrees), (4) prohibit the use of agrochemicals in the *bas-fonds*, and (5) incorporate an option to make a specified swap of chimpanzee habitat within the enclave village area for agricultural land elsewhere in the forest.

**Natural regeneration.** The management plan should rely on natural regeneration as the major strategy for regenerating the forest; enrichment planting should be comparatively minor in extent.

**Environmental monitoring.** The management plan should incorporate a system of monitoring and evaluation by which the effectiveness of forest protection and conservation might be periodically assessed.

## C. Forest Use

### C1. Cultivation

The level of cultivation within the forest is at a historical low point owing to the eviction in 1994 of farmers from their fields within the forest. In the opinion of local forestry staff, nearly all the savanna areas of Nialama Forest are also fallow of varying ages. Since savanna types are the dominant vegetation, it may be concluded that shifting cultivation has historically been a prevalent land practice in the forest, even at the time of reservation in 1943. Certainly, shifting cultivation has been a traditional land management practice in most parts of Africa. Accordingly, many rural people remain convinced of their inalienable right to cultivate, despite the abrogation of these rights by colonial authorities at the time of reservation. This underlying belief is reinforced by increasing shortages of cultivable land caused by increasing population pressures.

Cultivation rights in the *bas-fonds* were granted at the time of forest reservation in 1943, although this was restricted to the *riziculture marais* (semi-wetland). In practice, many other food crops and some cultivated trees are also grown there. At present, there are 25 identified bas-fond areas, with an aggregate area of 26 ha, as listed in Tables I-3 through I-5. A particular environmental hazard associated with intensive cultivation of the *bas-fonds* is the possible future applications of agrochemicals, which might pollute water supplies.



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## Table I-3. Areas of Bas-Fonds

| Bas-fond number | Area (ha) | Bas-fond number | Area (ha) |
|---|---|---|---|
| 1 | 3.44 | 14 | 1.32 |
| 2 | 2.54 | 15 | 1.09 |
| 3 | 0.77 | 16 | 0.35 |
| 4 | 0.42 | 17 | 0.24 |
| 5 | 0.43 | 18 | 0.27 |
| 6 | 0.45 | 19 | 0.45 |
| 7 | 2.08 | 20 | 0.59 |
| 8 | 0.41 | 21 | 0.30 |
| 9 | 2.72 | 22 | 0.27 |
| 10 | 1.69 | 23 | 0.24 |
| 11 | 0.28 | 24 | 0.48 |
| 12 | 3.25 | 25 | 0.45 |
| 13 | 1.35 | | |
| **Total area (bas-fonds)** | | | 25.43 |

## Table I-4. Areas of Tapades

| Tapade Number | Identification | Area (ha) |
|---|---|---|
| 1 | Bondily Kouyaté | 4.46 |
| 2 | Issa Nimagan | 8.66 |
| **Total area (tapades)** | | 13. |



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**Table I-5. Identification of bas-fonds in the Nialama Forest**

| N° | LOCALIZATION | DESCRIPTION | VILLAGE | OBSERVATION |
|---|---|---|---|---|
| 1 | Zone Kansouma, située avant la tapade de Elhadj Boudily Kouyaté | • Sud-Est de la tapade<br>• Cultivé par l'Imam de Linsan-Saran, Elhadj Moussa Dramé | Linsan-Saran | Sud ouest tapade de Elhadj Boundily<br><br>(Très grand bas-fond) |
| 2 | Longeant le cours d'eau Néna | Traversé par la piste Dansouma Diawbhé appartenant à Thierno Satala | Diawbhé | Le long de Néna bas-fonds situé en bas du village Diawbhé<br>(Bas-fond moyen) |
| 3<br>4<br>5<br>6 | Longeant le cours d'eau Néna contigüe à 2 | Pour les villageois de Diawbhé | Diawbhé | Contigüe à 2, au nord de 2<br><br>(Bas-fonds moyens) |
| 7 | Le long du cours d'eau Néna, suite: 2,3,4,5,6 | Selon les villageois des bas-fonds appartenant au citoyen Marouf de Diawbhé | Diawbhé | En bas du village Diawbhé<br><br>(Bas-fond moyen) |
| 8 | Avant d'arriver à la tapade de Elhadj Bouncily | Zone Dansouma<br>Est de la tapade Elhadj Bouncily | Linsan-Saran | A 200 m du sentier menant à la tapade<br><br>(Bas-fond moyen) |
| 9 | Suite du bas-fond N° 8 | Zone de Dansouma pare-feu cultivé<br>Thierno Samba Ténen de Tyéwèré | Tyéwèré | En bas du bas-fond N° 8<br><br>(Bas-fond moyen) |
| 10 | En bas de la source de Gargassaki | Nord-Est de Tyéwèré appartenant à Thierno Satenen Baldé | Tyéwèré | (Très grand bas-fond) |
| 11 | A Danpatan | Nord-Ouest de Tyéwèré pour feu<br>Thierno Samba Ténen | Tyéwèré | (Petit bas-fond) |
| 12 | En bas de la falaise de Kagnégandé le long du cours d'eau Dalabahun | Situé à l'ouest de l'ancienne piste Bendougou-Tyéwèré pare-feu cultivé<br>Thierno Algassimou Baldé | Kagnégandé | (Très grand Bas-fond) |
| 13 | Le long du cours d'eau Fiira | Sud-Est de Nialama longeant le sentier Nialama-Tyéwèré | Nyalama | (Petit bas-fond) |
| 14 | Le long du cours d'eau Néna | Confluence Néna Touguiwel pour Thierno Amadou Oury Baldé Linsan-Foulbhé | Linsan-Foulbhé | (Bas-fond moyen) |

| N° | LOCALIZATION | DESCRIPTION | VILLAGE | OBSERVATION |
|---|---|---|---|---|
| 15 | Le long du cours d'eau Néna | En bas du jardin maraîcher de Linsan-Foulbhé<br>Pour les villageois de Linsan-Foulbhé | Linsan-Foulbhé | (Bas-fond moyen) |
| 16 | Le long du cours d'eau Dansouma | • Bas-fond localisé sur la rive de Kansouma<br>• De Goundoupi à Sigon, à travers la rivière Kansouma, appartient au citoyen Mamdou Sliou Koulibaly de Sigon | Sigon | Dévier la piste Konba-Linsan 20 km<br>Prenez le sentier menant à Gourdoupi<br>A 20 m déviez à votre droite<br>(Très grand bas-fond) |
| 17 | Bananeraie de Sigon | Situé à 30 m de la source aménagée et de la parcelle reboisée, appartient au chérif de Sigon | Sigon | (Très petite bananeraie près de 15 pieds) |
| 18 | Bananeraie de Goundoupi | A l'ouest du village de Goundoupi<br>Appartient à Sara Bayo | Goundoupi | (Très grande bananeraie plus de 1.500 pieds) |
| 19 | Le long du cours d'eau Koundou | A l'ouest du village de Goundoupi<br>Nom du bas-fond: Bantandondé | Goundoupi | A l'est du N° 18<br>(Très grand bas-fond) |
| 20 | Le long du cours d'eau Fiira | Au nord du sentier menant Tyéwèré-Nialama<br>Appartient à Amadou Korka Baldé | Tyéwèré | (Petit bas-fond) |
| 21<br>22<br>23 | Le long du cours d'eau Fiira | A côté de Nonkohi<br>A côté de Nonkohi<br>A Didèré Komba | Tyéwèré | (Petits bas-fonds) |
| 24 | Le long du cours d'eau Fiira | Bas-fond contigüe au N° 13 | Nyalama | (Petit bas-fond) |
| 25 | Bananeraie de Linsan-Saran | Située à l'ouest de la tapade de Elhadj Bouncily lui appartenant | Linsan-Saran | (Grande bananeraie)<br>Près de 1.000 pieds |

The *bas-fond* areas of Nialama present a special challenge to forest management. They are situated along water courses that should be protected from production activities, according to the objectives of the management plan and the reservation document. Cultivation of the *bas-fonds* is therefore incompatible with management objectives.

### C2. Grazing

There are about 5,750 livestock in and around the forest.[10] Although grazing of domesticated animals is prohibited in Nialama Forest under the terms of the reservation document, the need for watering sources obliges farmers to let their cattle enter the forest during the dry season. Because herd boys rarely accompany cattle herds, it would be difficult in practice to enforce the prohibition.

Cattle may browse certain tree species planted to regenerate the forest, which affects the trees' survival rate. However, grazing also reduces the fuel load from accumulated grass and other litter. Graziers are often held responsible for the large number of wild fires that occur from the fires they light to encourage the regrowth of palatable grasses.

### C3. Sources of Food and Medicines

A recent study revealed that local people use leaves, roots, and barks of up to 14 species of trees, as well as herbs, to treat a variety of ailments, including jaundice, rheumatism, parasites, impotence, menstrual disorders, and unwanted pregnancy, as listed in Table I-6. Traditional medicine is still used to treat many ailments such as jaundice and infertility.[11]

**Table I-6. List of Forest Plants Used Locally for Medicinal Purposes**

| Vernacular (*Botanical*) Names | Part of plant | Use |
|---|---|---|
| Sindya (*Cassia sieberiana*) | Roots, bark | Impotence; menstrual disorders |
| Kahi (*Khaya senegalensis*) | Bark | Jaundice |
| Boulou-Kountou (*Cussonia djalonensis*) | Bark, leaves | Rheumatic arthritis |
| Gowla-Palel (*) | Roots | Rheumatic arthritis |
| Gogo, Gogo Kulala (*, herbs) | Roots | Internal parasites |
| Le Fafarou (*) | Roots | Jaundice |
| Bamboo (*Oxytenanthera abyssinica*) and Kahi (*Khaya senegalensis*) | Mixture of leaves | Abortions |
| Koura (*Parinari excelsa*) | Bark | General all purpose |
| Koura (*Parinari excelsa*) (with other unspecified items) | Seeds | Hemorrhoids |
| Lingué (*Afzelia africana*) | Bark, wood | Unspecified |

[10] Report of the sociologist, Environmental Assessment, USAID, 1996

[11] Bocar Sow (undated); some of these medicinal plants are restricted to veterinary usage.



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| Vernacular (*Botanical*) Names | Part of plant | Use |
|---|---|---|
| Kindé (*) | (*) | (*) |
| Boto Bhala (*Deterium*) | Roots, bark | (*) |
| Koura-Wongolo (*Parinari curatellifolia*) | Roots, bark | (*) |
| Mbotyola (*Erythrina senegalensis*) | Bark | (*) |
| Kéri (*Margaritaria discoidea syn. Phyllanthus discoideus*) | Bark | Internal parasites (veterinary) |
| Dafi (*Bridelia ferruginea*) | Leaves | Coughs (veterinary) |
| **Note:** (*) unidentified | | |

Many sauces, soups and other foods are made from the leaves of forest plants; some of these are listed in Table I-7.

**Table I-7. Forest Plants Used Locally as Sources of Food**

| Vernacular (*Botanical*) Names | Part of plant | Use |
|---|---|---|
| Neré (*Parkia biglobosa*) | Seeds | Ojo, Sumbara—kitchen use |
| *Spondias mombin* and *Ficus* spp. | Fruit | Edible |
| Karité (*Vitellaria paradoxum*) | Seeds | Butter |

The food and medicinal sources are used primarily for domestic needs, but many are also sold in local markets. The prices in Linsan Saran are low (e.g., 50 Guinean francs [FG]) for common medicines, but may range from 10,000 to 45,000 FG in Labé for the more efficacious treatments.

Nialama Forest may be home to other plants with undetermined biochemical and medicinal properties. For example, local people describe a highly poisonous tree (*Bossi*). Also, some animals such as snakes are hunted for their medicinal properties.

### C4. Timber

Under the terms of the forest code, local residents are permitted to cut trees under a free license to construct their own buildings. Commercial use of timber and firewood cut from the forest reserve is strictly prohibited.

A thriving local market in Labé offers a steady demand for timber to produce furniture and for construction. These requirements are met from a wide area, but in past years Nialama Forest was a major supplier of raw wood. A local logging team fells trees within the forest reserve by invitation of the CRD at Linsan Saran.[12] The traditional timber species in this part of Guinea are shown in Table I-8.

[12] It is presumed that this use is exclusively for local domestic requirements.



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**Table I-8. Market Specifications and Values of Various Forest Products**

| Species | Length | Width and thickness | Price at forest gate (FG) |
|---|---|---|---|
| **Traditional red timber**<br>Lingué (*Afzelia africana*)<br>Tyimé (*Milicia regia*)<br>Kahi (*Khaya senegalensis*) | 4 - 5 m | 18-20 cm wide; 6-7 cm thick | 800-1000 per meter |
| **Lesser known timber**<br>Bani (*Pterocarpus erinaceous*) | As above | As above | |
| **Utility white timber**<br>Zyewè (*Daniellia oliveri*)<br>Luukun (*Bombax costatum*) | as above | As above | (not known) |
| **Bamboo** | 3 - 4 m | No limits | 20,000 per 1,000 |
| **Palm species**<br>Rônier (*Borassus aethiopium*) | 4 - 5 m | No limits | 300 per 5m |
| **Firewood** | fagot comprises 6-7 pieces; assumed equal to one stere | | 350-500 per fagot |

Lingué is used almost exclusively for furniture because of its color and grain, whereas Kaya and Tyimé are used more for windows, doors, table tops, and utility furniture. Rônier is used for house construction because of its durability and resistance to termites.

Supplies of the traditional (red) timber species are becoming scarcer. For some end-products, utility grade (white) wood is being used, for example, for packing crates and temporary shuttering, where quality and durability are not required.

Increasing local use is being made of Bani as a readily available substitute for the traditional red timbers. Bani is well known as a timber species in neighboring Senegal but less so in Guinea.[13] However, some carpenters around Nialama Forest and in Labé appreciate the timber, and it is accepted in the market place.

### C5. Firewood

Most (90 percent) of households in Fouta Djallon depend on firewood for cooking and winter heating. In the towns, these domestic demands are supplemented by those from bakeries and other commercial users, such as restaurants.

Bani is a preferred species for firewood and is relatively plentiful, compared to other species with desirable burning properties. It is prepared in fagots, each comprising six to seven

[13] Timber from Bani is known as *vène*.



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pieces, and selling for 350-500 FG at roadside.[14] In principle, a cutting tax of 50 FG per stere is payable, although it has been stated elsewhere that firewood cutting is tax-free.[15]

### C6. Bamboo

Bamboo *(Oxytenanthera abyssinica)* has several local uses, including house construction, screens, partitions, and baskets, as well as limited medicinal use. In most cases, poles are sold rough in lengths of 3 to 4 meters. A bundle of 10 pieces of bamboo sells for 200 FG, and a load of 1,000 for 20,000 FG. In the latter case, a tax of 5,000 FG is payable.

It has been also been suggested that a new market for bamboo could be developed as a substitute for rattan in the manufacture of utility furniture. This would depend on the acceptability of bamboo, its working properties, the skills of the furniture makers, and marketing considerations such as design, price, quality, and distance from the market place.

### C7. Wild Animal Products

Much of the information concerning the wildlife resources of Nialama Forest originates from hunters' reports. Deer (duiker), hares, and partridges are commonly hunted as animal protein supplements to family diet. Other animals, such as red monkeys, are hunted for medicinal properties.

In this context, there is an increasing shortage of animals such as the duiker for household consumption. Local people are mindful that natural predators, such as leopards, will attack domesticated livestock when their usual prey is unavailable.

## D. Social and Economic Factors

### D1. Population

The *peuhls* are the indigenous inhabitants of the Koundou watershed. The first village to be established in the Koundou watershed was Linsan Fulbhé in 1612 A.D. Two distinct social groups are represented: the *fulbhé* (nobles) and the *djalonké* (former slaves and captive craftsmen). A third social group, the *sarakollé* (merchants and farmers), are of Mandingo origin but have been present for the past 300 years.

About 30 villages are situated within or neighboring the forest. Table I-9 lists 16 of the most important villages, in terms of proximity and/or population; generally, each comprises only one social group.

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[14] The volume of a fagot is one stere, equivalent to 0.65 cubic meters ($m^3$) solid volume.

[15] Bocar Sow (undated) states that *"les bûcherons (de bois de chauffe) ne sont pas soumis à aucune taxe forestière."*



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**Table I-9. Villages by Socio-ethnic Group and Descending Order of Population**

| Name of Village | Socio-ethic group | Population |
|---|---|---|
| Linsan Saran | Sarakollé | 1120 |
| Tyéweré | Djalonké | 404 |
| Linsan Foulbhé | Fulbhé | 367 |
| Kokolou | Fulbhé | 339 |
| Kagnégandé | Fulbhé | 325 |
| Diawbhé | Djalonké | (*) |
| Telobofi | Djalonké | 208 |
| Donghol | Djalonké | 174 |
| Bendougou | Djalonké | 114 |
| Sigon | Djalonké | 85 |
| Bassan | Fulbhé | 65 |
| Guemé | Fulbhé | 59 |
| Néteré | Djalonké | 57 |
| Goundoupi | Djalonké | 52 |
| Madina | Fulbhé | 31 |
| Nyalama | Djalonké | (**) |
| All villages (excl. Nialama) | | 3,400 |

**Source:** Guinea NRM project (1994)
(*): The population figure for Diawbhé is included with that for Kagnégandé.
(**) No population figure is available for Nialama Village.

The population figures date from 1994 and, according to some reports, have been growing at a high rate in recent years owing to the return of people displaced from Liberia and Sierra Leone.[16]

Several villages west and northwest of the forest boundary, in the Prefecture of Gaoual, are not yet formally involved in the process leading to co-management of Nialama Forest. These include Sébétére, Sambaya, Fulasso, Dondo Boto, and Bomini.

### D2. Forest Needs

During the process leading to co-management of Nialama Forest, three surveys into local needs from the forest were conducted.[17] The first survey was carried out in June and July 1996, through 15 separate meetings of 31 different villages and hamlets, with the participation of 577 villagers. The members of each of 14 villages, or group of villages, were asked questions about their use of the forest, according to whether the use was an "Actual Use (X)" or an "Ancient Use (A)." Table I-10 summarizes the numbers of villages using the Nialama Forest for various purposes.

[16] Population figures taken from PGRN (1994).

[17] Described in Williams and Thiam (1996).

**Table I-10. Numbers of Villages Using Nialama Forest for Various Purposes**

| Forest Use | Actual Use | Ancient Use |
|---|---|---|
| Agricultural fields | 3 | 6 |
| Bas-fonds | 1 | 0 |
| Grazing | 13 | 0 |
| Firewood | 6 | 0 |
| Timber | 6 | 1 |
| Straw/reeds | 8 | 1 |
| Bamboo | 10 | 2 |
| Other uses | 25 | 3 |

**Source:** Williams & Thiam (1996)

According to this initial survey, access to grazing and the harvesting of bamboo and straw were the most commonly cited uses by villages of the forest. It is notable that only three villages admitted to actual cultivation in the forest. The interpretation of "ancient use" referred to the situation existing before the evictions of farmers by DNFF in 1994.

The second survey of forest use took place at the village assembly held on July 16, 1996. Four members from each of 30 villages were delegated to attend. The four delegates included one village elder (male), one woman, one young person, and one craftsman. There were 114 villagers from 25 villages at the event.

The village delegates were allocated to four working groups (elders, women, youth, and craftsmen), and each of these four groups was asked to rank 30 uses of the forest, in order of perceived priority, by allocating 200 points (bean counters) among the uses. Table I-11 summarizes the top 10 overall uses.

**Table I-11. Top Ten Priority Uses of Forest**

| Forest Product/Use | Points | Ranking |
|---|---|---|
| Agricultural fields | 211 | 1 |
| Service wood | 80 | 2 |
| Bamboo | 62 | 3 |
| Straw | 61 | 4 |
| Grazing | 50 | 5 |
| Wild fruit | 38 | 6 |
| Timber | 33 | 7 |
| Domestic water | 32 | 8 |
| Medicinal plants | 27 | 9 |
| Firewood | 22 | 10 |

**Source:** Williams & Thiam (1996)

Although these top 10 uses account for more than 75 percent of the votes, access to the forest for agricultural cultivation clearly dwarfs all other perceived priorities, apart from wood.



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Including use of *bas-fonds* areas, the total votes for cultivation were 222 out of a total of 773 cast. The total of all votes cast for wood products of various kinds was 169.

The third survey of forest use was carried out by asking the 16 elected members of the forest committee to rank the importance of Nialama Forest as a source of supply of various forest products and services for three categories of villages—enclave, bordering, and distant. Committee members initially misinterpreted this question as referring to aspirations or ancient uses, rather than actual current sources. There was strong confirmation of the dependence on the forest by (1) the enclave villages for all requirements, including agriculture; and (2) all other villages for all requirements, except agriculture and leaf mulch.

### D3. Prioritization of Villages

The priority ranking for a village indicates its degree of dependence on the forest, and therefore its importance for the management planning process.[18] Table I-12 lists villages according to priority for management planning.

**Table I-12. Villages According to Priority for Management Planning**

| **Priority (1):** Completely dependent on forest | **Priority (2):** Highly dependent on forest | **Priority (3):** Not very dependent on forest |
|---|---|---|
| Kagnégandé<br>Diawbhé | Linsan Saran<br>Linsan Foulbhé<br>Guemé<br>Madina<br>Tyéweré<br>Bendougou<br>Nyalama<br>Sigon<br>Néteré<br>Goundoupi | Bassan<br>Kokolou<br>Telobofi<br>Donghol |

## E. Area Information

Annex B contains a full list of maps and air photographs.

### E1. National Map Series

The only national map applicable to the forest area is number NC 28 XXIV (Labé) of the series *Afrique Occidentale Française: Carte Régulière*. This provides full detail at a scale of 1:200,000, but is dated 1937. It is unlikely that a map of this scale and age would prove useful for management planning. It does serve, however, as a location map.

[18] Based on Action Plan, 1996.

### E2. Aerial Photographs of Koundou Watershed

An aerial survey of the Koundou watershed #9 (Fouta Djalon) was carried out by *Hauman und Zu Isdorf GmbH.* during March-May, 1989. The coverage excludes that part of Nialama Forest that lies outside the Koundou watershed. Panchromatic and infrared photographs were provided, with an approximate scale of 1:30,000. Thirty-seven exposures in four bands were flown as shown in Table I-13. Because the photograph frames overlap, they may be viewed in stereo using a stereoscope. The evergreen elements in gallery forests show up well, but because the photographs were taken at the end of the dry season, the deciduous vegetation does not show on the panchromatic prints.

**Table I-13. Aerial Photographs**

| Band | Direction | Photo. numbers |
|---|---|---|
| 1 | East to West | 360 - 368 |
| 2 | West to East | 350 - 359 |
| 3 | East to West | 341 - 349 |
| 4 | West to East | 332 - 340 |
| Bands 1 - 4 are arranged north to south | | |

A mosaic assemblage of the photographs was compiled with an approximate scale of 1:10,000. There are 16 mosaics in four bands (A-B) corresponding to bands (1-4) of the base air photographs. Table I-14 shows the labeling of photograph mosaics. Although the mosaics cannot be used for stereo viewing, they are useful for examining details of forest areas such as fallow lands, villages, roads, and water courses.

**Table I-14. Labeling of Photo Mosaics**

| | | | |
|---|---|---|---|
| A1 | A2 | A3 | A4 |
| B1 | B2 | B3 | B4 |
| C1 | C2 | C3 | C4 |
| D1 | D2 | D3 | D4 |

### E3. Topographic Maps of Koundou Watershed

Topographic maps of Koundou watershed #9 have been derived from the air photographs at two scales. As with the photographs, only that part of Nialama Forest which lies within Koundou BRP is covered. There is a single (large) sheet at 1:10,000, and a series of X maps at 1:5,000. Each mosaic photograph print is represented by up to 4 maps at 1:5,000, as shown in Table I-15. The topographic maps are at a good scale (especially 1:10,000) for use in forest planning. Details of villages, roads, and water courses are shown, as well as contour lines. The coordinate system used is the Universal Transverse Mercator using kilometer squares. The maps contain some errors that relate to the position of Sigon Village and to the naming of various water courses.

**Table I-15. Labeling of Topographic Maps**

| Mosaic B2 | |
|---|---|
| B2/A | B2/B |
| B2/D | B2/C |

### E4. Forest Map of Nialama Forest

The Bureau Technique of DNFF prepared this map in 1995 on the request of the project. The map is based on the air photography of 1989, supplemented by SPOT satellite imagery, and supported by forest visits to confirm the interpretation of forest vegetation. Some inconsistencies in vegetation classification were revealed during the forest inventory. The Bureau Technique of DNFF keeps a digital master copy.

The map scale is approximately 1:42,000, which is not given on the maps. The coordinate system is decimal longitude and latitude and is therefore incompatible with the topographic map series.

The map shows forest vegetation mapping interpreted from the photograph mosaics, and most water courses, villages, and roads. It therefore provides a good overview of the forest, but is not sufficiently close-scale for planning purposes.

The classified boundary of the forest was plotted before field checks were undertaken, and all boundaries shown are subject to confirmation. The northeast forest boundary is shown incorrectly on the map.

After revision of the forest map at the Bureau Technique, it should show at least 15 thematic levels in three categories: (1) general, (2) natural resources, and (3) forest management, as shown in Table I-16.

**Table I-16. Categories and Thematic Layers in Forest Map**

| |
|---|
| **(1) General**<br>• Local towns and villages<br>• Roads<br>• Actual boundaries<br>• Prescribed boundary points |
| **(2) Natural resources**<br>• Escarpments<br>• Streams<br>• Limit of watershed #9<br>• Forest vegetation classes<br>• Wildlife habitats |



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**(3) Forest management**
- Protection, production, and bowé areas
- Forest blocks/village zones
- Firebreaks
- Agroforestry areas
- Bas-fond areas
- Bamboo management areas
- Inventory transects and plot locations

## F. Forest Inventory

DNFF carried out a forest inventory during 1995-1996. Annex D contains a full description of the design and results obtained. The main value of the inventory carried out has been to provide indicative figures for the forest as a whole. However, owing to the unstratified design and low sampling intensity, the inventory cannot be used to estimate population parameters for particular forest type classes or territorial subdivisions. Although an estimate of merchantable volume has been derived, the inventory cannot be used to locate and assess potential harvest areas. The following section summarizes the implications of the forest inventory for management.

### F1. Forest Classification

Classification of the forest by vegetation type is important because each type will require different treatments and, possibly, separate working circles.

The vegetative cover of Nialama may be described as dry deciduous (*forêt sèche*), with islands of gallery forest along water courses and areas of herbaceous grassland on the *bowal* areas. The classification used in forest mapping and inventory assessment of Nialama has differentiated four major formations with minor sub-divisions (see Table I-1).

The forest map shows the dominant forest vegetation type to be *savanne arbustive*, with smaller amounts of *savane arborée claire*. Local forestry staff believe that nearly all the *savane* areas of Nialama Forest are also fallow lands of varying ages. Since savane types are the dominant vegetation, it may be concluded that shifting cultivation has been a prevalent land use in the forest.

Only small areas of closed forest (*forêt galerie* and *savane arborée dense*) remain. These should be protected against further loss and degradation.

### F2. Size Distribution

The shape of the diameter class distributions for all species recorded in the inventory portrays the inverse relationship between individual tree size and frequency of occurrence, which typifies uneven age natural forests.

The aggregation of tree diameters into an overall diameter distribution tends to obscure the occurrence of areas with distorted distributions. For example, as has been noted in the field, some areas or species may be devoid of smaller diameter classes, and others may have no larger trees. A diameter distribution at the stand level (if it were available) would, therefore, provide a useful diagnosis of stand development and could indicate the need for management interventions, such as selective thinning, to improve the distribution.

### F3. Species Composition

A total of 77 tree species (with diameters of at least 10 centimeters DBH) were recorded during the forest inventory. The most common species is *Pterocarpus erinaceous* (Bani), which accounted for 26 percent of trees measured. Although the forest stock is dominated by just a few species (six species account for 50 percent), the fact that the other 50 percent of measured trees belong to 71 other species illustrates the importance of species diversity in Nialama Forest.

The species mix is more diverse in the smaller diameter classes than in the larger ones, in which Bani predominates. The prevalence of a few species, such as Bani, in the larger sizes illustrates the higher mortality affecting other species and is consistent with the development of a fire-conditioned ecology in which a small number of tree species dominate. However, some species are inherently small, regardless of competition and their environment.

It is clear that species of high timber value, such as *Khaya senegalensis*, *Milicia regia, Afzelia africana,* and *Borassus aethiopum,* are comparatively rare and that their growing stock could not sustain an exploitation program at the present time.

### F4. Regeneration

Some areas of old fallow lands have been abandoned for enough time to ensure secondary forest regrowth. Also, some of the areas of young fallow lands exhibit adequate regeneration by colonizing species. However, forest regeneration remains poor in some areas of fallow lands, which are characterized by razor grasses and annual fires.

Three species, *Piliostigma thonningii*, *Markhemia tomentosa,* and *Combretum spp.*, dominate the regeneration recorded in the inventory. These are rapid colonizers, which are able to recover quickly after the passage of fire and can out-compete invasive grass species.

### F5. Stand Parameters

Calculations of stand parameters, such as mean stocking, the diameter distribution, height, and basal area showed extreme variability, and the number of sample plots in some vegetation types was too few to provide a basis for analysis (for example, only one plot in *savane arborée dense*).[19]

However, Table I-17 presents a tentative characterization of six forest vegetation types of Nialama Forest in terms of indicative basal area limits. Since basal area is a measure of stand density and provides a good index of woody competition, the application of such limits could serve as a yardstick to measure forest degradation of the respective vegetation classes (Lowe, 1996).

[19] Mean stocking is measured in stems per hectare, height in meters, and basal area in square meters per hectare ($m^2$/ha). Diameter distribution is the name given to the array of frequencies of trees measured in each diameter class. The class interval used in the current presentation is 5 centimeters (cm); the minimum DBH class is 10.0 to 14.9 cm; the biggest class is assumed to be 55.0 to 59.9 cm. Basal area is calculated from DBHs as the sum of the cross-sectional areas at breast height of all measured trees, expressed on a per hectare basis.

**Table I-17. Indicative Basal Area Limits for Forest Vegetation Classes in Nialama Forest**

| | Basal Area ($m^2$/ha) | | |
|---|---|---|---|
| **Forest Vegetation Types** | **Mean** | **Minimum** | **Maximum** |
| Forêt galerie | 13.8 | 10 | 20 |
| Savane arborée dense | 12.3 | 8 | 13 |
| Savane arborée claire | 9.4 | 8 | 13 |
| Savane arbustive | 6.6 | 5 | 8 |
| Jeune jachère | 5.3 | 5 | 8 |
| Savane bowé | 4.5 | 3 | 5 |

**Source:** File VAR-SUM

The required observations of basal area required might come from repeated inventory assessments or from direct measurements of selected area to monitor the effect of management of fire and cultivation in the forest.

### F6. Harvesting Potential

It is clear that species of high timber value, such as *Khaya senegalensis*, *Milicia regia, Afzelia africana,* and *Borassus aethiopum* are comparatively rare, and that their growing stock could not sustain an exploitation program at the present time.

Only Bani is sufficiently widespread in the forest to allow sustainable wood harvesting. Only about 16 percent of the Bani trees measured could be considered for eventual timber use (classes A and B); the remaining trees were judged suitable only for firewood (class C). The diameter distributions of Bani trees show that class C trees are more abundant in small DBH classes than larger ones.

Selection felling and thinning would be governed by minimum diameter limit. For the allowable cut of Bani for timber (classes A and B), it is assumed that a conservative limit of 45 cm DBH should be applied to the minimum harvesting size and that trees more than 50 cm DBH are technically over-mature. The target size for harvesting Bani is therefore set at 45 to 50 cm DBH.

For the firewood market, smaller diameters are preferred (10 to 35 cm). The selective thinning of lower quality trees should favor the development of trees in class A and B. However, to prevent the possible removal of trees with commercial potential, the management plan places a lower harvesting limit of 35 cm DBH on trees of class C.

According to calculations based on the inventory results, the annual allowable cut of Bani is 200 trees (approx. 300 $m^3$) of class A & B, and 1,200 trees (approx. 2,000 steres) of class C. Table I-18 shows the annual allowable harvest of Bani.

**Table I-18. Annual Allowable Harvest of Bani**

| Quality Classes | Number of trees | True Volume Equivalent ($m^3$) |
|---|---|---|
| A and B | 200 | 300 |
| C | 1,200 | 1,300 |

**Note:** Volume of class C corresponds to 2,000 steres.
**Source:** lotus file AAC

The calculation is based on five assumptions:

- Approximately 70 percent (7,000 ha) of the declared forest area (10,000 ha) falls within the forest production category.[20]
- The free growth rotation of Bani to 55 cm DBH is 60 years.
- The average time of passage of trees between successive diameter classes is 10 years.
- The minimum diameters for harvesting of trees in classes A and B is 45 cm and, in class C, 35 cm.
- An additional amount, equivalent to approximately 10 percent of the stock of oversize trees (with DBH exceeding 50 cm), should be cut each year, to counteract the development of an over-mature growing stock.

The calculation of annual allowable harvest of Bani needs to be repeated every five years, taking into account the ease or difficulties reported in locating harvestable trees, the actual rate of harvesting compared to that planned, and periodic fresh inventories of the Bani wood resource.

## G. Wildlife Resources

### G1. Wildlife

The wildlife of Nialama Forest is not well documented. A recent survey (Ham, 1995) listed 25 species of mammals in the forest on the basis of at least one of the following: hunter's report, tracks, feeding remains, feces, sleeping sites, vocalizations, visual observations, or dead animals. Hunters' observations were the most common indicators.

Six mammals were listed as abundant, including the chimpanzee, 14 were listed as common; and 5 were listed as rare.[21] Another seven mammals, which once existed but are no longer found in the zone, were also listed.[22]

Within the forest, the main habitat of the chimpanzees lies to the north-east of the enclave villages of Kagnégandé and Diawbhé. Although most chimpanzee nests and transit routes lay in

[20] Forest production category is the remaining area of the entire forest, after excluding areas falling into protection categories and bowal.

[21] Tropical African hedgehog, giant pangolin, leopard, western bushbuck, duiker.

[22] Wild dog, striped hyena, spotted hyena, lion, roan antelope, giant eland, buffalo.



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the forest reserve, outside the enclave, a part of the enclave (estimated as 25 ha) is occupied and visited by chimpanzees. The area concerned has a riparian gallery forest of little agricultural value. It does, however, include land formally allocated to those villages at the time of forest reservation. Several species of trees (e.g., *Parkia biglobosa*, *Spondias mombin,* and *Ficus* spp.) provide fruit and nuts for chimpanzees and humans.

### G2. Birds

A preliminary survey of birds observed in Nialama Forest listed 32 bird species, of which 17 were not observed elsewhere in the Koundou watershed. These numbers may be contrasted with the total of 54 bird species observed either in or close to the forest (Bourque, 1995).

# SECTION II
# ANALYSIS AND STRATEGY

## A. Problem Statement

### A1. Forest Degradation

Forest degradation can be defined as the loss of biological diversity, the transition to a forest vegetation type of lower biomass (e.g., from *savanne arborée dense* to *savanne arborée claire*), or the complete loss of all tree cover. The main factors leading to forest degradation in Nialama Forest are wild fires, agricultural encroachment, and to an undetermined extent grazing.

These pressures existed at the time of classification in 1943 and for probably at least a century previous to that. It is thought that if the current management void were to remain, the forest would likely disappear in the next generation (MacLain, 1994).

The problems facing management are (1) reducing the number of wild fires occurring late in the dry season, so that the temperature and duration of fires do not destroy the vegetation's chances of regeneration; and (b) preventing permanent agricultural encroachment and discouraging any shortening of fallow rotations following temporary cultivation in the forest.

### A2. Rural Poverty

In a rural economy, the chief cause of poverty is shortage of fertile cultivable land on which to support a family and, perhaps, to produce a surplus crop for cash sale or barter. In the villages surrounding Nialama Forest and, in particular, the enclave villages, no opportunities for employment exist. Consequently, a shortage of farm production will inevitably drive young families to seek a livelihood elsewhere.

Many families depend on supplies of wood and non-wood forest products from the forest, such as bamboo, firewood, and game. These uses for family consumption are permitted in classified forests under the forest code. However, commercialization of forest products to generate income is not currently allowed.

The problems facing management are to (1) provide cultivable land without encouraging forest degradation, and (2) facilitate the limited commercialization of forest products as a means to supplementing family budgets.

### A3. Ecological Importance

Despite a partial degradation of large portions of Nialama Forest, the forest remains a reservoir of biological diversity and provides a variety of habitats for wildlife, including protected species such as chimpanzees and leopards. The problem facing management is to protect the ecological integrity of the forest without unduly restricting the production opportunities accruing to the local population.



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### A4. Watershed Catchment

Nialama Forest overlays two adjacent water catchment areas. The regional importance of the Fouta Djallon as the font of major water supplies for neighboring countries is well recognized. Also, on a local level, water supplies for domestic use, drinking, and livestock depend on the perennial streams that begin within the forest area, particularly in the dry season.

A mixed level canopy forest provides the most effective vegetation cover for the protection of soils in water catchment areas. This type of canopy protects against direct precipitation, surface erosion, and stream bank erosion. The problem facing management is how to minimize the increased exposure to erosion that might accompany production activities within the forest, as well as to limit erosion risks arising from wild fire damage to vegetation cover.

### A5. Institutional Weakness of State Forest Service

Despite the high number of classified forests in Guinea, few have current management plans. Given the lack of budgetary, material, and human resources, the forest service is bound to concentrate its activities on forests capable of providing a revenue stream to the government.

The forest service at prefecture level has insufficient resources available to actively manage and monitor Nialama Forest. Currently, an *agent forestier* assists one *cantonnement forestier*, but the *cantonnement forestier* is without technical support from either prefecture or national levels. The problem facing management is to devise a simple management plan that the forest committee can implement while the DNFF/SPFF fulfills a monitoring and technical assistance role.

## B. Objectives

Taking account of the problems to be addressed, six objectives have been defined for the technical management plan. They are not prioritized because all are important. However, it is likely that the forest committee will be more interested in objectives 4 through 6. From a local standpoint, they may support objective 3, the protection of the watershed. This was also the primary stated objective for forest classification in 1943.

**Arrest deforestation and forest degradation by:**

- Affirming the classified status of Nialama Forest
- Maintaining the boundary integrity
- Preventing permanent conversion to other land uses
- Ensuring that forest remains the long-term vegetation cover

**Protect the forest ecology by:**

- Protecting and maintaining the health and vitality of forest resources
- Maintaining the biological diversity of forest resources, including fauna
- Protecting the population and habitat of all protected species such as chimpanzees

**Protect the watershed by:**

- Preventing soil exposure on steep slopes
- Limiting the duration of cultivation on gentle slopes



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- Excluding production activities near sources of water courses and along their banks

**Provide access to cultivable land by:**

- Introducing agroforestry systems in selected areas of the forest
- Continuing access to existing *bas-fonds*
- Providing limited access for grazing

**Enhance the supply of forest products by:**

- Introducing timber and firewood harvesting of Bani

**Enhance the opportunities for income generation by:**

- Permitting the commercialization of timber, firewood, and other forest products
- Promoting the commercializing bamboo on a pilot basis

## C. Silvicultural Management

### C1. Fire Management

Fire management is the most important component of the technical proposals for the management of the Nialama Forest Reserve. The role of communities in fire management is therefore central to the proposed co-management contract between the forest committee and DNFF.

It is recognized that the species composition in the forest is a result of the fire-conditioned ecology. It is therefore likely that the complete exclusion of fire, if that were achievable, would result in a different species mix, particularly among larger trees. However, a strategy of fire exclusion would lead to an accumulation of combustible matter in the forest, which would exacerbate the temperature, severity, and duration of any fire that eventually entered the forest. Such an event could have catastrophic consequences for the entire range of vegetation and would destroy much wildlife and its habitat.

A program of controlled burning will therefore be proposed. This will take advantage of natural firebreaks (such as permanent water courses) within the forest. Fire management should involve the use of early burning to reduce fuel loads, burn temperatures, and duration, but management should not seek to eliminate fire from the forest.

### C2. Natural Regeneration

Any silvicultural system used in natural forest management must ensure regeneration and recovery of the forest after any proposed exploitation. Although the inventory assessment of regeneration was potentially flawed, there is ample visual evidence that natural regeneration thrives throughout all the forest, except on *bowal* and some limited areas of old fallow which have been overcome by invasive grasses.[1] Where natural regeneration does prevail, the maintenance costs are minimal and a policy of benign neglect may be practiced after an initial

[1] This problem is severe in the area of Kansouma and Bulli Bahbi.

period of fire protection. The high initial stocking provided by natural regeneration offers some insurance against mortality losses.

In comparison, tree planting is a high-risk strategy, both technically and economically, and is likely to fail for several technical reasons. Little is known about the nursery requirements of many native species, a problem which may be accompanied by poor matching of species to site. In addition, planted trees face all the dangers that beset natural regeneration, such as competition, lack of weed control, fire, and grazing.

Economically, the physical and financial resources required to sustain a planting program of significant size are not likely to be available in the foreseeable future from DNFF, the forest committee, or any donor project. Even if such resources were available, the long rotations involved, especially in the case of the high-value species (such as *Milicia regia*, *Khaya senegalensis,* and *Afzelia africana*), would prevent any positive economic rate of return on the planting. Therefore, natural regeneration should be the first choice in all areas of the forest, and tree planting should be confined to identified problem areas where natural regeneration has failed, or is likely to fail.

### C3. Agroforestry

Fire management, which is essential to reverse forest degradation, is inescapably linked to access to cultivatable land in the forest. Whereas fire management should be DNFF's top priority, all consultations with the forest committee have shown that the issue of cultivatable land dwarfs all others. Indeed, the forest committee's credibility hinges on its success in successfully negotiating this access with DNFF. Additional use rights, such as timber harvesting, have a low priority, and DNFF must fully recognize this in contract negotiations.

Local forestry staff believe that nearly all the savanna areas of Nialama Forest are also fallow lands of varying ages. Since savanna vegetation is dominant, it may be concluded that shifting cultivation has been a prevalent land use in the forest, even at the time of reservation in 1943. Certainly, shifting cultivation has historically been the traditional land management practice in most parts of Africa. Nevertheless, as noted previously, natural regeneration thrives in most areas of Nialama Forest.

When practiced on a rotational fallow, shifting cultivation can be managed in a sustainable agroforestry system. The only difference between managed rotational fallow and taungya is a reliance on natural regeneration rather than reliance on a high-risk strategy of tree planting.

Uncontrolled cultivation in the forest leads to forest degradation. Therefore, the management plan proposes a strict management regimen that would link the successful protection of regeneration from fire and grazing to the conditional availability of new areas for cultivation. Such areas would exclude protected areas. Furthermore, to provide flexibility in application, it is proposed to limit the extent of agroforestry areas.

Managed rotational fallow, coupled with the acceptance and protection of naturally regenerating areas, should be introduced in selected parts of the forest that are not classed as protected areas. The areas under cultivation at any time should not exceed five percent of the entire forest.

### C4. Cultivation in the *Bas-fonds*

The *bas-fond* areas of Nialama present a special challenge to forest management. They are situated along water courses that, according to the objectives of the management plan and the classification document, should be protected from production activities. Cultivation of the *bas-fonds* is therefore incompatible with management objectives.

However, despite this contradiction, cultivation rights were granted at the time of forest classification in 1943, although this was restricted to the *riziculture marais*.[2] This definition has proved elastic, and cultivation of the *bas-fond* areas of the forest could potentially expand uncontrollably unless the management plan and co-management contract specify limits. Currently, *bas-fonds* extend to noninundated areas and, on occasion, up slopes. Nor are the crops confined to rice; it is common to find vegetable and other cash crops being grown in the *bas-fonds*. Although it may be argued that such practices are consistent with the objective of income generation, the ownership pattern of the *bas-fonds* restricts the benefits to a few people only.

A hazard associated with intensive cultivation of the *bas-fonds* is the possible future applications of agrochemicals, which might pollute water supplies.[3] The possible future expansion of *bas-fonds* should be subject to a limit of five ha per year for five years. No agrochemicals (pesticides, herbicides, or inorganic fertilizers) should be permitted in the *bas-fonds*.

### C5. Wood Harvesting

According to the inventory results, sustainable production of timber and firewood from Bani is possible. This would be carried out by selective felling of timber trees and selective thinning of poor quality trees for firewood. Selective felling of Bani for timber and selective thinning of class C trees for firewood should be carried out in parts of the forest that are not classed as protected areas. Owing to the low number of stems per hectare and the low-impact technologies available, no special guidelines concerning harvesting methods are required.

Harvesting would be governed by minimum diameter limits. According to market requirements and local sawing techniques, Bani trees harvested for timber (classes A and B) should have diameters of at least 45 cm DBH at time of felling. Trees exceeding 55 cm DBH are too large for manual harvesting methods.

For the firewood market, smaller diameters are preferred (10 to 35 cm). The selective thinning of lower quality trees should favor the development of trees in classes A and B. However, to prevent possible removal of trees with commercial potential, the management plan places a lower harvesting limit of 35 cm DBH on trees of class C.

Because the results from the inventory cannot be used to locate and assess potential harvest areas for harvest volumes, overall harvesting limits will be applied to the production area of the forest as a whole.

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[2] Rice grown in marsh or semi-inundated land.

[3] This hazard was first identified in the Environmental Assessment, USAID, 1996.

Annual allowable harvest of Bani has been calculated on specific assumptions concerning the productive area of the forest, the free-growth rotation to technical maturity, the time of passage between successive diameter classes, and the minimum DBH of trees that may be harvested. Also, an additional harvesting allocation has been justified because of the current excess of oversize Bani trees indicated by the inventory.

Only Bani is sufficiently widespread in the forest to allow sustainable wood harvesting. Other species of low value, such as *Daniellia oliveri*, occur in the larger diameter classes (more than 45 cm). In principle, these may be harvested, subject to the marking being carried out by the *agent forestier*.

It is clear that species of high timber value, such as *Khaya senegalensis*, *Milicia regia, Afzelia africana,* and *Borassus aethiopum,* are comparatively rare, and that their growing stock could not currently sustain an exploitation program.

### C6. Harvesting of Bamboo

Although the inventory assessed the presence of bamboo, the locations and extent of this resource are not well defined. The most remarkable aspect of bamboo is that flowering is rare, but when it occurs, the aboveground parts of the plant will die. According to the consultant's understanding of the species concerned (*Oxytenanthera abyssinica*), flowering takes place at intervals of between 15 and 30 years. The regular harvesting of all stems on a plant may inhibit flowering and so prolong its productive life.

Bamboo is used locally for house construction and maintenance, and according to information received directly from villagers, supplies are adequate for that purpose. It has been suggested (Guinea NRM, 1996) that bamboo might be commercialized by local villagers as furniture. However, furniture makers usually prefer to use rattan. Also, efforts to add value to primary products at a distance from the end-market are likely to involve problems of stock control and cash flow. More importantly, the necessary skills and appreciation of market conditions may not exist locally.

An alternative approach is to consolidate the production of existing bamboo products, such as screens and poles, and ensure sustainable supply. This would involve setting up a sales outlet on the national highway at Komba.

## D. Forest Zoning and Area Organization

As a result of forest mapping, the forest vegetation has been classified into *forêt galerie*, *savanne,* and *bowé* (see Table I-1). For management purposes, it is also necessary to distinguish:

- Functional categories
- Spatial organization (forest blocks)
- Working circles

### D1. Functional Categories

All classified land within Nialama Forest should be managed in one of the three following categories as shown in Table II-1.

**Table II-1. Estimated Areas of Functional Categories (provisional)[4]**

| Category | Area (ha) |
|---|---|
| Protected | 2,000 |
| Bowal | 1,000 |
| Production | 7,000 |
| Forest Total | 10,000 |

**Protected areas** are defined as:

- Gallery forests
- Springs or water courses
- Steep slopes exceeding 30 degrees or 60 percent (approximately)
- A buffer of 10 meters each side (total 20 meters) of a perennial stream
- A buffer of 5 meters each side (total 10 meters) of other streams
- Habitat areas of legally protected mammals (including a buffer of 100 meters)
- Identified wildlife transit routes
- Regeneration or replanted areas

***Bowé* areas** are defined as:

- Lateritic plateau with grass or *savanne bowé* vegetation cover

**Production areas** are defined as:

- Forest land outside the protected area and *bowal*

### D2. Forest Blocks

Forest blocks provide the area framework for assigning protection responsibilities, localizing interventions, and allocating conditional benefits.[5] For organizational and administrative purposes, Nialama Forest has been tentatively subdivided into seven provisional forest blocks, each a contiguous area identified on the basis of village zones.[6]

A survey of the individual use zones of 30 villages was undertaken as part of the co-management process in 1996 (Williams and Thiam, 1996), which differentiated seven principal forest uses. During the technical management planning phase, these were synthesized into a map of village zones within Nialama Forest. The following criteria were used for identifying the village zones:

[4] Estimated areas are subject to revision following more detailed analysis of maps.

[5] The term "conditional benefit" refers to those cultivation and tree exploitation rights that are not already granted under existing legal provisions.

[6] This allocation is provisional, pending further discussion with the forest committee, and its approval of a final allocation.

- The allocation of conditional benefits should be linked to the acceptance by villages, either singly or in groups, of territorial responsibility for forest protection.
- The zones should correspond, as much as possible, to traditional tenure and usufruct rights.
- The areas and potential of the zones should match the needs and forest-dependence of the corresponding villages.
- The boundaries of each zone should, where possible, coincide with natural fire breaks.[7]

Table II-2 shows the estimated areas of village zones in the Nialama Classified Forest. The revised forest map shows the position and limits of each village zone. The forest blocks constitute the primary spatial organizational structure for forest management.

**Table II-2. Estimated Areas of Village Zones in Nialama Classified Forest (provisional)[8]**

| Zone | Villages | Limits | Population | Area (ha) |
|---|---|---|---|---|
| 1 | Nialama | | 250 (est) | 1,000 |
| 2 | Tyewère | | 404 | 1,600 |
| 3 | Kagnégandé, Diawbhé, Bendougou | | 439 | 1,600 |
| 4 | Sigon, Bassan | | 150 | 1,000 |
| 5 | Linsan Foulbhé | | 367 | 1,600 |
| 6 | Linsan Saran | | 1,120 | 1,600 |
| 7 | Goundoupi, Nètère, Donghol, Telobofi | | 491 | 1,600 |

Notes: THIS TABLE IS PROVISIONAL-(i) it does not yet include some villages (e.g. Madina) already participating in the co-management process; nor (ii) include possible new villages (e.g. Bomini); and, (iii) areas are indicative estimates, subject to verification.

### D3. Working Circles

The management plan for Nialama defines six working circles, as follows:

- Fire management
- Wildlife protection

[7] Natural firebreaks are, in order of preference: perennial water courses, roads, escarpments, valleys, and ridges. Footpaths, although not usually wide enough to serve as firebreaks, are acceptable because they provide access to the fire.

[8] Estimated areas are subject to revision following the completion of the zoning exercise and the approval of the Comité Forêt.



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- Agroforestry
- Cultivation in *bas-fonds*
- Productive management of Bani
- Productive management of bamboo

Each working circle applies to one of the three functional categories (protection, production, or bowé) and constitutes a set of treatments intended to achieve a common immediate objective.

Each working circle applies to one or more forest blocks (village zones). In a multipurpose forest, it is not possible to assign a unique working circle to a particular area unit. This means that subdivision of forest blocks into compartments cannot be done.[9]

## E. Co-Management and Administration Arrangements

The management plan will provide the technical conditions underlying a co-management contract that has yet to be negotiated between DNFF and the forest committee, on behalf of the participating villages.

Duties and responsibilities will need to be allocated at various levels on each side of the contract, by DNFF at headquarters, prefecture, and cantonnement levels; and by the forest committee at committee and village levels.

PGRN's possible role in implementing the management plan will also need to be defined in two time frames: in the short term, until the end of the current phase (September, 1997); and in the medium term, during any successor project. Analytically, duties and responsibilities will be allocated according to functional categories, village zones, and working circles.

### E1. DNFF

The Forest Management Division of DNFF will allocate forest land between protection and production categories, according to the guidelines set out in section D.

Within limits laid down in the management plan, the SPFF will issue annual composite licences for timber felling, silvicultural thinning, bamboo harvesting, and game hunting. Such licences are intended to apply to additional rights, over and above customary entitlements, that may be commercialized.

The *cantonnement forestier* will provide technical assistance to the forest committee, particularly in the interpretation and localization of the management plan, and will be the point of contact between the forest committee and DNFF.

The *agent forestier* will be responsible for identifying specific areas for the treatment interventions (e.g., agroforestry) laid down in the management plan and selecting and marking trees for felling. The *cantonnement forestier* will be responsible for approving locations.

[9] The term "compartment" is used here in the narrow sense to mean a contiguous area identified by a particular treatment intervention regime.



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Neither the *cantonnement forestier* nor the *agent forestier* will exercise any authority or policing role. The *cantonnement forestier* will be responsible for monitoring and evaluating the plan, but not for its actual implementation.

The *agent forestier* will be responsible for the daily monitoring of the plan implementation. He will provide the information needed for monitoring and will report transgressions directly to the *cantonnement forestier* and the forest committee.

Collection of license fees will be carried out on a quarterly basis directly between the forest committee and SPFF. Transgression fines and penalties will be determined as part of the annual evaluation and will be paid directly, when levied, to SPFF.

**E2. Forest Committee**

The allocation of forest land to the village zones will be carried out by the forest committee, having obtained the approval of all village assemblies concerned, that is, those with a direct or competing interest.

The forest committee will ensure compliance by the participating villages with respect to:

- The programs, provisions, and conditions of the management plan, especially in relation to fire management and agroforestry
- The forest code
- The conditions contained in the reservation document

The forest committee will control and allocate contracts for timber felling, firewood cutting, bamboo harvesting, and game hunting, within the overall composite licenses issued by SPFF.

Payment of appropriate license fees to SPFF at the prefecture level will be made out of contract revenues. Transgression penalties will be paid annually by the forest committee, after evaluation.

**E3. Villages**

Villages will be delegated by the forest committee to apply supervision, control, and sanction of village members with respect to:

**Agricultural activities:**

- Identification of suitable agroforestry land
- Allocation of allotted cultivation land among farmers of the village
- Notification of potential additional *bas-fond* areas
- Prevention of cultivation of unauthorized *bas-fonds*
- The control of grazing

**Forest protection:**

- Protection of regeneration areas and other designated zones
- Prevention of unauthorized harvesting of trees, bamboo, or other forest products
- Early burning in village zone
- Fighting fires within and up to boundary of village zone
- Prevention of unauthorized hunting

**Forest harvesting:**

- Identification of bamboo groves and trees for harvesting or thinning, in accordance with guidelines set out in the management plan
- Harvesting of bamboo and other forest products within the village zone

### E4. The Project

The project will need to provide continued technical assistance during plan implementation. Additionally, if acceptable to both parties to the contract (DNFF and the forest committee), the project should conduct an annual evaluation and prepare the contract compliance statement.

## F. Monitoring and Evaluation

Monitoring and evaluation is an integral part of a technical management plan. Five aspects of the plan that require monitoring and evaluation are (1) treatments, (2) effects of treatment, (3) unplanned fire events, (4) agricultural areas, and (5) contractual compliance.

**Treatments.** The intervention programs specify treatments according to directives and schedules. Monitoring should record if, when, and how much treatment was carried out. For example, monitoring should record if early controlled burning was completed in each forest block before the date suggested, and whether regeneration and other protected areas in the respective blocks were, in fact, protected from the fire.

**Effects of treatments.** It is equally important to record the effects of treatments, for example, to make notes comparing the survival of regeneration in parcels protected from fire with those not protected. In this way, the results of treatments based on incomplete knowledge can be monitored and adjusted as experience is gained. This will constitute a simple program of applied research.

One aspect of particular importance will be the monitoring of regeneration within the system of agroforestry, to determine whether cultivation adversely affects natural regeneration and/or whether tree planting will be required.

Also included in treatments is the selective harvesting of Bani for timber and firewood. Monitoring should record the numbers of trees cut and estimates of volumes removed.

**Unplanned fire events.** Although there will be a program of early controlled burning, it is expected that a certain number of wild fires will still enter the forest. Monitoring should record the dates, locations, and approximate surface areas affected. Records should be kept in the same way for controlled burns which occur after the date limits prescribed in the treatment schedule.

However, it is not necessary to record under this section the planned controlled burns carried out before the date limits.

**Agricultural areas.** All agricultural cultivation activities in the forest should be recorded for each forest block or zone. This includes both planned agroforestry and unapproved activities which come to light. The information recorded should include the location, approximate surface area, duration and age as a cultivation site, crops and village of farmer.

**Contract compliance.** Monitoring should make use of standard record forms that have been prepared for this purpose. It is suggested that these be completed quarterly (i.e., every three months) and within two weeks at the end of a quarter.

Evaluation should be carried out annually on the basis of monitoring the standard record forms. The evaluation should be mainly quantitative but contain text commentary. It should include:

- A comparison between planned and actual treatments
- An assessment of the results of treatments
- An assessment of the results of any discrepancies between planned and actual treatments
- An assessment of the impact of unplanned fires on the forest
- An assessment of agricultural cultivation in the forest

On the basis of the technical plan evaluation, a compliance statement should be completed annually. This statement may then serve as a basis for contract renewal.

The purpose of any research proposed in this management plan is to improve the technical basis for treatments. Research activities should concentrate on the monitoring of the implementation and effects of prescribed treatments, and not include any long-term commitments or areas of wider interest. Accordingly, only simple applied research is proposed, oriented to monitoring the implementation and effects of treatments prescribed in the intervention programs of the management plan so that misunderstandings can be corrected as experience is gained.

To monitor the forest cover of Nialama Forest, a periodic assessment should be carried out every five years, using SPOT satellite images to interpret changes. This could be done under the auspices of the Bureau Technique of DNFF.

It is also proposed that a study be carried out by the local people's knowledge of plants found in Nialama Forest that have medicinal and strong biochemical properties. This could be done by a research student (as part of a Ph.D. program) in cooperation with the local forestry staff and forest committee. The objective would be to investigate potential applications of any unique findings.

# SECTION III
# INTERVENTION PROGRAMS

## A. Forest Protection

### A1. General Limitations on Production Activities

**No cutting of trees, pasturage, or cultivation will be permitted in protected areas.**

Protected areas have been defined as:

- Gallery forests
- Springs of water courses
- Steep slopes exceeding 30 degrees or 60 percent (approx)
- A buffer of 10 meters each side (total 20 meters) of a perennial stream
- A buffer of 5 meters each side (total 10 meters) of other streams
- Habitat areas of legally protected mammals (including a buffer of 100 meters)
- Identified wildlife transit routes
- Regeneration or replanted areas

**No cutting will be permitted of trees that are:**

- Not approved and marked by an *agent forestier*
- Of important timber value[1]
- Of important food value to humans and/or wildlife[2]
- With a DBH of less than 45 cm, unless they are
    - Part of silvicultural thinning programs
    - Part of an approved agroforestry zone

### A2. Boundary Integrity

**Immediate Objective:** *Maintenance on the ground of the reserved status of the forest.*

**Treatment Directives:**

- The process of identifying and demarcating the actual and locally recognized limits of the forest reserve should continue.

---

[1] High value trees include *Borassus aethiopum*, *Khaya senegalensis*, *Afzelia africana*, and *Milicia regia*. This restriction will be reviewed every five years.

[2] The list currently includes *Parkia biglobosa*, *Spondias mombin*, and *Ficus* spp.

- The actual ground positions of all corner points (A through N) should be recorded with a GPS using multiple readings to reduce errors.[3]

**Table III-1. Treatment Schedule for Boundary Integrity**

| Treatment | Locations | Quantity | Timing | Executed by |
|---|---|---|---|---|
| Identify and demarcate forest boundary | Forest boundary | 48 km | 1997-1998 | *Cantonnement forestier* |
| Determine GPS positions of boundary points | Forest boundary (A-N) | 14 points | 1997-1998 | *Cantonnement forestier* |

### A3. Fire Management

**Immediate Objective:** *To manage fire impact on the forest by reducing the severity, temperature, and duration of fires, but not to eliminate them.*

**Treatment Directives:**

- Controlled burning should be practiced throughout the forest, except in:
  - Habitat areas of legally protected mammals
  - Regeneration or replanted areas
- Controlled burning in each village zone should be carried out by the responsible village, taking advantage of natural fire breaks and limits
- Controlled burning on steep slopes (exceeding 30 degrees or 60 percent) should always proceed downhill and use side breaks to limit lateral spread

**Table III-2. Treatment Schedule for Fire Management**

| Treatment | Locations | Quantity | Timing | Executed by |
|---|---|---|---|---|
| Prepare any artificial firebreaks | Forest boundary and boundaries of village zones | | Before mid-November | village |
| Controlled burning | Bowal | | Before end-November | village |
| Controlled burning (10 meter wide strips) | Along boundaries between village zones, along forest boundaries and steep slopes | | Before mid-December | village |
| Controlled burning | In remaining areas, prioritizing *jeune jachère* with regeneration 3-10 years old and bamboo groves | | Before mid-January | village |

[3] A minimum of 500 observations is recommended. The PGRN has a GPS with an automatic averaging function. Points B-C have already been located using multiple observations, points G-K with single observations.



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### A4. Wildlife Protection

**Immediate Objective:** *Maintenance of habitat and food sources for fauna, especially chimps and other protected species currently found in Nialama Forest Reserve.*

**Treatment Directives:**

- The management agreement between DNFF and the forest committee will include a clause confirming cultivation rights for the enclave villages of Kagnégandé and Diawbhé in the forest reserve on the eastern flank of the enclave in exchange for setting aside that part of the enclave in which the chimpanzee habitat is situated. The area involved amounts to approximately 25 ha. Initially, no change of classée status would be involved.[4]

- Maps will be prepared showing all known habitat areas for protected species in Nialama, including a buffer of 100 meters and wildlife routes identified within the forest.

**Table III-3. Treatment Schedule for Wildlife Protection**

| Treatment | Locations | Quantity | Timing | Executed by |
|---|---|---|---|---|
| Protect area of chimpanzee nests | Northeast corner (near point "O") of enclave | 25 ha | 1997-98 | DNFF |
| Assign substitute cultivatable land | East of enclave, south of chimpanzee nesting area; west of T. river | 25 ha | 1997-98 | DNFF |
| Prepare maps | Enclave land swap; habitat areas of protected species | 2 maps | 1997-98 | DNFF with project assistance in field |
| Propose adjustment to reservation document | Enclave land swap | Amended document | 1998-99 | DNFF |

## B. Forest Production

Production activities are constrained by the general limitations on production activities discussed at the beginning of this section.

### B1. Agroforestry

**Immediate Objective:** *Provision of cultivable land, and the rehabilitation of forest cover in ex-cultivated areas of forest (excluding bas-fonds) using agroforestry systems and natural regeneration, supplemented by enrichment planting.*

[4] The revised forest map shows the areas involved.



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**Treatment Directives:**

- Each village will be assigned an identified agroforestry zone within its village zone, according to the terms of the management contract agreed to by DNFF and the forest committee. To provide a contingent reserve of land, the extent of the agroforestry zone will not exceed 33 percent of the potentially productive land area (after deducting protective area and bowé). The agroforestry zone excludes steep slopes exceeding 30 degrees or 60 percent.

- Subdivision of the agroforestry zone for use by individual families from that village will be made by the village concerned.

- The preferred agroforestry system will be rotational fallow, which will rely on natural regeneration of forest tree species; in those cases where natural regeneration has failed, or is likely to fail, enrichment planting with native species under taungya may be used.

- The length of rotation will be set initially at 16 years, with an option to extend; the period of cultivation will be set at two years, with a fallow of 14 years. This will correspond to a land use intensity factor of 12.5 percent, which is well below the level of 30 percent above which cultivation could be described as semi-permanent.[5]

- A given agroforestry zone will be nominally divided into eight equal parcels. These need not be contiguous, but should be within 500 meters of each other to facilitate supervision.

- On entering a parcel to cultivate, the farmer may clear that parcel of small trees and use them as firewood, provided that:

  - They are less than 15 cm DBH.
  - They are not protected species.
  - There would remain an adequate number of larger over story trees (100/ha; at approximately 10 meters apart).

- After cultivating the first parcel for two years, farmers will move on to a second parcel for an additional two years.

- During the cultivation of the second parcel, the farmer must fully protect the first parcel from cultivation, fire and grazing to nurture natural regeneration.

- After an additional two years, the farmer may proceed to a third parcel if, and only if, the protection of the first parcel has been implemented. Failure at this point will disqualify the farmer concerned from further cultivation.

- Assuming a successful progression to a third parcel, the farmer becomes responsible for the full protection of the second parcel. After the fourth year, the first parcel then becomes only partially protected, which means that it must receive controlled burning

[5] The land use intensity factor (R) is calculated as (Cx100) / (C+B), where C equals the duration of agricultural use and B equals the duration of fallow. The size of the land use factor should not be confused with the percentage of forest cover under cultivation, which will not exceed a maximum limit of 5 percent.



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each year according to the directives of the fire management program; limited grazing may also be permitted at this stage.

- The rotation will be complete when the eighth parcel is abandoned, whereupon the farmer may re-enter the first parcel.
- If the stocking at the end of the cycle is judged by the *agent forestier* to be insufficient to permit re-entry by the farmer, a substitute parcel will be arranged from the contingency reserve areas.[6]
- If it is decided to extend the rotation to favor the growth of timber-sized trees, land may be drawn from the contingency reserve area, enabling the rotation to be extended up to 48 years.
- In those areas where regeneration has failed, or is likely to fail, enrichment planting using native species may be carried out. Each village will be encouraged to set up a bare-root tree nursery for that purpose.
- Because areas of poor natural regeneration are usually areas that suffer from severe annual fires, user rights of the planted trees should be granted to the families concerned to encourage protection.
- The design of the rotational fallow cycle is indicative and may be changed to suit circumstances (for example, high inherent soil fertility), provided that the land use intensity factor should not exceed 20 percent (equivalent to 3 years cultivation and 12 years fallow).

**Table III-4. Treatment Schedule for Agroforestry**

| Treatment | Locations | Quantity (ha) | Timing | Executed by |
|---|---|---|---|---|
| Partially clear smaller trees from parcel of land | Spread over 7 village zones | 145 | Year 1: (Jan-April) | villages |
| Cultivate | | 290 | Years 1-2 | villages |
| Fully protect | | 290 | Years 3-4 | villages |
| Partially protect | | 1730 | Years 5-16 | villages |

Given that the estimated productive area of Nialama Forest is assumed to be 7,000 ha, the overall area of the agroforestry working circle would not exceed 2,333 ha (33.3 percent), and the maximum area under cultivation at any one time would be 290 ha, which is less than 3 percent of the entire forest area of 10,000 ha. On average, this would amount to no more than 41 ha in each village zone.

[6] The contingent reserve area will be 50 percent of potential productive area; see treatment directive (1) above.



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### B2. Management of Cultivation in *Bas-Fonds*

**Immediate Objective:** *Income generation for village inhabitants and protection of water courses.*

**Treatment Directives:**

- The register and map of existing *bas-fonds* and tapades in the forest reserve will be accepted and registered as an annex to the management contract between DNFF and the forest committee.
- From the effective date of the management contract, no more than 5 additional *bas-fonds*, or 1 ha in area, whichever is smaller, will be surveyed and registered each year. No more than one additional *bas-fond* area will be allowed for any one family.
- Registered *bas-fonds* and tapades within the classée forest may be used for cultivation in accordance with the conditions of the classée document.
- Cultivation of nonregistered *bas-fonds* will not be permitted.
- Newly established *bas-fonds* may not involve the clearance of stream bank vegetation within 10 meters of a perennial stream, or within 5 meters of any other stream.
- No *bas-fond* may extend onto slopes with a gradient exceeding 30 degrees (or 60 percent) without erosion protection measures.
- No agrochemicals (e.g., herbicides, pesticides, inorganic fertilizers) will be permitted in the *bas-fonds*.

**Table III-5. Treatment Schedule for Bas-Fonds Cultivation**

| Treatment | Locations | Quantity | Timing | Executed by |
|---|---|---|---|---|
| Consolidate existing *bas-fond* areas | As per Table I-5 | 26 ha | 1997-1998 | DNFF |
| Survey and register additional *bas-fond* areas | Not within any area of gallery forest or near to a stream head | 5 *bas-fonds* or 1 hectare | Annual review | DNFF |

### B3. Productive Management of Bani

**Immediate Objective:** *Management of Bani* Pterocarpus erinaceous *resource for promotion of timber value, supply of firewood, and income generation.*

**Treatment Directives:**

- The silvicultural system to be used in the management of Bani will be a selection system.



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- The harvesting of Bani for timber will be selective, based on a minimum girth limit of 45 cm DBH for Bani trees of quality classes A and B.[7]

- Selective thinning of Bani for firewood will be carried out, based on a minimum girth limit of 35 cm DBH for Bani trees of quality class C.

- The *agent forestier* will mark with white paint and record the diameter of all potential timber trees (classes A and B) of Bani in all diameter sizes from 35 cm upwards, to ensure that they are not harvested prematurely. Trees allowed for selective thinning will be marked with a slash/cut.

- All tree marking will be carried out by the *agent forestier* within the limits imposed by the management plan.

- The levels of prescribed harvesting will be reviewed every five years.

**Table III-6. Treatment Schedule for Productive Management of Bani**

| Treatment | Locations | Quantity (maximum) | Timing | Executed by |
|---|---|---|---|---|
| Selective harvesting (quality classes A & B) | All village zones | 200 trees/year<br>300 $m^3$/year | Annual | Under control of forest committee |
| Selective thinning (quality class C) | All village zones | 1,200 tree/yr<br>2,000 stere/yr | Annual | Under control of forest committee |

### B4. Productive Management of Bamboo

**Immediate Objective:** *Management of bamboo resource for increased productivity and income generation*

**Treatment Directives:**

- The location of the main bamboo groves in each village zone will be mapped and their condition recorded.

- Regular harvesting on a 3-year cutting cycle will be introduced in these principal groves.

- The effects of different cutting practices will be tested by pairing selective and 100 percent cutting of poles.

- A commercial sales outlet for bamboo will be established on the national route at Komba to assess market potential.

[7] Quality classes A, B, and C are defined in the forest inventory instructions



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## Table III-7. Treatment Schedule for the Productive Management of Bamboo

| Treatment | Locations | Quantity | Timing | Executed by |
|---|---|---|---|---|
| Locate and record main groves | All village zones | Between 2 and 10 groves in each village zone | 1997 | *Agent forestier* and villages |
| Harvest | Main groves | Between 1,000 and 5,000 poles per year in each village zone | Annual | Villages |
| Sales | Komba | About 20,000 poles per year | Annual | Forest committee and villages |



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# SECTION IV
# ECONOMIC AND FINANCIAL ANALYSIS

## A. Resource Budgets

As part of the proposed co-management contract, the parties involved will commit themselves to certain responsibilities and actions. Each party will need to provide the resources required.

DNFF/SPFF will be responsible for support with mapping and management planning services at headquarters level, as well as the provision of technical advice, monitoring, and evaluation at local level. This will necessitate the posting of a full-time *agent forestier* and will also involve require a 50 percent commitment of the *cantonnement forestier*. Some project support may be required for specialist technical functions.

The forest committee will need to commit time for meetings, general oversight, and administration. They will require the support of the project in the latter respect.

Villages will be required to commit the labor necessary for the preparation of firebreaks, controlled early burning, and fire fighting in their respective village zones. As a rough estimate, a figure of one man-day per two ha is proposed, amounting to 5,000 man-days for the entire forest. The labor input would vary according to whether the forest area was in the production, protection, or *bowal* categories.

Assuming a daily wage of 1,000 FG, the shadow cost of village labor required for protection services would amount to 5,000,000 FG annually.

## B. Direct Local Benefits

The various benefits expected from the proposed management plan may be categorized as direct or indirect. Direct benefits may be measured in physical, economic, or financial terms, and will accrue locally to:

- DNFF at the prefecture level
- The forest committee
- Village communities
- Individual households

Clearly, the proposed co-management contract should ensure that the direct benefits to each party will exceed the resource costs involved. Although the economic values of the agricultural benefits have not been calculated, these are believed to be substantial.

Indirect benefits, such as the protection of the forest ecology and of the watershed, are not easily quantifiable and also accrue to non-local beneficiaries. These are not assessed here, although they should weigh heavily with DNFF at the national level and with potential development partners (donors).

### B1. Agricultural Opportunities for Local People

**Bas-fonds.** These areas offer opportunities for households to grow staple rice as well as small-scale commercial crops of vegetables and other produce. An area of 26 ha per year spread over 25 sites is currently available for local households. This amount may be increased by up to one hectare on five new sites annually. To encourage more equitable access to *bas-fond* areas, the additional benefit will be restricted to one site per family.

**Agroforestry.** A maximum area of 290 ha in any one year will be made available in selected areas in the various village zones for use by households. This land, which will be of variable fertility, should provide at least two annual crops, as well as a firewood harvest from smaller trees cleared before cultivation.

### B2. Forest Products Harvesting

**Timber harvesting.** The management plan permits the selective felling of up to 200 trees of Bani in quality classes A and B each year. This is estimated to yield 300 $m^3$ of round timber, worth approximately 10,500,000 FG per year, felled at roadside. An estimated 4,800,000 FG tax would be payable (by the forest committee) from that sales value each year. The benefits would accrue to (1) the forest committee, which would sell cutting contracts within a general composite licence issued by SPFF; (2) individual wood cutters and sawyers who would sell the products; (3) SPFF/DNFF who would receive tax revenues from the forest committee; and (4) CRD, which would share in DNFF tax revenues.

**Firewood harvesting.** Up to 1,200 trees of Bani in quality class C may be selectively thinned or felled for firewood each year. This is estimated to yield 2000 steres of firewood, worth approximately 850,000 FG per year, felled at roadside. Tax payable from this is estimated to be 100,000 FG. The benefits would accrue in a similar manner to those for timber harvesting.

**Bamboo harvesting.** Up to 20,000 bamboo poles may be cut for commercial sale each year. These are estimated to be worth 400,000 FG per year, with tax payable of 100,000 FG. The benefits would accrue to individual households and to DNFF/SPFF. Table IV-1 shows the values of forest production and tax revenues.

**Table IV-1. Value of Forest Production and of Tax Revenues**

| Forest Product | No. of Trees | Quantity measure | Quantity per year | Price (FG) | Value FG/year | Tax (FG) | Revenue FG/year |
|---|---|---|---|---|---|---|---|
| Timber | 200 | $m^3$ | 300 | 35,000 | 10,500,000 | 16,000 | 4,800,000 |
| Firewood | 1,200 | stere | 2,000 | 425 | 850,000 | 50 | 10,000 |
| Bamboo | | poles | 20,000 | 20 | 400,000 | 5 | 100,000 |
| | | | | **Total** | 11,750,000 | **Total** | 5,000,000 |

# SECTION V

# REFERENCES

## ANNEX A
## LIST OF LEGISLATIVE ORDERS AND DIRECTIVES

Legislation and Regulations

Ordonnance 081/PRG/SGG/89 du 20 décembre 1989 portant code forestier.

Ordonnance 097/P/RG/SGG/90 du 28 novembre 1990 complétant certaines dispositions du Code forestier.

Décret No. 227/PRG/SGG/89 du 20 décembre 1989 portant application du code forestier.

Décret No. 237/PRG/SGG/90 du 28 novembre 1990 complétant et rectifiant certaines dispositions du décret no. 227/PRG/SGG/89 du 20 décembre 1989 portant application du code forestier.

Décret D/93/110 du 10 juin 1993 portant composition, organisation et fonctionnement des organes du Fonds Forestier National.

Arrêté conjoint A/92/2592/MARA/MPF portant tarification des taxes et redevances de chasse.

Arrêté conjoint A/92/3809/MARA/MPF fixant lest tarifs des taxes et des redevances forestières et le prix de vente du pin, du gmelina et du teck.

Ordonnance No. 092/PRG/SGG/90 du 22 octobre 1990 portant organisation et fonctionnement des communautés rurales de développement.

Ordonnance No. 091/PRG/SGG/90 du 22 octobre 1990 portant régime financier et fiscal des communautés rurales de développement (C.R.D.).

Ordonnance 093/PRG/85 du 17 avril 1985 portant constitution des districts ruraux, mise en place et attributions des conseils les représentant.

Ordonnance 092/019 du 30 mars 1992 portant Code foncier et domanial. Published in the Journal Officiel de la République de Guinée. May 1992, Special Series.

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DNFC. March 24, 1994. Memo No. 0187/DNFC. Arrêt des activités de lotissement du domaine classé de l'Etat.



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# ANNEX A

## LEGISLATIVE ORDERS AND DIRECTIVES

## SECTION V
## REFERENCES


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## ANNEX B
## DOCUMENTS RELATING TO THE RESERVATION OF THE NIALAMA FOREST

23 JUIL 1943
ARRETE portant classement de la forêt de Nialama (cercle de Labé - Guinée française)

DIRECTION GENERALE DES SERVICES ECONOMIQUES
Forêts
---
2667 SE/F

Le Gouverneur Général
de l'Afrique Occidentale Française

Vu le décret du 18 octobre 1904 réorganisant le Gouvernement Général de l'Afrique occidentale française et les actes subséquents qui l'ont modifié;
Vu le décret du 4 juillet 1935 sur le régime forestier en A.O.F.;
Vu le décret du 15 novembre 1835 portant réglementation des terres domaniales en A.O.F.;
Sur la proposition du Gouvernement de la Guinée française;

A R R E T E:

Article 1er. Est intégrée dans le domaine forestier classé la forêt dite de Nialama (cercle de Labé) d'une surface approximative de 10.000 hectares, dont les limites sont définies ainsi qu'il suit:

Soient:

A le confluent du marigot Dinquidonko et de la rivière Bomini
B le confluent du marigot Paraolkambali et de la rivière Bomini
C la source du Paraol Kambali
D le point de la piste de Nialama à Linsan, situé à 8.340 mètres de C sur la droite CD faisant un angle de II° vers l'Ouest avec la direction du Nord géographique
E le point situé à 3.300 mètres de D sur la droite DE faisant un angle de 82° vers l'Est avec la direction au Nord géographique
F le point situé à 2.400 mètres de E sur la droite EF faisant un angle de 125° 30 vers l'Est avec la direction du Nord géographique
G le point situé à 5.120 mètres de F sur la droite FG faisant un angle de 119° vers l'Est avec la direction du Nord géographique
H le point situé au Sud du village de Linsan à 3.430 mètres de G sur la droite GH faisant un angle de 146° vers l'Est avec la direction du Nord géographique
I le point du marigot Démounatroun situé à 2.040 mètres de H sur la droite HI faisant un angle de 164° vers l'Est avec la direction du Nord géographique



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J le point situé à 3.020 mètres de I sur la droite IJ faisant un angle de 169° vers l'Ouest avec la direction du Nord géographique
K le point situé à 3.300 mètres de J sur la droite JK faisant un angle de 112° vers l'Ouest avec la direction du Nord géographique
L le point situé à 3.850 mètres de K sur la droite KL faisant un angle de 94° vers l'Ouest avec la direction du Nord géographique
M le point situé à 2.730 mètres de L sur la droite LM faisant un angle de 23° vers l'Ouest avec la direction du Nord géographique
N le point situé à 4.100 mètres de M sur la droite MN faisant un angle de 14° vers l'Est avec la direction du Nord géographique.

Les limites sont:

Au Nord: la ligne brisée DEFG (piste Nialama-Linsan rectifié ) de D à G

A l'Est: la droite GH la ligne brisée HIJ (piste Linsan-Goundoupi rectifiée) de H à J

Au Sud: la ligne brisée JKL (piste Goundoupi-Sigon rectifiée) de J à L

A l'Ouest: la ligne brisée LMNA de L à A la rivière Bomini de A à B, le marigot Paraol Kambali de B à C la droite CD, la limite de forêt de A à D étant également celle du cercle de Gaoual.

Article 2—Est distraite du périmètre classé l'enclave du Kagnagande- Diaobé ainsi définie :

Soient:
O — le point situé à 2.700 mètres de la mosquée de Linsan sur la droite ayant ce bâtiment comme origine et faisant un angle de 104° vers l'Ouest avec la direction du Nord géographique
P — le point situé à 1.500 mètres à l'Ouest de O
Q — le point situé à 1.000 mètres au Sud de P
R — le point situé à 1.000 mètres au Sud de O

L'enclave de Kagnagandé-Diaobé est constituée par le rectangle OPQR.

Article 3—Les droits d'usage des indigènes sur la forêt classée sont ceux énumérés à l'article 14 du décret du 4 juillet 1935, complétés par les dispositions suivantes :

(a) la culture du riz de marais est autorisée à l'intérieur du périmètre classé, dans les terrains qui s'y prêtent;
(b) le parcours des troupeaux est interdit en dehors des pistes longeant ou traversant la forêt.

Article 4—La répression des infractions aux dispositions du présent arrêté s'effectuera conformément aux prescriptions du titre V du décret du 4 juillet 1935.

Article 5—Le Gouverneur de la Guinée française est chargé de l'exécution du présent arrêté qui sera enregistré, publié et communiqué partout
où besoin sera.

Ampliations
Signé : ? COURMARIE
Cabinet I
J.O.A.O.F I



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Illisible I

SERVICE DES EAUX ET FORETS

ETAT FRANCAIS

N° 228 E/F

Travail - Famille - Patrie -

Conakry, le 25 mars 1943
Le Chef du Service des Eaux et Forêts
à Contrôleur des Eaux et Forêts
à --- LABE ---

Réponse à votre 131 du 21 mars 1943:

1°/ Périmètre de Nialama est énoncé très correctement - (Toutefois il est préférable, quand cela est possible, de rapporter quelques uns des points du Périmètre à des accidents du terrain.)

2°/ Le Périmètre que vous avez défini constitue la forêt à classer. Les droits de culture, d'habitation et de feux accordés au Foulasso Kagnagandé - Diaobé sont incompatibles avec le régime de la forêt classée.

Il convient donc soit de faire déguerpir ce foulasso dans un délai à fixer (I an). soit de déterminer topographiquement une enclave qui soustraira le foulasso et ses cultures au Périmètre classé -- Cette enclave sera alors rattachée à un point du Périmètre et desser-vi par un passage obligatoire pour les troupeaux.

3°/ Pour les rizières de marais au contraire l'autorisation mentionnée au P.V. de la Commission de classement est très judicieuse et tout à fait justifiée.
De même pour les lianes à caoutchouc.
Conclusion
(A) Facultatif - Définir le cas échéant par rapport à un accident du terrain (Marigot source et un ou plusieurs des points D à N
(B) Obligatoire - Définir topographiquement - ou supprimer enclave Kagnagandé.

CERCLE DE LABE
---

O/J
AVIS D'AFFICHAGE
---

Application Article ?
Décret 4/7/1935
---

Projet de classement de la Réserve de Nialama

Le terrain ci-dessous défini fait l'objet d'un projet de classement en forêt domaniale

DÉFINITION DES LIMITES : soient:

A - le point situé au confluent Dinquidonko et du Bomini.
B - le point situé au confluent du Bomini et du Paraol Kambali.
C - le point situé à la source du Paraol Kambali.
D - le point situé sur la piste de Nialama à 3340m de C sur une droite faisant un angle de II degrés avec le Nord géographique et passant par la Paraol Kambali, le sommet de la montagne Yatak et entre les marigots Raonadian et Belinko.

E - le point situé à 3300 m de D sur une droite faisant un angle de 278° avec le N.G.
F - le point situé à 2400m de E sur une droite faisant un angle de 254°3 avec le N. G.
G - le point situé à 5120 de F sur une droite faisant un angle de 241° avec le N.G.
H - le point situé à 3430m de G. sur une droite faisant un angle de 21° avec le N.G.
I - le point situé à 2040m de H sur une droite faisant un angle de 196° avec le N.G.
J - le point situé à 3020m de I sur une droite faisant un angle de 169° avec le N.G.
K - le point situé à 3300m de J. sur une droite faisant un angle de II° avec le N.G.
L - le point situé à 3850m de K. sur une droite faisant un angle de 94° avec le N.G.
M- le point situé à 2730m de L. sur une droite faisant un angle de 25° avec le N.G.
N° le point situé à 4100m de M. sur une droite faisant un angle de 34° avec le N.G.

REMARQUE: du point A au point D la limite de la réserve est également limite entre les cercles de Gaoual et Labé -

Ces limites matérialisées par un layon pare -feu, sont jalonnés de bornes formées de pyramides de pierres surmontées d'un piquet.

Les coupes de bois, feux, pâturage, cultures seront interdite à l'intérieur de ce Périmètre./.

Labé, le 26 Février 1943
Le Commandant de Cercle
Signature illisible



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Eaux et Forêts
/-
N° ,, 117 Efl

Contrôleur Forestier

à Mr le Chef d'Inspection Forestière
de la Moyenne Guinée,
Mamou

s/c de Monsieur l'Administrateur
Commandant Le Cercle de en réserve

Labé

A/s= d'une mise
forestière

J'ai l'honneur de vous proposer la
mise en réserve d'un territoire d'une superficie d'environ 10.000 Ha, situé dans le canton de Popodara, cercle de Labé. Cette réserve pourrait
être dite "Réserve de Nialama".

But de la mise en Réserve -

Cette région
comprend quelque forêt, de nombreux marigots complètement secs en saison sèche ; c'est d'ailleurs pour cette raison que le pays est très peu peuplé et que les seuls foulassos de Kagnagandé et Diaobé qui se trouvent dans la réserve sont inhabités en cette saison. Notre but est de reconstituer le boisement afin que les marigots puissent se régulariser. Ce but est facile à atteindre étant donné l'état actuel du boisement, clairsemé certes, mais suffisamment dense pour permettre une rapide régénération naturelle.

Les feux de brousse parcourent cette région chaque année.

Habitants et terrains de cultures

Deux foulassos

Kagnagandé et Diaobé situées à mi-chemin sur la piste de Bomini à Linsan sont enclavés dans la réserve. Situés sur le bowal, ces deux foulassos ne sont habités qu'en saison des pluies. Faute d'eau en saison sèche les indigénes (sic) émigrent vers la Bantala avec les troupeaux. Ne restent aux foulassos que les impotents et les vieillards.

En accord avec le Chef de Canton de Popodara, Alfa Yaya, nous avons sur place, délimité les terrains de cultures laissés aux indigénes (sic) autour des foulassos ou villages. Il est entendu que le Chef de canton gardera les terrains marécageux compris dans la réserve et sur lesquels il cultive du riz. De même pour une petite riziére (sic), appartenant à Alfa Bakar, chef du canton de Diari.

Limites de la réserve

Soient:

A. le point situé au confluent du Dinquidonko et du Bomini-

B. le point situé au confluent du Bomini et du Paraol Kambali-

C. le point situé à la source du Paraol Kambali-

D. le point situé sur la piste de Nialama à 3.340m de C sur une droite faisant un angle de 11 degrés avec le Nord géographique et passant par le bowal Kambali, le sommet de la montagne Yatak et entre les marigots Raonadian et Belinko-

E. le point situé à 3300m de D sur une droite faisant un angle de 278° avec le N. G.-

F. le point situé à 2400m de E sur une droite faisant un angle de 234°30 avec le N. G.-

G. le point située à (5120) de F sur une droite faisant un angle de 241° avec le N. G.-



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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| H. | le point situé à | 3430$^m$ de G | sur une droite | faisant un angle de | | | | 214° | avec le N.G. |
| I. | " | " | 2040$^m$ de H | " | " | " | " | 196° | " |
| J. | " | " | 3020$^m$ de I | " | " | " | " | 169° | " |
| K. | | " | " | 3300m de J | " | " | " | " | 112° " |
| L. | " | " | 3850m de K | " | " | " | " | 94° | " |
| M. | | " | " | 2730m de L | " | " | " | " | 23° " |
| N. | | " | " | 4100m de M | " | " | " | " | 346° " |

Remarque = du point A au point D la limite de la réserve est également limite entre les cercles de Gaoual et Labé.

Ces limites , matérialisées par un layon pare-feu sont jalonnées de bornes formées de pyramides de pierres surmontées d'un piquet.-

Gardes connaissant la réserve.-
Sako Sidibé
Aldiouma Diallo
Jean Potanos

Gardien de la Réserve.-
Moussa Bella - ancien tirailleur -
pièce jointe
plan au 20 000e
Labé le 5 janvier 1943
*Signature illisible*

*Illisible* Vu et transmis - sans observation
Labé le 13 Février 1943
Le C.t de Cercle
*Signature illisible*

Vu et transmis
Mamou le 15.2.43
Le Chef d'Inspection
*Signature illisible*

18.2.43
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# ANNEX C
# FOREST BOUNDARIES

## Table C-1. Forest Boundaries

(1) Prescribed Forest Boundary Points (Reservation Document)

Points A, B, and C defined by ground features:

A = le confluent du marigot Dinquidonko et de la riviere Bomini
B = le confluent du marigot Paraol Kambali et de la riviere Bomini
C = la source du Paraol Kambali

Points D to N defined by an open traverse of 36.6 Km, based on C as an anchor point:

| | Distance (metres) | Bearing (degrees GN) |
|---|---|---|
| C-D | 3340 | 349 |
| D-E | 3300 | 82 |
| E-F | 2400 | 125 |
| F-G | 5120 | 119 |
| G-H | 3430 | 146 |
| H-I | 2040 | 164 |
| I-J | 3020 | 191 |
| J-K | 3300 | 248 |
| K-L | 3850 | 266 |
| L-M | 2730 | 337 |
| M-N | 4100 | 14 |

(2) GPS Fixes of Point B and of Anchor Point C

| Classee Marker | No. of Fixes | UTM (Km) Easting | UTM (Km) Northing |
|---|---|---|---|
| Point B | 3 | 740.225 | 1301.791 |
| Point C[1] | 5 | 740.006 | 1302.290 |

[1] Point C offset 20m at 340gn

(3) GPS Fixes of Actual Boundary Points (G to K)

| Classee Marker | Jeton # | Actuelles UTM (Km) Easting | UTM (Km) Northing |
|---|---|---|---|
| G | 212 | 749.899 | 1,302.964 |
| H | 213 | 751.848 | 1,300.177 |
| I | 214 | 752.546 | 1,299.279 |
| J | 215 | 752.200 | 1,294.960 |
| K | 216 | 748.359 | 1,293.398 |

(4) Projected Postions of points D to N

| Classee Marker | UTM (Km) Easting | UTM (Km) Northing |
|---|---|---|
| Point C[2] | 740.022 | 1302.279 |
| C-D | 739.385 | 1305.557 |
| D-E | 742.653 | 1306.017 |
| E-F | 744.619 | 1304.640 |
| F-G | 749.097 | 1302.158 |
| G-H | 751.015 | 1299.314 |
| H-I | 751.577 | 1297.353 |
| I-J | 751.001 | 1294.389 |
| J-K | 747.941 | 1293.153 |
| K-L | 744.101 | 1292.884 |
| L-M | 743.034 | 1295.397 |
| M-N | 744.026 | 1299.375 |

[2] Based on fix of position C and traverses C to N

(5) Differences (actual-projected)

| Classee Marker | Difference (metres) UTM (m) Easting | UTM (m) Northing |
|---|---|---|
| G | 802 | 806 |
| H | 833 | 863 |
| I | 969 | 1,926 |
| J | 1,199 | 571 |
| K | 418 | 245 |



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**Table C-2. Forest Enclave Boundary**

Foret Classee de Nyalama
Enclave Boundary

Anchor Point (Mosque at Linsan Foulbhe)

| UTM (Km) Easting | UTM (Km) Northing |
|---|---|
| 751.813 | 1,301.344 |

| Enclave Corner pts. | Prescribed Corner Points | | Actual Boundary | | Differences | |
|---|---|---|---|---|---|---|
| | UTM (Km) Easting | UTM (Km) Northing | UTM (Km) Easting | UTM (Km) Northing | UTM (m) Easting | UTM (m) Northing |
| Corner O | 749.198 | 1,300.668 | 748.389 | 1,301.017 | -808.999999999969 | 349.00000000016 |
| Corner P | 747.698 | 1,300.656 | 747.833 | 1,301.182 | 134.999999999991 | 526.000000000067 |
| Corner Q | 747.706 | 1,299.656 | 746.799 | 1,300.683 | -907.000000000039 | 1027.00000000004 |
| Corner R | 749.206 | 1,299.668 | 747.354 | 1,299.692 | -1851.99999999998 | 24.0000000001146 |



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# ANNEX D
# FOREST INVENTORY

## A. Design

This inventory was carried out during the dry seasons over two years (1995-1996) by a team of DNFF technicians headed by the Chief of the Inventory Section, Division of Management, DNFF. The design was based on the Guinean practice to rely on national knowledge and expertise, thus minimizing training requirements.

The design used 16 subjectively located transects, along which a total of 60 plots were systematically positioned, with between 2 and 5 plots per transect (see Table D-1). Each plot was a rectangle of 0.5 hectares (200 m long x 25 m wide), with 400 m between plots. No use was made of the available aerial photographs for stratification.

**Table D-1. Localisation actuelle de placettes**

| Layon (L) | Placettes | No. des Plac. | Degrés | Notes |
|---|---|---|---|---|
| 1 | 1, 2, 3, 4 | 4 | 300 W | |
| 2 | 5, 6, 7, 8 | 4 | 300 W | |
| 3 | 10 | 1 | 300 W | Plac.9 → L17 |
| 4 | 11, 12, 13, 14 | 4 | 120 E | |
| 5 | 15, 16, 17, 18, 19 | 5 | 120 E | |
| 6 | 20, 21, 22, 23 | 4 | 120 E | |
| 7 | 24, 25, 26, 27 | 4 | 300 W | |
| 8 | 28, 29, 30 | 3 | 120 E | |
| 9 | 31, 32, 33 | 3 | 300 W | |
| 10 | 34, 35, 36, 37 | 4 | 300 W | |
| 11 | 38, 39, 40, 42 | 4 | 300 W | Plac. 41 → L17 |
| 12 | 43, 44, 45, 46 | 4 | 300 W | |
| 13 | 48 | 1 | 120 E | Plac. 47, 49 & 50 → L18, L16, L14 resp. |
| 14 | 51, 52, 53, 54, 50 | 5 | 300 W | Plac. 50 ← L13 |
| 15 | 55, 56, 57 | 3 | 120 E | |
| 16 | 58, 59, 60, 49 | 4 | 300 W | Plac. 49 ← L13 |
| 17 | 9, 41 | 2 | 120 E | Plac. 9,41 ← L3,L11, resp. |
| 18 | 47 | 1 | 120 E | Plac. 47 ← L13 |
| | | 60 | | Placette transférée:→ de - a;← a de Localisation des layons en carte X. |



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Given that the population area is approximately 10,000 hectares, the sampling intensity was 0.3 percent.[1] This is sufficient only for a reconnaissance-level inventory. In a forest of this type and size, sampling intensities of 1 percent for a resource inventory and 3 percent for a management-level inventory would be indicated. For this reason, the consultant did not overly rely on the estimates. Furthermore, because the allocation of sample plots in the inventory was not stratified or randomized, the consultant made no attempt to calculate the statistical error of the population estimates.

The main value of the inventory has been to provide figures indicative of the forest as a whole. However, the inventory cannot be used to estimate population parameters for particular forest type classes or territorial subdivisions. Although an estimate of merchantable volume has been derived, the inventory could not be used to locate and assess potential harvest areas.

Bearing in mind the above limitation, the objective was primarily aimed at assessing the stocking of various tree species, tree diameters, heights, and volumes of wood. The minimum diameter class recorded was 10 cm DBH, and trees below that limit were ignored. All eligible trees in every plot were identified, measured for DBH, and measured for height.

Supplementary scores were given in respect to regeneration and for the importance of the Bani (*Pterocarpus erinaceous*) and bamboo populations. The inventory was not designed to estimate smaller trees or regeneration (although regeneration was reported qualitatively). Information of that kind is essential for manipulating and monitoring the development of natural forest. An important criterion of sustainable forest management is that the silvicultural system ensure adequate regeneration, particularly in relation to harvesting interventions.

The plot size (0.5 ha) used in the inventory was appropriate for sampling relatively few larger trees. The inventory fieldwork could have proceeded more quickly if measurements of the more numerous smaller trees and of regeneration had been confined to subplots. For example, regeneration could have been assessed on four subplots of 0.01 ha, each located at a corner of the main plot. Also, smaller trees (5-15 cm DBH) could have been measured on four sub-plots of 0.05 ha.

Comprehensive measurements for height, which are relatively time-consuming, are only needed for trees for which a volume calculation would be meaningful—that is, those of merchantable species, form, and size (more than 45 cm DBH), and those in the two classes immediately below that threshold (35-39 and 40-44 cm).[2] Information on heights is not required for silvicultural management at the stand level.

## B. Forest Classification

Classification of the forest by vegetation type is important because each type will require different treatments and, possibly, separate working circles.

The vegetative cover of Nialama may be described as either dry deciduous (*forêt seche*) with isolated areas of gallery forest and islands along water courses or areas of herbaceous

[1] Calculated total sample area (30 ha) divided by forest area (10,000 ha), where sample area is calculated as 60 plots x 0.5 ha.

[2] Correspondingly higher thresholds would apply in the case of felling limits of 55 cm.



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grassland on the *bowé* areas (Table D-2). The classification used in forest mapping and inventory assessment of Nialama has differentiated four major formations with minor subdivisions.

**Table D-2. Forest Vegetation Classification (TO BE COMPLETED BY DNFF)**

| Vegetation Class | Code | Area (Ha) | Percent of Forest |
|---|---|---|---|
| *1: Forêt Galerie* | FG | | |
| *2: Savanna:* | SA | | |
| *2a: S.aborée dense* | SAd | | |
| *2b: S.aborée claire* | SAc | | |
| *2c: S.arbustive* | SAa | | |
| *2d: S.de Bowé* | SAw | | |
| *3: Bowé* | BW | | |
| *4: Culture:* | CU | | |
| *4a: Jeune Jachère* | CUj | | |
| *4b: Tapade* | CUt | | |
| *4c: Défrichement* | CUd | | |
| *4d: Bas-fonds (rizières)* | CUr | | |
| Forest Total | | 10,000 | 100.0 |

**Source:** Revised Forest Map; Bureaux de Technique, DNFF.

The forest map is a draft based on the photo mosaics. Although it showed areas of culture, it did not differentiate between classes 4a, 4c, and 4d. Furthermore, for mapping purposes, the definition of *jeune jachère* was limited to ongoing cultivation or areas cultivated within the previous two years; in the inventory, the time limit applied was up to five years.

The forest map shows the dominant forest vegetation type to be *savanne arbustive*, with smaller amounts of *savanne arborée claire*. In the opinion of local forestry staff, nearly all the *savanne* areas (a vegetation type) of Nialama forest are also *jachère* (a land use category) of varying age. Since *savanne* types are the dominant vegetation, it may be concluded that shifting cultivation has been a prevalent land use in the forest.

The classification of plots according to the inventory is given in Table D-3.

**Table D-3. Allocation of Sample Plots by Forest Vegetation Class**

| Vegetation Class | Num. of Plots |
|---|---|
| *1:Forêt Galerie* | 2 |
| *2:Savanna:* | |
| *2a: S.aborée dense* | 1 |
| *2b: S.aborée claire* | 16 |
| *2c: S.arbustive* | 30 |
| *2d: S.de Bowé* | 2 |
| *3:Bowal* | 1 |
| *4:Culture:* | |
| *4a: Jeune Jachère* | 8 |
| *4b: Tapade* | - |
| *4c: Défrichement* | - |
| *4d: Bas-fonds (rizières)* | - |
| Forest Total | 60 |

**Note:** Sample plots falling on Bowé areas were relocated in all but one case.

Although *vielle jachère* was defined as a category for use in the inventory, in practice it is difficult to distinguish between *vielle jachère* and *savanne arbustive* or *savanne arborée claire*. Consequently, areas of *vielle jachère* have been tabulated as *savanne arbustive* in Table D-1.

There remain only small areas of closed forest (*forêt galerie* and *savanne arborée dense*). These should be protected against further loss and degradation.

## C. Size Distribution

The shape of the diameter class distributions for all species recorded in the inventory demonstrates the inverse relationship between individual tree size and frequency of occurrence that typifies natural forests of uneven age. The focus of interest in diameter distribution is the relative frequency of different species, and how this relative frequency varies through the different diameter classes. Although, as noted in section A above, measurements were restricted to trees of at least 10 cm DBH, the frequency of trees in the sub-10 cm classes would normally be expected to be far greater than in the classes that were measured above that limit.

The diameter distribution (Table D-4) shows the results of competitive pressures on the survival and development of trees of the various species present. It also demonstrates that, as stands become older, a smaller proportion of trees will grow in diameter into the larger classes. Those other trees which do not grow, may remain the same size, die naturally, or be harvested.



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**Table D-4** Tiges par classe de diamètre (cms)
- nombre des tiges mesurées dans l'inventaire
- tiges par hectare

Plot size 0.5
No. of Plots 60
Sample area = 30.0
Sample intensity = m 0.3

| Nombre de tiges | 10-14 | 15-19 | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50-54 | 55- | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Toutes espèces | 2,349 | 1,202 | 577 | 395 | 253 | 190 | 124 | 75 | 67 | 67 | 5,339 |
| Bani | 531 | 304 | 168 | 97 | 96 | 73 | 51 | 33 | 34 | 34 | 1,415 |
| **Tiges par ha** | **10-14** | **15-19** | **20-24** | **25-29** | **30-34** | **35-39** | **40-44** | **45-49** | **50-54** | **55-** | **Total** |
| Toutes espèces | 78.3 | 40.1 | 19.2 | 13.2 | 8.4 | 6.3 | 4.1 | 2.5 | 2.2 | 3.6 | 178.0 |
| Bani | 17.7 | 10.1 | 5.6 | 3.2 | 3.2 | 2.4 | 1.7 | 1.1 | 1.1 | 0.9 | 47.2 |

The aggegration of tree diameters into an overall diameter distribution tends to obscure the occurrence of areas with distorted distributions. For example, as has been noted in the field, some areas or species may be devoid of smaller diameter classes, while others may have no trees of larger size. A diameter distribution at the stand level, therefore, can provide a useful diagnosis of stand development and can indicate the need for management interventions, such as selective thinning, to improve the distribution.

## D. Species Composition

A total of 77 tree species with diameters of at least 10 cm DBH were recorded during the forest inventory. Of this number, only 22 occurred with a frequency exceeding 1.0 percent of the total. As Table D-5 in Appendix A shows, the forest stock is dominated by just a few species.

Bani (*Pterocarpus erinaceous*) predominates (26 percent of trees measured). The five most common species account for around 50 percent of trees measured. The average stocking of Bani of 47 stems per hectare may be compared with the average stocking of 178 stems per hectare for all species. Thus, while Bani is the most common species, the fact that the other 50 percent of measured trees belong to 71 other species illustrates the importance of species diversity in Nialama Forest.

As shown in Table D-4 above, the species mix is more diverse in the smaller diameter classes than in the larger ones in which Bani predominates. The prevalence of a few species, such as Bani, in the larger-diameter size illustrates the higher mortality affecting other species, and is consistent with the development of a fire-conditioned ecology in which a relatively small number of tree species dominate. It should also be borne in mind, however, that some species are inherently small, regardless of competition or environment.

It is clear that species of high timber value, such as *Khaya senegalensis*, *Milicia regia*, *Afzelia africana*, and *Borassus aethiopum*, are comparatively rare, and that their growing stock could not sustain an exploitation program at the present time.

## E. Regeneration

In each sample plot of the inventory, an assessment was made of the amount of regeneration and number of species represented (see Table D-6 in Appendix A).

Some areas of *vielle jachère* have been abandoned for long enough to ensure secondary forest regrowth. Also, some of the areas of *jeune jachère* exhibit adequate regeneration by colonizing species. However, in some *jachère* areas, characterized by "razor" grasses and annual fires, forest regeneration remains poor.

The regeneration recorded in the inventory is dominated by three species, *Piliostigma thonningii*, *Markhemia tomentosa,* and *Combretum* spp (see Table D-7 in Appendix A). These are rapid colonizers quickly recovering after the passage of fire and out-competing invasive grass species.

The paucity of observations of regeneration of *Pterocarpus erinaceous* in the sample plots is puzzling. The most likely explanation, which was offered by the project technical assistance team, is that the regeneration survey component was inadequately implemented and supervised. If this were not the case, however, the absence of Bani from the sub-10 cm DBH size class could be attributable to some change in forest ecology which has occurred over the past five years or so. In 1994, as noted above, many farmers were forced to abandon cultivation in the forest. This exodus was accompanied by a corresponding increase in the frequency and severity of wildfires. The consultant is not postulating this specific diagnosis, but the management plan contains proposals to monitor the effects of cultivation and fire on regeneration.

## F. Stand Parameters

The measurement of DBH for all trees of over 10 cm DBH in each sample plot enables the calculation of stand parameters, such as mean stocking (stems per hectare), the diameter distribution,[3] height in meters, and basal area.[4]

Due to the lack of *a priori* stratification by forest type vegetation, these calculations (see Tabled D-8 and D-8b in Appendix A) showed extreme variability. The number of sample plots in some vegetation types was too few to provide a basis for analysis (for example, one plot in *savanne arborée dense*).

## G. Harvesting Potential

It is clear that species of high timber value, such as *Khaya senegalensis*, *Milicia regia, Afzelia africana*, and *Borassus aethiopum* are comparatively rare, and that their growing stock could not sustain an exploitation program at the present time.

Only Bani is sufficiently widespread in the forest to allow sustainable wood harvesting. During the inventory, Bani trees were assessed for merchantability using a three-point scale.[5] Only about 16 percent of the Bani trees measured could be considered for eventual timber use (classes A and B); the remaining trees were judged suitable only for firewood (class C).

The diameter distributions of Bani trees (see Table D-9 in Appendix A) show that class C trees are relatively more abundant in smaller DBH classes than in larger ones. This could be due

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[3] Diameter distribution is the name given to the array of frequencies of trees measured in each diameter class. The class interval used in the current presentation is 5 cm; the minimum DBH class is 10.0-14.9 cm; the biggest class is assumed to be 55.0-59.9 cm.

[4] Basal area, expressed in square meters per hectare ($m^2$/ha), is calculated from DBHs as the sum of the cross-sectional areas at breast height of all measured trees, expressed on a per hectare basis.

[5] Quality Classes: A - prime timber; B - suitable for secondary timber uses; C - suitable only as firewood. These scores (A, B, C) have been converted into numeric equivalents (1, 2, 3, respectively) to enable averages to be calculated.

to one of several causes: bias in quality assessment between different diameter classes by the inventory field crews, improved form as trees grow, or unauthorized harvesting of poor quality trees for firewood.

Selection felling and thinning would be governed by minimum diameter limit. For timber trees, a DBH of 40 cm is considered by DNFF (and by sawyers) to be the minimum size for yielding sawlogs. (Pit sawing, the usual method employed, cannot be used for small logs due to the high conversion losses incurred.) Logs from trees exceeding 55 cm DBH are too large for manual or animal-traction harvesting methods.

According to the inventory estimates, there exists a stock of overmature (i.e., exceeding 50 cm) Bani, particularly ones exceeding 55 cm DBH (see Table D-9 in Appendix A).

For the purposes of determining an estimate of allowable cut of Bani for timber (classes A and B), it will be assumed that a conservative figure of 45 cm DBH should be applied to the minimum harvesting size, and that trees over 50 cm DBH are technically over-mature. The target size for harvesting Bani is therefore set at 45-50 cm DBH.

For the firewood market, smaller diameters (10-35 cm) are preferred. The selective thinning of lower quality trees should favor the development of trees in classes A and B. However, to prevent possible removal of trees with commercial potential, the management plan places a lower harvesting limit of 35 cm DBH on trees of class C.

# APPENDIX A
# INVENTORY TABLES

## Table D5. Composition des espèces
(tiges > 10 cms DHP)

| | |
|---|---|
| Plot Size | 0.5 |
| No. of Plots | 60 |
| Sample Area | 30.0 |

| No. | Espèce | Quantité | Pourcentage du total | Tiges/ hectare | |
|---|---|---|---|---|---|
| 1 | Pterocarpus erinaceus | 1416 | 26.5% | 47.2 | 26.5% |
| 2 | Piliostigma thonningii | 437 | 8.2% | 14.6 | 34.7% |
| 3 | Xeroderris stuhlmannii | 338 | 6.3% | 11.3 | 41.0% |
| 4 | Pericopsis laxiflora | 271 | 5.1% | 9.0 | 46.1% |
| 5 | Daniellia oliveri | 254 | 4.8% | 8.5 | 50.9% |
| 6 | Crossopteryx febrifuga | 248 | 4.6% | 8.3 | 55.5% |
| 7 | Hymenocardia acida | 150 | 2.8% | 5.0 | 58.3% |
| 8 | Detarium microcarpum | 148 | 2.8% | 4.9 | 61.1% |
| 9 | Lophira alata | 132 | 2.5% | 4.4 | 63.5% |
| 10 | Teminalia macroptera | 129 | 2.4% | 4.3 | 66.0% |
| 11 | Markhamia tomentosa | 116 | 2.2% | 3.9 | 68.1% |
| 12 | Terminalia albida | 109 | 2.0% | 3.6 | 70.2% |
| 13 | Hexalobus monopetalus | 104 | 1.9% | 3.5 | 72.1% |
| 14 | Parkia biglobosa | 103 | 1.9% | 3.4 | 74.0% |
| 15 | Lannea acida | 93 | 1.7% | 3.1 | 75.8% |
| 16 | Bridelia ferruginea | 84 | 1.6% | 2.8 | 77.4% |
| 17 | Bombax costatum | 81 | 1.5% | 2.7 | 78.9% |
| 18 | Prosopis africana | 74 | 1.4% | 2.5 | 80.3% |
| 19 | Entada africana | 71 | 1.3% | 2.4 | 81.6% |
| 20 | Lannea velutina | 68 | 1.3% | 2.3 | 82.9% |
| 21 | Combretum nigricans | 68 | 1.3% | 2.3 | 84.1% |
| 22 | Phyllanthus discoideus | 61 | 1.1% | 2.0 | 85.3% |
| 23 | Hannoa undulata | 45 | 0.8% | 1.5 | 86.1% |
| 24 | Combretum glutinosum | 37 | 0.7% | 1.2 | 86.8% |
| 25 | Holarrhena floribunda | 38 | 0.7% | 1.3 | 87.5% |
| 26 | Ficus capensis | 35 | 0.7% | 1.2 | 88.2% |
| 27 | Anthonotha crassifolia | 35 | 0.7% | 1.2 | 88.8% |
| 28 | Cassia sieberiana | 34 | 0.6% | 1.1 | 89.5% |
| 29 | Vitex doniana | 33 | 0.6% | 1.1 | 90.1% |
| 30 | Pseudospondias microcarpa | 33 | 0.6% | 1.1 | 90.7% |
| 31 | Spondias mombin | 31 | 0.6% | 1.0 | 91.3% |
| 32 | Albizia glaberrima | 29 | 0.5% | 1.0 | 91.8% |
| 33 | Khaya senegalensis | 27 | 0.5% | 0.9 | 92.3% |

| No. | Espèce | Quantité | Pourcentage du total | Tiges/ hectare | |
|---|---|---|---|---|---|
| 34 | Ficus polita | 27 | 0.5% | 0.9 | 92.8% |
| 35 | Parinari sp. | 27 | 0.5% | 0.9 | 93.4% |
| 36 | Ficus glumosa | 25 | 0.5% | 0.8 | 93.8% |
| 37 | Uapaca togoensis | 24 | 0.4% | 0.8 | 94.3% |
| 38 | Stereospermum kunthianum | 22 | 0.4% | 0.7 | 94.7% |
| 39 | Erythrophleum suaveolens | 21 | 0.4% | 0.7 | 95.1% |
| 40 | Dalbergia boehmii | 20 | 0.4% | 0.7 | 0.4% |
| 41 | Terminalia glaucescens | 20 | 0.4% | 0.7 | 0.4% |
| 42 | Cola cordifolia | 19 | 0.4% | 0.6 | 0.7% |
| 43 | Cussonia djalonensis | 17 | 0.3% | 0.6 | 1.0% |
| 44 | Acacia ataxacantha | 15 | 0.3% | 0.5 | 1.3% |
| 45 | Sterculia tragacantha | 14 | 0.3% | 0.5 | 97.0% |
| 46 | Nyassi (Pular) | 13 | 0.2% | 0.4 | 97.3% |
| 47 | Annona senegalensis | 12 | 0.2% | 0.4 | 97.5% |
| 48 | Anthocleista djalonensis | 11 | 0.2% | 0.4 | 97.7% |
| 49 | Afzelia africana | 11 | 0.2% | 0.4 | 97.9% |
| 50 | Albizia zygia | 11 | 0.2% | 0.4 | 98.1% |
| 51 | Ficus gnaphalocarpa | 9 | 0.2% | 0.3 | 98.3% |
| 52 | Anthostema senegalense | 7 | 0.1% | 0.2 | 98.4% |
| 53 | Nauclea latifolia | 6 | 0.1% | 0.2 | 98.5% |
| 54 | Schrebera arborea | 5 | 0.1% | 0.2 | 98.6% |
| 55 | Wanda (Pular) | 5 | 0.1% | 0.2 | 98.7% |
| 56 | Ceiba pentandra | 5 | 0.1% | 0.2 | 98.8% |
| 57 | Harungana madagascariensis | 5 | 0.1% | 0.2 | 98.9% |
| 58 | Erythrina senegalensis | 5 | 0.1% | 0.2 | 99.0% |
| 59 | Borassus aethiopum | 4 | 0.1% | 0.1 | 99.1% |
| 60 | Carapa procera | 4 | 0.1% | 0.1 | 99.2% |
| 61 | Milicia regia | 4 | 0.1% | 0.1 | 99.2% |
| 62 | Ficus ovata | 4 | 0.1% | 0.1 | 99.3% |
| 63 | Syzygium guineense | 4 | 0.1% | 0.1 | 99.4% |
| 64 | Dichrostachys cinerea | 4 | 0.1% | 0.1 | 99.5% |
| 65 | Ban-Bami (Pular) | 4 | 0.1% | 0.1 | 99.5% |
| 66 | Gardenia triacantha | 3 | 0.1% | 0.1 | 99.6% |
| 67 | Isobelinia doka | 3 | 0.1% | 0.1 | 99.6% |
| 68 | Indeterminate No. 1 | 3 | 0.1% | 0.1 | 99.7% |
| 69 | Goro Ndioldu (Pular) | 3 | 0.1% | 0.1 | 99.8% |
| 70 | Combretum micranthum | 3 | 0.1% | 0.1 | 99.8% |
| 71 | Dialium guineense | 2 | 0.0% | 0.1 | 99.9% |
| 72 | Mitragyna stipulosa | 2 | 0.0% | 0.1 | 99.9% |
| 73 | Xylopia aethiopica | 2 | 0.0% | 0.1 | 99.9% |
| 74 | Indeterminate No. 2 | 1 | 0.0% | 0.0 | 99.9% |
| 75 | Securiadaca longipedunculaca | 1 | 0.0% | 0.0 | 100.0% |
| 76 | Detarium senegalense | 1 | 0.0% | 0.0 | 100.0% |
| 77 | Trema orientalis | 1 | 0.0% | 0.0 | 100.0% |
| | TOTAL | 5341 | 100.0% | 178.0 | |

## Table D6. Sommaire des renseignements descriptifs des placettes

| No. de placette | Topographie | Sol | Formation végétale | Régéneration (1-3) | Régéneration (Espec.) | Bani. (1/0) | Bambou (0-3) | Notes |
|---|---|---|---|---|---|---|---|---|
| 1 | terrain plat | graveleux | SAa | 3 | 3 | 1 | 1 | *Formation végétale* |
| 2 | terrain plat | graveleux | SAc | 1 | 1 | 1 | 1 | *Savane* |
| 3 | pente faible | argileux | SAa | 1 | 3 | 1 | 0 | SAa S.Arbustive |
| 4 | terrain plat | pierreux | SAa | 2 | 3 | 1 | 0 | SAc S.Arborée Claire |
| 5 | terrain plat | pierreux | SAa | 3 | 5 | 1 | 1 | SAd S.Arborée dense |
| 6 | pente faible | pierreux | SAa | 2 | 3 | 1 | 0 | SAw S.Bow_ |
| 7 | terrain plat | argileux | SAa | 1 | 6 | 1 | 2 | *Autres* |
| 8 | terrain plat | argileux | SAc | 3 | 2 | 1 | 3 | FG Forêt galerie |
| 9 | pente faible | pierreux | SAa | 2 | 4 | 1 | 0 | CUj Jeune jachère |
| 10 | terrain plat | argileux | SAc | 2 | 3 | 1 | 1 | BW Bowal |
| 11 | pente faible | argileux | SAc | 2 | 2 | 1 | 1 | |
| 12 | pente faible | pierreux/ hydromorphie | FG | 3 | 4 | 1 | 1 | |
| 13 | terrain plat | pierreux | SAc | 2 | 4 | 0 | 1 | |
| 14 | terrain plat | argileux | SAc | 2 | 3 | 0 | 1 | *Régéneration* |
| 15 | terrain plat | pierreux | SAa | 2 | 1 | 0 | 2 | *Occurrence (1-3)* |
| 16 | terrain plat | pierreux | SAc | 2 | 3 | 0 | 1 | 3 abondant |
| 17 | pente faible | hydromorphie | CUj | 2 | 3 | 0 | 0 | 2 moins abondant |
| 18 | terrain plat | argileux | SAa | 2 | 4 | 0 | 2 | 1 rare |
| 19 | terrain plat | argileux | SAa | 2 | 5 | 0 | 1 | *Espèces (nombre)* |
| 20 | pente faible | pierreux | SAa | 2 | 7 | 1 | 1 | |
| 21 | pente faible | pierreux | SAa | 2 | 4 | 1 | 1 | *Bani (import. en peuplement)* |
| 22 | pente faible | pierreux | SAc | 3 | 3 | 1 | 1 | 0 non |
| 23 | pente faible | pierreux | SAa | 2 | 5 | 0 | 1 | 1 oui |
| 24 | pente faible | argileux | SAa | 3 | 5 | 0 | 0 | |
| 25 | pente faible | hydromorphie | SAa | 2 | 3 | 0 | 1 | *Bambou* |
| 26 | terrain plat | argileux | CUj | 2 | 3 | 0 | 0 | 3 abondant |
| 27 | terrain plat | pierreux | SAw | 2 | 3 | 0 | 1 | 2 moins abondant |
| 28 | pente faible | argileux | CUj | 2 | 4 | 0 | 1 | 1 rare |
| 29 | pente faible | pierreux | SAd | 2 | 5 | 0 | 1 | 0 absent |
| 30 | pente faible | pierreux | SAw | 2 | 3 | 0 | 1 | |
| 31 | terrain plat | pierreux | BW | 1 | 2 | 0 | 0 | |
| 32 | terrain plat | argileux | SAa | 3 | 1 | 0 | 0 | |
| 33 | pente faible | argileux | SAa | 2 | 3 | 0 | 0 | |
| 34 | pente faible | argileux | SAa | 2 | 3 | 0 | 1 | |
| 35 | pente faible | pierreux | SAc | 2 | 3 | 0 | 2 | |
| 36 | forte pente | pierreux | SAa | 2 | 1 | 0 | 1 | |
| 37 | forte pente | pierreux | SAc | 2 | 5 | 0 | 1 | |
| 38 | terrain plat | argileux | SAc | 2 | 5 | 0 | 1 | |
| 39 | terrain plat | pierreux | SAa | 2 | 2 | 0 | 1 | |
| 40 | terrain plat | argileux | CUj | 2 | 2 | 0 | 1 | |

| No. de placette | Topographie | Sol | Formation végétale | Régéneration (1-3) | (Espec.) | Bani. (1/0) | Bambou (0-3) | Notes |
|---|---|---|---|---|---|---|---|---|
| 41 | terrain plat | argileux | SAa | 2 | 4 | 1 | 1 | |
| 42 | pente faible | argileux/ limoneux | FG | 2 | 3 | 0 | 2 | |
| 43 | pente faible | pierreux | SAa | 3 | 4 | 0 | 0 | |
| 44 | pente faible | pierreux | CUj | 2 | 4 | 0 | 0 | |
| 45 | pente faible | pierreux | SAa | 2 | 4 | 0 | 0 | |
| 46 | pente faible | pierreux | SAa | 3 | 4 | 0 | 1 | |
| 47 | pente faible | pierreux | SAa | 2 | 4 | 0 | 2 | |
| 48 | forte pente | pierreux | CUj | 2 | 2 | 0 | 0 | |
| 49 | terrain plat | argileux | CUj | 3 | 4 | 0 | 0 | |
| 50 | terrain plat | argileux | SAc | 2 | 4 | 1 | 3 | |
| 51 | terrain plat | pierreux | SAa | 2 | 2 | 0 | 0 | |
| 52 | forte pente | pierreux | SAa | 2 | 3 | 0 | 3 | |
| 53 | pente faible | argileux | SAc | 2 | 7 | 0 | 2 | |
| 54 | pente faible | argileux | SAc | 2 | 3 | 1 | 1 | |
| 55 | forte pente | argileux | CUj | 1 | 2 | 0 | 1 | |
| 56 | pente faible | argileux | SAa | 2 | 2 | 1 | 1 | |
| 57 | pente faible | argileux | SAc | 2 | 7 | 0 | 1 | |
| 58 | terrain plat | pierreux | SAa | 2 | 3 | 0 | 0 | |
| 59 | forte pente | argileux | SAc | 2 | 2 | 0 | 3 | |
| 60 | terrain plat | argileux | SAa | 2 | 2 | 1 | 1 | |

| | |
|---|---|
| SBW | 2 |
| SAD | 1 |
| SAC | 16 |
| SA | 29 |
| JJ | 8 |
| FG | 1 |
| BW | 1 |
| BF | 2 |
| | 60 |

## Table D7. Composition des espèces régénération

| Espèces | No. | Pourcent |
|---|---|---|
| Piliostigma thonningii | 24 | 11.9% |
| Markhamia tomentosa | 22 | 10.9% |
| Combretum glutinosum | 19 | 9.5% |
| Detarium spp. | 11 | 5.5% |
| Parkia biglobosa | 11 | 5.5% |
| Bombax costatum | 10 | 5.0% |
| Hymenocardia acida | 10 | 5.0% |
| Combretum aculeatum | 6 | 3.0% |
| Terminalia albida | 6 | 3.0% |
| Lophira alata | 5 | 2.5% |
| Holarrhena floribunda | 5 | 2.5% |
| Vitex doniana | 5 | 2.5% |
| Xeroderris stuhlmannii | 5 | 2.5% |
| Gardenia triacantha | 4 | 2.0% |
| Anthonotha crassifolia | 4 | 2.0% |
| Cassia sieberiana | 4 | 2.0% |
| Pterocarpus erinaceus | 4 | 2.0% |
| Crossopteryx febrifuga | 4 | 2.0% |
| Annona senegalensis | 4 | 2.0% |
| Pericopsis laxiflora | 4 | 2.0% |
| Teminalia macroptera | 4 | 2.0% |
| Hannoa undulata | 3 | 1.5% |
| Nauclea latifolia | 3 | 1.5% |
| Bridelia ferruginea | 3 | 1.5% |
| Terminalia glaucescens | 3 | 1.5% |
| Hexalobus monopetalus | 2 | 1.0% |
| Sterculia tragacantha | 2 | 1.0% |
| Combretum micranthum | 2 | 1.0% |
| Albizia spp. | 2 | 1.0% |
| Lannea velutina | 1 | 0.5% |
| Parinari sp. | 1 | 0.5% |
| Vaprica | 1 | 0.5% |
| Stry.spin | 1 | 0.5% |
| Acacia ataxacantha | 1 | 0.5% |
| Phyllanthus discoidea | 1 | 0.5% |
| Prosopis africana | 1 | 0.5% |
| Spondias mombin | 1 | 0.5% |
| Ficus spp. | 1 | 0.5% |
| Ximenia | 1 | 0.5% |
| | 201 | 100.0% |

**Table D8. Inventaire de la Forêt Classée de Nialama (1996)**
**Sommaire des renseignnements des dimensions des placettes**

| Nombre de placette | Nombre des tiges | par hectare | Diamètre (cm DHP) | Hauteur (m) | Surface terrienne ($m^2$/ha) | Formation végétale |
|---|---|---|---|---|---|---|
| 1 | 115 | 230 | 15.6 | 9.1 | 5.7 | SA |
| 2 | 96 | 192 | 24.9 | 9.6 | 11.7 | SAC |
| 3 | 112 | 224 | 20.8 | 8.4 | 10.5 | SA |
| 4 | 65 | 130 | 21.0 | 8.7 | 6.2 | SA |
| 5 | 172 | 344 | 17.3 | 6.9 | 9.7 | SA |
| 6 | 81 | 162 | 20.7 | 7.4 | 7.2 | SA |
| 7 | 42 | 84 | 19.5 | 7.0 | 3.2 | SA |
| 8 | 127 | 254 | 17.0 | 9.0 | 7.5 | SAC |
| 9 | 135 | 270 | 15.7 | 6.2 | 5.9 | SA |
| 10 | 90 | 180 | 24.2 | 10.0 | 10.3 | SAC |
| 11 | 163 | 326 | 18.4 | 8.8 | 10.3 | SAC |
| 12 | 65 | 130 | 24.8 | 11.7 | 10.0 | FG |
| 13 | 77 | 154 | 23.5 | 9.8 | 8.2 | SAC |
| 14 | 69 | 138 | 22.8 | 9.4 | 6.9 | SAC |
| 15 | 58 | 116 | 23.3 | 10.2 | 6.2 | SA |
| 16 | 41 | 82 | 29.8 | 11.0 | 6.8 | SAC |
| 17 | 25 | 50 | 32.7 | 15.2 | 5.1 | JJ |
| 18 | 86 | 172 | 20.6 | 10.0 | 7.7 | SA |
| 19 | 49 | 98 | 16.9 | 7.1 | 2.7 | SA |
| 20 | 131 | 262 | 18.5 | 8.3 | 9.6 | SA |
| 21 | 126 | 252 | 16.8 | 7.3 | 6.5 | SA |
| 22 | 135 | 270 | 19.3 | 10.9 | 9.9 | SAC |
| 23 | 76 | 152 | 18.0 | 9.0 | 4.8 | SA |
| 24 | 111 | 222 | 19.2 | 8.1 | 8.0 | SA |
| 25 | 22 | 44 | 27.0 | 9.4 | 3.6 | SA |
| 26 | 34 | 68 | 26.3 | 11.0 | 5.3 | JJ |
| 27 | 81 | 162 | 18.3 | 7.8 | 5.6 | SBW |
| 28 | 74 | 148 | 20.9 | 8.6 | 6.8 | JJ |
| 29 | 193 | 386 | 18.5 | 8.8 | 12.3 | SAD |
| 30 | 66 | 132 | 16.5 | 6.4 | 3.4 | SBW |
| 31 | 56 | 112 | 20.4 | 7.0 | 4.6 | BW |
| 32 | 26 | 52 | 31.1 | 12.9 | 5.3 | SA |
| 33 | 129 | 258 | 17.3 | 8.6 | 6.9 | SA |
| 34 | 90 | 180 | 21.5 | 10.0 | 8.6 | SA |
| 35 | 70 | 140 | 24.5 | 11.3 | 8.0 | SAC |
| 36 | 164 | 328 | 18.2 | 8.8 | 10.8 | SA |
| 37 | 180 | 360 | 16.7 | 8.6 | 9.6 | SAC |
| 38 | 162 | 324 | 21.1 | 11.2 | 13.5 | SAC |
| 39 | 116 | 232 | 19.3 | 9.9 | 8.2 | SA |
| 40 | 28 | 56 | 31.9 | 13.3 | 5.5 | JJ |
| 41 | 89 | 178 | 21.5 | 8.1 | 8.4 | SA |

| Nombre de placette | Nombre des tiges | par hectare | Diamètre (cm DHP) | Hauteur (m) | Surface terrienne ($m^2$/ha) | Formation végétale |
|---|---|---|---|---|---|---|
| 42 | 94 | 188 | 26.6 | 11.2 | 17.6 | FG |
| 43 | 41 | 82 | 20.9 | 8.9 | 4.5 | SA |
| 44 | 45 | 90 | 29.9 | 12.8 | 9.1 | JJ |
| 45 | 82 | 164 | 18.4 | 8.8 | 6.2 | SA |
| 46 | 134 | 268 | 14.4 | 9.5 | 5.3 | SA |
| 47 | 89 | 178 | 16.7 | 7.3 | 5.4 | SA |
| 48 | 47 | 94 | 15.7 | 6.9 | 3.0 | JJ |
| 49 | 51 | 102 | 15.2 | 6.7 | 2.3 | JJ |
| 50 | 76 | 152 | 18.4 | 8.6 | 5.7 | SAC |
| 51 | 25 | 50 | 20.4 | 7.8 | 2.1 | SA |
| 52 | 86 | 172 | 18.5 | 9.4 | 5.6 | SA |
| 53 | 121 | 242 | 20.4 | 10.0 | 9.1 | SAC |
| 54 | 151 | 302 | 17.9 | 9.2 | 9.5 | SAC |
| 55 | 35 | 70 | 26.3 | 8.3 | 4.9 | JJ |
| 56 | 71 | 142 | 16.8 | 8.0 | 4.6 | SA |
| 57 | 179 | 358 | 19.1 | 10.2 | 13.1 | SAC |
| 58 | 50 | 100 | 20.4 | 6.0 | 4.6 | SA |
| 59 | 81 | 162 | 23.3 | 10.8 | 9.9 | SAC |
| 60 | 54 | 108 | 30.5 | 9.6 | 13.2 | SA |
| TOTAL | 5339 | 172 | 20.4 | 8.9 | 7.1 | |

**Table D8b. Sommaire des renseignnements pour formation végétale**

| | SPH | DBH | BA |
|---|---|---|---|
| SBW | 132 | 16.5 | 3.4 |
| SBW | 162 | 18.3 | 5.6 |
| SAD | 386 | 18.5 | 12.3 |
| SAC | 324 | 21.1 | 13.5 |
| SAC | 358 | 19.1 | 13.1 |
| SAC | 192 | 24.9 | 11.7 |
| SAC | 180 | 24.2 | 10.3 |
| SAC | 326 | 18.4 | 10.3 |
| SAC | 270 | 19.3 | 9.9 |
| SAC | 162 | 23.3 | 9.9 |
| SAC | 360 | 16.7 | 9.6 |
| SAC | 302 | 17.9 | 9.5 |
| SAC | 242 | 20.4 | 9.1 |
| SAC | 154 | 23.5 | 8.2 |
| SAC | 140 | 24.5 | 8.0 |
| SAC | 254 | 17.0 | 7.5 |
| SAC | 138 | 22.8 | 6.9 |
| SAC | 82 | 29.8 | 6.8 |
| SAC | 152 | 18.4 | 5.7 |
| SA | 108 | 30.5 | 13.2 |
| SA | 328 | 18.2 | 10.8 |
| SA | 224 | 20.8 | 10.5 |
| SA | 344 | 17.3 | 9.7 |
| SA | 262 | 18.5 | 9.6 |
| SA | 180 | 21.5 | 8.6 |
| SA | 178 | 21.5 | 8.4 |
| SA | 232 | 19.3 | 8.2 |
| SA | 222 | 19.2 | 8.0 |
| SA | 172 | 20.6 | 7.7 |
| SA | 162 | 20.7 | 7.2 |
| SA | 258 | 17.3 | 6.9 |
| SA | 252 | 16.8 | 6.5 |
| SA | 130 | 21.0 | 6.2 |
| SA | 116 | 23.3 | 6.2 |
| SA | 164 | 18.4 | 6.2 |
| SA | 270 | 15.7 | 5.9 |
| SA | 230 | 15.6 | 5.7 |
| SA | 172 | 18.5 | 5.6 |
| SA | 178 | 16.7 | 5.4 |
| SA | 52 | 31.1 | 5.3 |
| SA | 268 | 14.4 | 5.3 |
| SA | 152 | 18.0 | 4.8 |
| SA | 142 | 16.8 | 4.6 |
| SA | 100 | 20.4 | 4.6 |

| | SPH | DBH | BA |
|---|---|---|---|
| SA | 82 | 20.9 | 4.5 |
| SA | 44 | 27.0 | 3.6 |
| SA | 84 | 19.5 | 3.2 |
| SA | 98 | 16.9 | 2.7 |
| SA | 50 | 20.4 | 2.1 |
| JJ | 90 | 29.9 | 9.1 |
| JJ | 148 | 20.9 | 6.8 |
| JJ | 56 | 31.9 | 5.5 |
| JJ | 68 | 26.3 | 5.3 |
| JJ | 50 | 32.7 | 5.1 |
| JJ | 70 | 26.3 | 4.9 |
| JJ | 94 | 15.7 | 3.0 |
| JJ | 102 | 15.2 | 2.3 |
| FG | 188 | 26.6 | 17.6 |
| FG | 130 | 24.8 | 10.0 |
| BW | 112 | 20.4 | 4.6 |
| FG | 159 | 25.7 | 13.8 |
| SAD | 386 | 18.5 | 12.3 |
| SAC | 227 | 21.3 | 9.4 |
| SA | 175 | 19.9 | 6.6 |
| JJ | 85 | 24.9 | 5.3 |
| SBW | 147 | 17.4 | 4.5 |
| BW | 112 | 20.4 | 4.6 |

## Table D9. Tiges classée par diamètre (cms)

- Nombre des tiges mesurées dans l'inventaire
- Tiges par hectare

| | |
|---|---|
| Plot Size | 0.5 |
| No. of Plots | 60 |
| Sample Area | 30.0 |
| Sample Intensity | 0.3% |

| | Bani seulement | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| No. de tiges | 10-14 | 15-19 | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50-54 | 55- | total |
| Qualité A | 7 | 3 | 5 | 7 | 2 | 3 | 2 | 1 | 2 | 0 | 32 |
| Qualité B | 61 | 58 | 36 | 21 | 26 | 18 | 8 | 7 | 3 | 8 | 246 |
| Qualité C | 463 | 243 | 127 | 69 | 68 | 52 | 41 | 25 | 29 | 20 | 1,137 |
| Toutes qualités | 531 | 304 | 168 | 97 | 96 | 73 | 51 | 33 | 34 | 28 | 1,415 |
| | | | | | | | | | | | |
| Tiges par ha | 10-14 | 15-19 | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50-54 | 55- | total |
| Qualité A | 0.2 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | 0.0 | 1.1 |
| Qualité B | 2.0 | 1.9 | 1.2 | 0.7 | 0.9 | 0.6 | 0.3 | 0.2 | 0.1 | 0.3 | 8.2 |
| Qualités (A+B) | 2.3 | 2.0 | 1.4 | 0.9 | 0.9 | 0.7 | 0.3 | 0.3 | 0.2 | 0.3 | 9.3 |
| Pourcent (A+B) | 24.5% | 21.9% | 14.7% | 10.1% | 10.1% | 7.6% | 3.6% | 2.9% | 1.8% | 2.9% | 100.0% |
| Qualité C | 15.4 | 8.1 | 4.2 | 2.3 | 2.3 | 1.7 | 1.4 | 0.8 | 1.0 | 0.7 | 37.9 |
| Qualités (A+B+C) | 17.7 | 10.1 | 5.6 | 3.2 | 3.2 | 2.4 | 1.7 | 1.1 | 1.1 | 0.9 | 47.2 |
| Pourcent (A+B+C) | 37.5% | 21.5% | 11.9% | 6.9% | 6.8% | 5.2% | 3.6% | 2.3% | 2.4% | 2.0% | 100.0% |