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PRELIMINARY REPORT ON SUSTAINABLE HARVESTING OF *PRUNUS AFRICANA* (ROSACEAE) IN THE MOUNT CAMEROON

Report prepared for the National Forestry Development Agency (ANAFOR), the Cameroon
CITES Scientific Authority for flora, in the frame of the project 'Non-detriment findings for
Prunus africana (Hook.f.) Kalkman in Cameroon+

By

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JME EXECUTIF

Prunus arricana (Rosaceae) globalement connu sous le vocable *Pygeum*, est un arbre qui pousse dans les forêts afro-montagnardes entre 1500 et 3000 m d'altitude, et sur sol volcanique et sous climat frais d'altitude. Son aire de distribution englobe la Côte d'Ivoire, la Guinée Équatoriale (île de Bioko), Sao Tome ?, Éthiopie, Kenya, Ouganda, Afrique du Sud, Madagascar, Congo, République Démocratique du Congo et Cameroun.

Au Cameroun, *Prunus* a été signalée principalement dans 4 régions (provinces) à savoir, le Nord Ouest, l'Ouest, le Sud Ouest, et l'Adamaoua.

Des extraits de l'écorce de cette plante ont été identifiés et patentés comme étant actifs dans le traitement de l'hypertrophie prostatique bénigne. Des capsules contenant des extraits d'écorce sont en vente en Europe depuis plus de 30 ans.

Prunus africana a été classée par l'Union Internationale pour la Conservation de la Nature comme espèce vulnérable. Ce fait a conduit à son classement dans l'annexe II de la Convention sur le Commerce International des espèces de faune et de flore sauvage menacées d'extinction (CITES) en 1995. Le quota annuel a subi des fluctuations jusqu'à la suspension du commerce en 2007 (entre 500 et 2000 tonnes). Depuis 2010, l'IBT et la CITES développent en collaboration avec le Gouvernement du Cameroun un projet intitulé « **Avis de Commerce Non Préjudiciable sur *Prunus africana* (Hook.f.) Kalkman au Cameroun** ». Les travaux entrepris dans le cadre dudit projet ont permis la reprise de l'exploitation de *Prunus africana* au Cameroun, avec un quota partiel de 150 tonnes pour la région du Nord ouest.

Le présent document rapporte la suite des résultats obtenus dans le cadre de ce projet pour la région du Sud ouest (mont Cameroun).

Le mont Cameroun est situé dans la région du Sud-ouest Cameroun, entre 3°57'N et 8°58' - 9°24'E, au fond de la baie de Biafra dans le golfe de Guinée. Il s'étend du Sud-ouest au Nord-est sur près de 45 km de long et 30 km de largeur. Le Mont Cameroun culmine à 4095 m au dessus de la mer et est de ce fait la plus haute montagne d'Afrique centrale et de l'Ouest. Il couvre une superficie de 25 000 km² et se trouve à cheval entre les départements de Fako et Meme. Le climat est de type subéquatorial sous régime de mousson. Le mont Cameroun a une richesse biologique unique avec un couvert végétal riche, dense et diversifié. En effet, c'est la seule zone en Afrique Centrale et de l'Ouest où la végétation est effectivement continue depuis le niveau de la mer jusqu'au sommet.

L'inventaire de *Prunus africana* a couvert une zone de 22 881,1 ha connue comme zone à *Prunus*. La superficie réellement sondée est de 255,3 ha, soit un taux de sondage de 1,11%. La méthode qui a été utilisée est celle dite « Adaptive Clusters Sampling (ACS) » ou échantillonnage adapté aux grappes. Elle a pour base la méthode conventionnelle d'inventaire d'aménagement généralement utilisée en forêt dense au Cameroun. La méthode ACS est indiquée en ce sens qu'elle permet de capter les grappes ou « clusters » de *Prunus* comme espèce grégaire.

La densité moyenne de *Prunus africana* dans le mont Cameroun est de 3,43 arbres/ha. La densité la plus forte se trouve à l'intérieur du parc. Elle est de plus de une fois et demi la densité des tiges trouvée hors parc. Ce fait confirme le rôle important du parc sur la conservation de *Prunus africana*. Le nombre total d'arbres de *Prunus* est estimé à 79 659 tiges. Soixante dix neuf pourcent (79%) de ces tiges se trouvent à l'intérieur du parc. Le nombre total des tiges exploitables est de 41 042 (51,5%). Ce chiffre regroupe les tiges vivantes de diamètre supérieur au diamètre minimum d'exploitabilité (DME) et les tiges dépérissantes ou mortes (bonus).

Une simulation du rendement annuel soutenu de l'écorce de *Prunus* a été faite sur la base du nombre de tiges exploitables, du rendement moyen par arbre et du temps nécessaire entre deux passages successifs sur le même arbre. Le rendement soutenu de *Prunus*

est de 410,42 tonnes/an, avec 348,84 tonnes dans le quota annuel de **205,21 tonnes de corce sèche** de Cameroun dont **174,42 tonnes** dans le parc et **30,78 tonnes** hors parc. Le quota annuel de 205,21 tonnes est considéré comme une moyenne entre le quota de 188,11 tonnes/an sous-estimé du fait notamment du long temps de rotation pour la couverture complète de la corce (6 ans) et celui de 225,73 tonnes/an sur-évaluée du fait du court temps de rotation qui devra séparer deux récoltes (5 ans) successives sur le même arbre.

Pour permettre la conservation de *Prunus africana* dans la région du mont Cameroun, il serait intéressant de :

- Renforcer tous les services forestiers dans la zone du mont Cameroun en capacités humaines, logistiques et en motivations financières pour mieux contrôler et suivre les opérations de récolte, de transformation et de transport de *Prunus* ;
- Faire un toilettage du nombre des opérateurs économiques qui font dans l'exploitation de *Prunus africana*, pour ne garder que des opérateurs soucieux de la gestion durable de la ressource ;
- Accélérer la mise en place des procédures de attribution des Unités de Allocation de *Prunus* ;
- Revoir les modalités d'accès à la ressource en terme de prix de vente de ce produit conformément à la réglementation forestière ;
- Revaloriser la taxe de régénération qui du reste est très faible. Les 10 FCFA/kg perçus par l'administration forestière ne peuvent en aucune façon permettre à l'État de garantir une gestion durable de ce produit;
- Prendre des mesures spécifiques pour le prélèvement durable de *Prunus africana* dans le parc conformément aux dispositions du décret de création du parc national du mont Cameroun;
- Mettre sur pied un bon système de traçabilité des produits qui seront récoltés;
- Encourager la création des plantations à *Prunus africana* dans la région du Sud Ouest Cameroun ;
- Accompagner les populations locales à développer les pratiques agricoles qui limitent l'extension des surfaces cultivées au détriment de la perte des forêts à *Prunus*.

Prunus africana is a species of the Rosaceae family, known under its commercial name as pygeum or African chery. It is a montane tree species of the tropical Africa including the Côte d'Ivoire, Equatorial Guinea (Bioko island), Sao Tome, Ethiopia, Kenya, Uganda, South Africa, Madagascar, Congo, the Democratic Republic of Congo, and Cameroon.

Concerns on the future of *Prunus africana* led to its listing in Appendix II of the Convention on International Trade in Endangered Species of wild Fauna and Flora (CITES) in 1994, becoming effective in 1995.

Recognizing the shortcomings in scientific information related to the sustainable harvesting of *Prunus africana*, the government of Cameroon submitted to the International Tropical Timber Organization (ITTO) for funding the project entitled **Í Non-detriment findings (NDF) for *Prunus africana* (Hook.f.) Kalman in CameroonÎ**.

The first important output of the project was the production of the partial NDF report on *Prunus africana* for the mount Oku, in the North west region of Cameroon. An annual quota of 150 tons of dried barks was proposed for that region (Amougou et al. 2010), which lifted the ban on the exportation of *Prunus* barks from Cameroon.

This second document reports results of specific activities conducted within this project in the south west region (the Mount Cameroon area).

The Mount Cameroon is located in the South west region of Cameroon, between 3°57q-4°27qlatitude North and 8°58q- 9°24qlongitude East in the bottom of the Biafra bot berry in the Guinean gulf. It is up to 4095 m and covers a total area of 25 000 square kilometre (km²), in the divisions of Fako and Meme. Mount Cameroon is composed of two main parts: the area inside the national park and the area outside the park.

The total area covered by *Prunus africana* in the mount Cameroon is 22 881,1 ha distributed in 16 014.732 ha inside the park and 6 868.719 ha outside the park. The method used to evaluate the abundance of *Prunus* in mount Cameroon is called %Adaptive Clusters Sampling (ACS)+. This method has its basis in the conventional forest inventory method often used to design the management plan in dense forests. The ACS method is advised since it captures the *Prunus* clustering characteristics. A total of 255.3 ha of forest were sampled. The average sampling intensity is 1.11%. The density of *Prunus* trees in mount Cameroon is 3.44 trees/ha distributed in 2.44 stems/ha outside and 3.93 stems/ha inside the park. The highest density observed inside the park confirms the key role of that protected area in the conservation of *Prunus africana* in Cameroon. A total number of *Prunus* trees (living, wilt or dead) estimated for the whole mount Cameroon area is 79 659. The number of living/healthy trees is 71 115 while that of dead or wilt trees is 8 544. Wilt and dead trees represent 8.1% of the total number of trees. Among living trees, only 32 498 trees representing 8.6% of the total have reached the minimum exploitable diameter (MED) and can therefore be harvested. A simulation of the sustainable yield of *Prunus* bark was made from estimates of the natural population, the average yield per tree and the length of time between successive debarkings required to allow total recovery of the bark. The annual yield of fresh bark of *Prunus* in the mount Cameroon area is 410 420 kg. **The quota of *Prunus* in mount Cameroon area is 205.21 tons of dried bark/year with 174.42 tons/year inside the park and 30.7 tons/year outside the park.** The 205.21 tons/year estimated are considered as the medium, obtained from the lowest estimated with a rate of recovery of 6 years (188.109.17 tons/year) and the highest estimate with a rate of recovery of 5 years (225.73 tons/year).

To ensure the conservation of *Prunus africana* in the mount Cameroon area, following actions should be taken:

decentralised forest units found in the area of mount
resources, logistics, and financial incentives in order to
monitor the exploitation, processing, and transport of

Prunus products;

- filter the number of companies who are working in the field of *Prunus africana* as to keep those who are interested in sustainable management of the resource;
- address the issue of equity in the trade exchanges on *Prunus africana*. This should ensure that local communities are well motivated to conserve *Prunus africana* in their forests;
- accelerate the implementation of the procedures for the attribution of the Prunus Allocation Units (PAU);
- revise the modalities of access to the resource in terms of the selling price in accordance with the current forest law;
- propose a better system of taxation of *Prunus* products. The current 10 FCFA/kilogram perceived by the Cameroon Government as the regeneration tax cannot ensure the activities required for the sustainable management of the resource;
- take specific measures for sustainable harvesting of *Prunus africana* barks inside the park in conformity with the decision that creates the park;
- develop and implement a fair tracking system to trace *Prunus* products from the forest till the exit points;
- encourage local people to develop *Prunus* plantations;
- assist local people in developing fair farming system that do not harm *Prunus* habitat.

Prunus africana is a species of the Rosaceae family, known under its commercial name as pygeum or African chery. It is a mountane tree species of the tropical Africa including the Côte d'Ivoire, Guinea equatorial (Bioko island), Sao Tome, Ethiopia, Kenya, Uganda, South Africa, Madagascar, Congo, the Democratic Republic of Congo, and Cameroon (Vivien et Faure 1985).

In Cameroon, *Prunus* bark exploitation started in 1972, and many trees around the Mt Cameroon have been exploited several times with four-year intervals. Legally for all trees above 30 cm diameter at breast high (bh), only two quarters of the bark are taken from the main stem up to the first branch. However, since 1985, many people were involved in the exploitation and the harvesting was done by untrained villagers. Many trees were debarked up to the smallest branches and others were felled with negative impact on the limited wild population of this tree species.

Concerns on the future of *Prunus africana* led to its listing in Appendix II of the Convention on International Trade in Endangered Species of wild Fauna and Flora (CITES) in 1994, becoming effective in 1995 (Sunderland and Tako 1999 cit. Tieguhong and Ndoye 2004). The impact of listing *Prunus africana* by CITES has been partially effective in reducing threats because it has helped to raise awareness about the problems posed by international trade.

The partial ban of *Prunus* exploitation in 1991, which was lifted in 1992; the ban on felling decided in 1993; and the reduction of quotas in 2008 were followed by the ban on the importation of Cameroon's *Prunus* into Europe space as a result of the decision undertaken by the European Commission in October 2007. This measure impacts both the economic operators and the local people for whom *Prunus* represents an important non timber forest product.

A key requirement of CITES is the non-detriment findings made by the Scientific Authority of the range State prior to export, certifying that export is not detrimental to the survival of the species. This requires information on the location, stock, growth and conditions of the species and on its ecology, regeneration and subsequent protection. Such information is often lacking, incomplete or imprecise making a proper evaluation of the sustainable levels of utilisation and conditions attached to be difficult. The Scientific Authorities also face obstacles due to inadequately trained staff or shortage of resources.

Recognizing the shortcomings in scientific information related to the sustainable harvesting of *Prunus africana*, the government of Cameroon has submitted to the International Tropical Timber Organization (ITTO) for funding one project entitled **Non-detriment findings for *Prunus africana* (Hook.f.) Kalman in Cameroon**. This project is being implemented by the National Forest Development Agency (ANAFOR), the Cameroon's CITES Scientific Authority for plants issues. Field specific activities started in July 2010 following the first meeting of the Steering Committee held on 20th July 2010. The first important output of the activity was the production of the partial NDF report on *Prunus africana* for the Mount Oku, in the North west region of Cameroon. An annual quota of 150 tons of dried barks was proposed for the North West region (Amougou et al. 2010), which lifted the ban on the exportation of *Prunus* barks from Cameroon.

This second document reports results of specific activities conducted within that project in the south west region, on the Mount Cameroon area to be précised.

1.2. Importance and compliance of the activity with the existing policies and strategies

As already mentioned in the previous report (Amougou et al. 2010), the work goes in line with the Cameroon's Forest and Environment Sectorial Program (FESP) developed in 2003

developed by the Cameroon Government as to bring into effect the provisions of the 1994 forest law. The FESP is structured to meet the objectives of two of the five components, including: Component 2 (Sub-component 2.4/Activity 2.4.1/Sub-activity 2.4.1.2: to undertake inventories to know the stock of Non timber forest products (NTFP) in each ecological zone, Sub-activity 2.4.1.3: to identify production sites and the trade chain of principal NTFP, Sub-activity 2.4.1.4: to create a database on NTFP, Sub-activity, activity 2.4.2./Sub-activity 2.4.2.1: to develop and disseminate the sustainable harvest methods, processing and domestication, Sub-activity 2.4.2.3: to build CITES organs capacities and Component 5 (Sub-component 5.3: research and monitoring).

The work is in compliance with the recent guidelines developed for *Prunus* management plan in Cameroon (Ingram et al. 2009).

The work also goes in line with the ITTO/CITES program ensuring that the international trade in CITES tropical listed tree species is non detrimental to their conservation (ITTO . CITES 2006).

1.3. Objectives

This work aims to gather and analyse data for sustaining *Prunus africana* together with its natural habitats in the South west region of Cameroon (the Mount Cameroon area). The specific objectives are to gather the basic information on the distribution, and abundance of this plant species and to present a comprehensive procedure followed to determine the stock and annual quota as useful tools for sustaining *P. africana* in the Mount Cameroon

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the logical steps and procedures followed to ensure sustainable harvesting of *Prunus africana* in the mount Cameroon.

2.1. Study area

Among the ten regions of Cameroon, six, namely Adamaoua (Ngaoundéré being the capital), the Centre (Yaoundé), Littoral (Douala), North West (Bamenda), Southwest (Buea), and West (Bafoussam), are those where populations of *Prunus africana* occur. But the main reserves of *Prunus africana* are observed in the Adamaoua, North West and South West regions. The major landscapes of Cameroon containing *Prunus* (Ingram et al. 2009) have been defined and consolidated into *Prunus* Allocation Units (PAUs) that cover six mountane areas (figure 2).

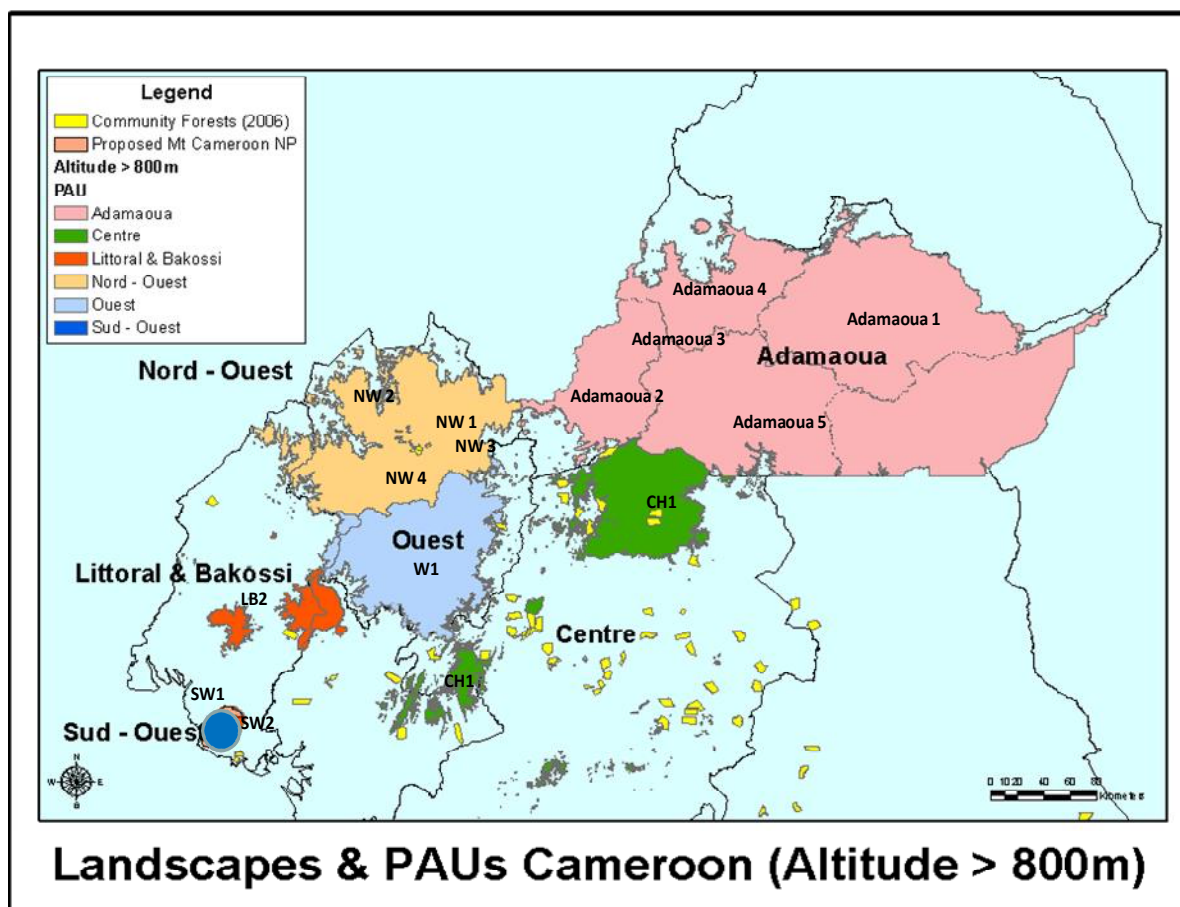


Figure 1: The six regions of *Prunus africana* in Cameroon

the South west region of Cameroon, between 3°57'q. 4°27'q latitude North and 8°58'q. 9°24'q longitude East in the bottom of the Biafra bot berry in the Guinean gulf (figure 2). It is up to 4095 m and covers a total area of 25 000 square kilometre (km²), in the divisions of Fako and Meme. The climate is a subequatorial type, on monsoon regime with two seasons: a short dried season from December to March and a long rainy season from April to November. The average temperature is 22°C in the altitude and it increases of 6°C every 100 m. The relative humidity remains at 75-80% due to the influence of clouds and fogs. Mount Cameroon is an active volcano of the Hawaiian type. Slopes are steep, soils are volcanic, fertile with a low capacity of water retention. Those soils, if well drained are good for agriculture (Ewusi 2003).

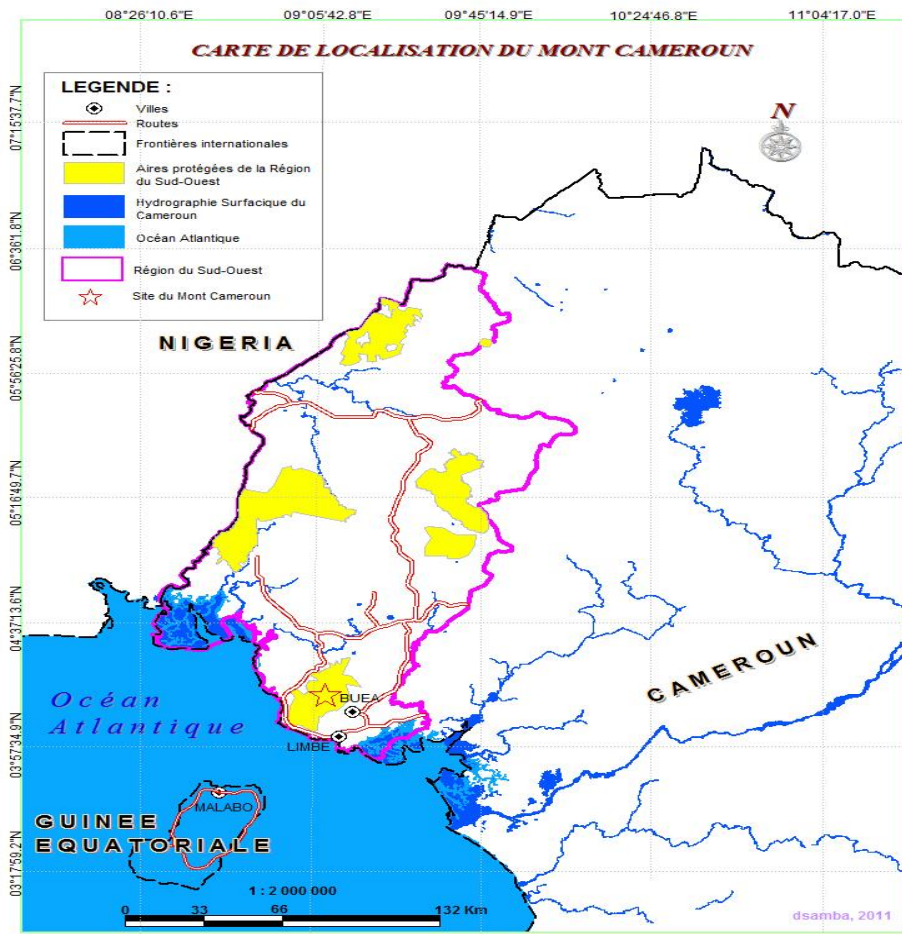


Figure 2. Location of mount Cameroon in the South west region of Cameroon

The Mount Cameroon has a high diversity of plant species. It is the only area in central Africa where the vegetation is continuous from the bottom at the sea level till the summit (ERM 1998). From bottom to the summit of the mount, there are four main vegetation types including: the sub-mountain forest, the mountain forest, the sub-mountain meadow, and the mountain meadow. The mountain forest is less rich in plant species compared to the sub-mountain forest. Characteristic trees found in the mountain forest include *Prunus africana*, *Schefflera abyssinica*, *Canthium dunlapii*, *Nuxia congesta*, *Clausena anisata*, *Syzygium staudii*.

also rich. Main mammals found in the mount include: *preussii*, *Cercopithecus erythrotis*. There exist also chimpanzees and elephants.

The mount Cameroon area was erected as national park in 2000.

2.2. History of *Prunus* bark harvesting in Mount Cameroon

Prunus bark exploitation started in 1972, and an important number of trees around the Mt. Cameroon have been exploited several times with four-year intervals. Legally for all trees above 30 cm dbh, only two quarters of the bark are taken from the main stem up to the first branch. However, since 1985, several peoples were involved in the exploitation and the harvesting was done by untrained villagers. As a result of this, many trees were debarked up to the smallest branches and others were felled with negative impact on the limited wild population of this tree species.

Prior to 1987, Plantecam Medicam, as it was known then, operated within a strict monopoly in the exploitation of *Prunus africana* in Cameroon. They set and adhered to strict harvesting guidelines such as no felling and no girdling but only the stripping of opposite quarters of the tree to allow for bark regeneration. Thereafter, a breakdown in this monopoly came with the issuance of licenses to a number of companies and individuals. This led to a dramatic increase in field operatives working in an area with corresponding increase in unsustainable practices, notably the felling of trees, total bark removal and non-respect for quotas set.

The lesson to be learnt here may be that increasing commercial competition without putting in place adequate management regimes, based on sound inventory data may probably lead to a corresponding increase in the amount and intensity of bark exploited. Therefore, the issuance of permits is not necessarily a guarantee of sustainability, especially when permits are issued with no harvesting controls being implemented (Sunderland and Tako 1999 cit. Tieguhong and Ndoye 2004).

Several threats can be observed for *Prunus africana* in Cameroon: habitat loss/degradation, inadequate techniques of harvesting and over harvesting. Forest clearing leading to population fragmentation, slash and burn cultivation, burning of the upper grassland, and commercial plantations are said to be also threats for *Prunus africana* (Akagou et Betti 2007; Ndam 1996).

2.3. Material and methods

Prunus inventories were carried out inside and outside the Mount Cameroon national park (Belinga 2011). The method used is called Adaptive Clusters Sampling (ACS) method.

This method has its basis in the known conventional forest inventory method often used in dense forests. In Cameroon, the classical forest inventory method is standardised for management inventories (MINEF, see arête n° 222).

2.3.1. Description of the classical method

2.3.1.1 Mapping

Materials used for mapping are made up of: a GPS Garmin C76 x, a topographic map at scale 1:200 000 produced by the National Institute for Cartography (INC), the forest photo interpretation manual produced by the former National Forest Development Agency (ONADEF 2007), aerial photos at scale 1:20 000 covering years 1983 to 1987 (5 to 6 sq km over 21 sq km analysed) obtained from the Forest Mapping and Remote Sensing Centre (CETELCAF), aerial photos at 1:50 000 ranging from 1949 to 1970 (28 sq km over 81 sq km) acquired from INC, a 30 m-resolution-Landsat image of 2007 (15 m panchromatic), the report of *Prunus* inventory produced by CIFOR in 2007. The GIS software used includes the ERDAS IMAGINE 9.3 and ARC GIS 9.3 computer packages.

on by stereoscopy, supervised classification of the geo
iving the strata shown by the forest map updated, the
supervised classification using 7 multi-spectral bands)
and field visits for habitats description (Samba, 2011).

2.3.1.2. Sampling design and intensity

According to the national standards, the sampling is systematic and stratified to 1 degree when the statistical unit is the plot. The samples or plots of 0,5 ha (250 m long x 200 m large) are distributed systematically throughout the entire population and not by stratum (forest type). The stratification is done definitively after the sampling. The systematic disposal of plots allows to assume that the intensity of sampling for each stratum is proportional to its area in the forest. Results of the inventory and their accuracy are calculated for each stratum.

In practice, sampling is carried along straight and continuous axes called %ayons+or lines or transects. These %ayons+are oriented along a predetermined magnetic direction but are systematically arranged in such a way that they are mostly parallel, equidistant and perpendicular to the general direction of both drainage and slopes.

Rectangular plots arranged along a %ayon+are contiguous (without alley or corridor of separation) and measure 250 m in the direction of the %ayon+(length) and 20 m in the direction perpendicular to the %ayon+(width). This gives a surface area of 0.5 ha for each plot. For the ACS method, additional circular plots of 0,2 ha will be added in respect of the conditions that will be clarified later.

The formula which allows to calculate the distance or interval between two %ayons+is as follows:

$$\text{interval} = \frac{\text{Net Area to probe or to survey (ha)} \times 20 \text{ m}}{\text{Area actually probed (ha)}}$$

The sampling intensity is the ratio between the area surveyed and the total area of the Forest. It must provide for the parameters studied, values which are representative of the general population and this, according to precisions criteria set in advance. But this precision of the results obtained with a given sampling intensity depends on the variability of the parameters measured in this population. Fixing in advance the desired precision, one must have some idea of this variability as to calculate the number of samples which will be collected (chosen).

In Cameroon, the sampling intensity for management inventories varies according to surface area to be covered. For areas over 50 000 ha, the sampling rate should be comprised between 0.5 and 1%, while for areas less than 50 000 ha, the sampling rate should be more than 1%. The surveys conducted so far in Mount Cameroon and using the technique presented here have estimated the useful area of *Prunus africana* in the both sub-mountain and mountain forests to 22 000 ha (Ewusi et al. 1996).

A total of 34 lines were proposed to cover the Mount Cameroon area for *Prunus* inventory including 20 lines inside the park, 4 outside the park and 10 covering the two sides of the park. The sampling design is illustrated in figure 3.

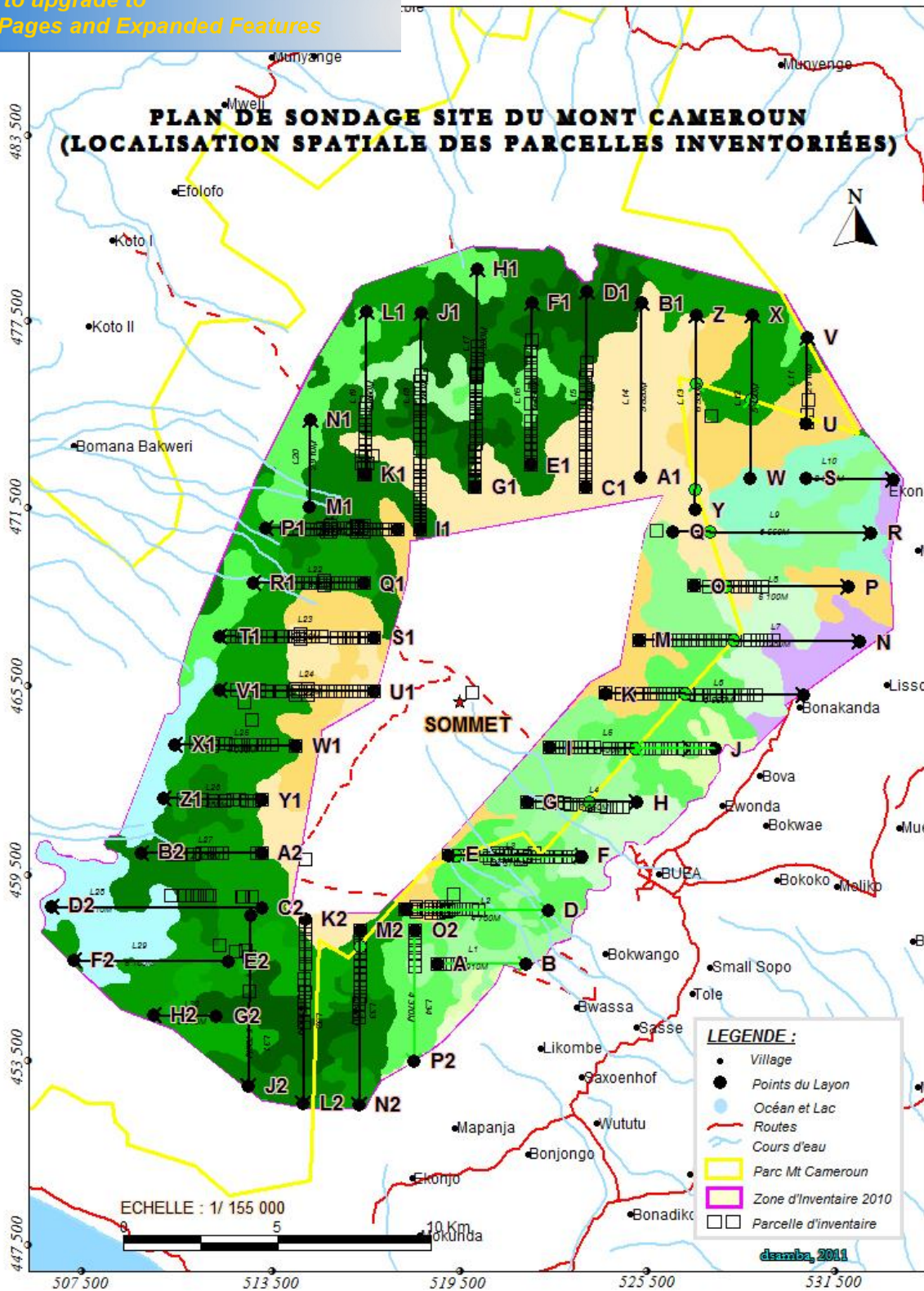


Figure 3 : Map of sampling design for *Prunus* inventory on the Mount Cameroon

Design

Design or line opening/transect cutting and counting

a) Line opening/transect cutting

This step consists of opening or cutting according to a defined magnetic direction, corridors or alleys of 1.5 m wide. These corridors are clearly cleaned by cutting shrubs, vines and branches that obstruct the passage. They are then identified by marks. The corridors constitute the reference system which will be used by the subsequent counting team. It is during the line opening that details on topography, habitat types, rivers and the corrected horizontal distance of the corridor (after reading the slopes) are given. It is also during this stage that the sample plots are identified and numbered. The data collected are recorded on specific sheet.

b) Counting

The counting step includes all operations relating to dendrological and dendrometric records. During the counting in rectangular and circular plots, several operations are made including: identification of stems of *Prunus africana*, the measurement of stems with diameter at breast height (dbh = 1.50 m) ≥ 5 cm, appreciation of the health state of the tree in three classes (dead trees, damaged trees, and living trees). The appreciation of the healthy status of the tree is mainly based on the health of the leaves and number of dried branches. Lines and plots are identified and numbered with their geographical coordinates and altitudes.

2.3.2. Theoretical basis of the Adaptive Clusters Sampling (ACS) method

The ACS method is advised to capture the *Prunus* clustering characteristics.

Considering y (total number of stems for example), the value of the parameter in the sampling unit (plot) of the traditional method, and C the condition (a limit number of stems for example) required to initiate an adaptive sampling. If $y > C$ in the indicated plot, additional circular plots are established in its periphery. If other units (circular plots) of the periphery have their $y > C$, then the process continues till obtaining a network of circular plots. The process stops when the condition can no longer be verified ($y < C$). If many units satisfy the conditions, then the sample will have many units in the entire population. The ACS sampling device is illustrated in figure 4.

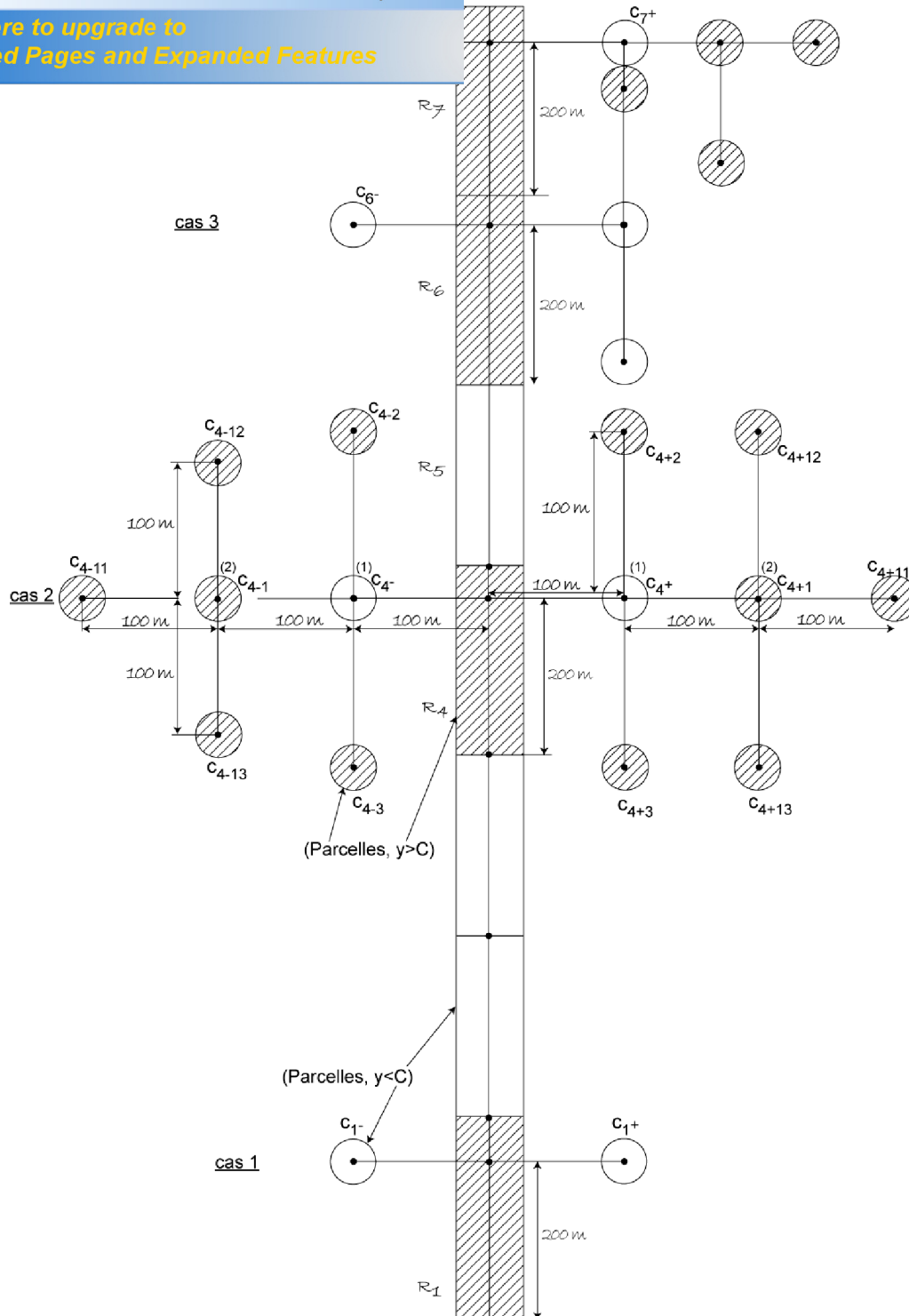


Figure 4: Sampling design of the ACS method

The ACS method has many advantages: it allows to have a good idea on the distribution of *Prunus* clusters, it provides many data, and good precisions, it is almost similar to a systematic or total inventory mostly when the sample becomes too large, it is more efficient on statistical basis compared to the traditional method (Fiona and al. 2000). The problem with the ACS method is that it is difficult to determine in advance the sampling intensity, and also that the method requires a mobilisation of human resource-efforts and funds.

For the inventory carried out in the mount Oku, all the area was assessed following the traditional inventory approach. Data analysis led to fix the condition C at 4 stems. This

is were subjected to ACS method. It is in such a way Cameroon area.

2.3.3. Simulation of sustainable yield of *Prunus africana*

As for the Adamaoua (Pouna and Belinga 2001), South west (Ewusi et al. 1996) and North west regions (Amougou et al. 2010), a simulation of the sustainable yield of *Prunus* bark was made from estimates of the natural population, the average yield per tree and the length of time between successive debarkings required to allow total recovery of the bark (Ondigui 2001).

$$Y_s = (D \times A \times H) / R.$$

Y_s = sustainable yield of bark per annum for the area;

D = population density of exploitation trees (stems/ha);

A = area of exploitable forest containing *Prunus*;

H = average sustainable yield of bark per tree (kg freshweight/tree/harvest) = 55 kg/tree;

R = rate of total recovery of the bark (in years).

2.4. Results

2.4.1. Sampling intensity

The mount Cameroon forest concerned in present work is about 22 881,085 ha. A total of 255,3 ha out of that surface area was covered by forest inventories giving an average sampling intensity is 1.11% (table 1).

Table 1. Sampling intensity and number of plots per forest

Forest of Mount Cameroon	<i>Prunus</i> area (ha)	Number of classical plots	Number of ACS plots	Sampling area (ha)	Sampling intensity (%)
Inside the national park	16 014.732	302	92	169.4	1.06
Outside the national park	6 868.719	159	32	85.9	1.25
Total/medium	22 881.085	461	124	255.3	1.11

Source: Belinga 2011

2.4.2. Density of *Prunus* stems

2.4.2.1. All trees

A total of 875 trees of *Prunus africana* were recorded in the 255.3 ha of the forest inventoried in Mount Cameroon. Six hundred sixty five (665) of those trees were recorded inside the national park, and 210 trees were recorded outside the park (Table 2).

Table 2. Distribution of number of trees recorded in the sample in different parts of the park

	C50-60	C60-70	C70-80	C80-90	C90-100	C100-110	C110-120	C>120	Total					
Inside the park	106	108	111	82	67	56	41	46	15	16	6	6	5	665
Outside park	43	61	38	16	19	15	8	2	5	1		2		210
Total /Medium	149	169	149	98	86	71	49	48	20	17	6	8	5	875

Table 3 shows the distribution of density of trees in different diameter classes. The average density obtained is 3.43 stems/ha. Inventories carried out with the traditional method in mount Cameroon found a density of 3.5 stems/ha (Ewusi et al. 1996). Those carried out in the same region with the ACS method proposed a density of 3.52 stems/ha (Ingram et al. 2009). The highest density of *Prunus* trees is recorded inside the park: 3.93 stems/ha. This density is at least 1,5 more high than the density of trees recorded outside the park, which confirms the key role of that protected area in the conservation of *Prunus africana*.

Table 3. Density of *Prunus* trees per diameter classes inside and outside the park

Situation according to the park	C<10	C10-20	C20-30	C30-40	C40-50	C50-60	C60-70	C70-80	C80-90	C90-100	C100-110	C110-120	C>120	Total
Inside the park	0,63	0,64	0,66	0,48	0,40	0,33	0,24	0,27	0,09	0,09	0,04	0,04	0,03	3,93
Outside park	0,50	0,71	0,44	0,19	0,22	0,17	0,09	0,02	0,06	0,01	0,00	0,02	0,00	2,44
Total /Medium	0,58	0,66	0,58	0,38	0,34	0,28	0,19	0,19	0,08	0,07	0,02	0,03	0,02	3,43

2.4.2.2. Living (healthy) trees

In this work, living (healthy) trees are those which are looking well, without dried branches. A total of 780 living trees were recorded, representing 89.1% of the total trees of the sample. (table 4). About 76.9% of the living trees were recorded inside the mount Cameroon national park.

Table 4. Distribution of Living *Prunus* stems in different diameter classes (C<10, C10-20, ...C>120)

Situation according to the park	C<10	C10-20	C20-30	C30-40	C40-50	C50-60	C60-70	C70-80	C80-90	C90-100	C100-110	C110-120	C>120	Total
Inside the park	99	101	96	75	59	49	39	42	14	12	5	4	5	600
Outside the park	42	59	32	14	10	9	7	1	4	1		1		180
Total	141	160	128	89	69	58	46	43	18	13	5	5	5	780

Figure 5 illustrates the specific curve of living *Prunus* stems in the natural forest of the mount Cameroon. We are in front of a normal situation where young individuals abund. This shows that *Prunus africana* population does not globally encounter problems of regeneration in the mount Cameroon region.

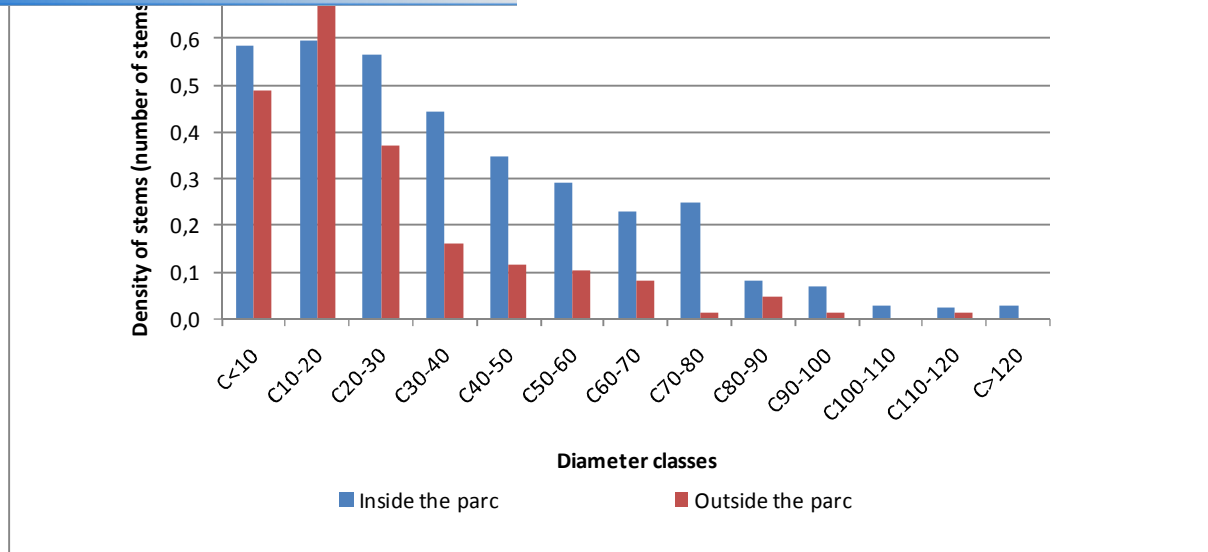


Figure 5. Distribution of living *Prunus* trees per diameter classes in the mount Cameroon

2.4.2.3. Dead and wilt trees

In this analysis, we group all stems described in the field as being wilt (with some branches dried) or died in one category. A total of 71 dead or wilt *Prunus* trees were recorded in the mount Cameroon. The average density of those trees is 0.3 stems/ha. The percentage of dead or wilt trees is $100 \times 71/875 = 8.1\%$, which is less than the results obtained in Mount Oku (10%) using the same method (Amougou et al. 2010). Many studies confirm that *Prunus* trees have been harvested using unsustainable techniques (debarking from roots to the branches) and 25% of those trees died or were dying (Akagou 2010; Ewusi et al. 1996; Tchouto 1996).

2.4.3. Total number of stems

Estimation of number of stems at the scale of the all mount Cameroon forest is presented in table 5. A total number of *Prunus* trees (living, wilt or dead) estimated for the whole mount Cameroon area is 79 659 trees. The number of living trees is 71 115 while that of dead or wilt trees is 8 544. The minimum exploitable diameter (MED) applied for *Prunus* in Cameroon is 30 cm. Among living trees, only 32 498 trees representing 8.6% of the total living trees have reached the MED and can therefore be harvested.

If we consider wilt and dead *Prunus* trees as the bonus that should be harvested, then the total number of trees to be harvested in the mount Cameroon is 41 042 trees which is high than what was obtained in mount Oku area (Amougou et al. 2010). The total number of *Prunus* trees retained for the simulation of the sustainable yield or harvesting quota is 41 042 trees.

is estimated in the mount Cameroon area

Situation according to the park	Total number of living stems (LS)	of dead and wilt stems (or the bonus)	Total number of stems	Number of living stems >= MED	Number of living stems >= MED + Bonus	Number of stems retained for simulation of quotas (SRSQ)
Inside the park	56 722.78	6 144.97	62 867.75	28 739.54	34 884.51	34 884.51
Outside the park	14 393.13	2 398.85	16 791.98	3 758.20	6 157.05	6 157.05
Total	71115.91	8543.82	79 659.73	38 739.54	41 041.57	41 042

2.4.4. Simulation of sustainable yield

In mount Oku area, research activities conducted within the Birdlife project revealed that the length of the rotation varies with the zone (division). Hence, in the Boyo division where the weather is too hot, results obtained tend to show that the harvester can return to the same tree after 4-5 years, while in the Bui division where it is too cold, this harvester must wait 5-6 years before returning back to the same tree.

Simulation of sustainable yield of *Prunus africana* in the mount Cameroon will therefore be based on two figures according to the rate of recovery: lowest estimate will be calculated using the rate of recovery of 6 years, while the highest estimate will be calculated based on the rate of 5 years. The average medium of the two figures will be used to simulate the sustainable yield or annual yield of bark.

The sustainable yield of fresh bark per annum for each forest will be = ((exploitable stems x average sustainable yield of bark per tree (= 55 kg))/ rate of total recovery of the bark (5 or 6 years)).

Table 6 shows the simulation of the sustainable yield of fresh bark per annum for each forest according to different level of estimates. From the table, it can be established that the annual yield of fresh bark of *Prunus* in the mount Cameroon area is 410 420 kg/year (410.42 tons/year).

Table 6. Simulation of the sustainable yield of fresh bark of *Prunus africana* per annum for each forest in the mount Cameroon

Situation according to the park	Number of stems retained for simulation of quotas (SRSQ)	Annual Sustainable yield_lowest estimate (R = 6 years) (kg)	Annual Sustainable yield_Highest estimate (R = 5 years) (kg)	Annual Sustainable yield_medium estimate (R = 5.5 years) (kg)
Inside the park	34 884.51	319774.70	383729.64	348845.13
Outside the park	6 157.05	56 439.67	67 727.60	61 570.55
Total	41 042	376 218.33	451 462	410 420

2.4.5. Simulation of the annual quota

In Cameroon, *Prunus africana* is exported in two forms: the raw bark and the powder. Powder here is referred to the bark shavings or the grinded barks. Whatever be the form, *Prunus* is exported in dried matter. The dried weight of *Prunus* barks to be exported is = 50% of fresh weight.

Table 7 shows the simulation of the annual quota according to different levels of estimates. From the table, it can be established that the annual quota of wild *Prunus* in mount Cameroon is 205 210 kg/year or **205.21 tons/year**. This quota is considered as the medium, obtained from the lowest estimated with a rate of recovery of 6 years (188.109.17 tons/year)

of recovery of 5 years (225.73 tons/year). The area at quota.

Table 7. Simulation of the annual quota for *Prunus africana* in the mount Oku region

Situation according to the park	Number of stems retained for simulation of quotas (SRSQ)	Annual Sustainable yield_lowest estimate (R = 6 years) (kg)	Annual Sustainable yield_Highest estimate (R = 5 years) (kg)	Annual Sustainable yield_medium estimate (R = 5.5 years) (kg)
Inside the park	34 884.51	159 887.35	191 864.82	174 422.56
Outside the park	6 157.05	28 219.84	33 863.80	30 785.27
Total	41 041.57	188 107.19	225 728.62	205 207.84

An important area of the Mount Cameroon forest have been erected in a protect area, as a national park. This means that harvesting *Prunus* barks in that area may be subjected to specific guidelines that the Cameroon Government should settle. It would be interesting if the Cameroon Government can accelerate the development of those guidelines as important tool for sustaining *Prunus* in the Mount Cameroon area.

The main services working in the exploitation, transport, and exportation of special products belong to the Ministry of Forestry and Wildlife/Fauna (MINFOF), Ministry of Agriculture and Rural Development (MINADER), and Ministry of Economy and Finances (MINEFI). This chain has been described in details in the previous reports together with the relevant problems encountered in the field (Betti 2008; Amougou et al. 2010).

The South west region is made of several decentralised forest units belonging to the Ministry of Forestry and Wildlife. At the regional level, there exists a delegation which comprises a forest department and a control and monitoring department. At the divisional level, the forest unit is coordinated by a delegation which comprises a forest section. Each subdivision hosts a local forest control post. The regional Delegation of Forestry and Wildlife is located in Buea city, at the bottom of the Mount Cameroon. The National park of mount Cameroon itself is managed by a conservator. All those measures show that the harvesting of *Prunus africana* can be carefully controlled and monitored, in order to avoid over exploitation.

To enhance the sustainable harvesting of *Prunus africana* in Mount Cameroon region, the Government of Cameroon should tackle key problems observed on the control as proposed by the previous report of *Prunus* drafted for the North west region (Amougou et al. 2010). The development of a fair tracking system will be very helpful to sustain the harvesting of *Prunus* in the whole region of South west.

CONCLUSIONS

Since July 2010, the National Forestry Development Agency (ANAFOR) launched a specific project with the support of ITTO and CITES to sustain *Prunus africana* in Cameroon. Mount Cameroon area is one of the most important part of the South west region hosting natural *Prunus africana*. The average density of *Prunus* is 3.43 trees/ha. The highest density of *Prunus* trees is found inside the park (3.93 stems/ha), which shows the importance of that protected area in the conservation of *Prunus africana* in Cameroon. The total number of *Prunus* trees was estimated at 75 659, seventy nine of which are found inside the park. The total number of exploitable trees is 41 042, with 34 885 inside the park and 6 157 outside the park. The annual quota estimated for the mount Cameroon is 205.21 tons with 174.42 tons/year inside the park and 30.7 tons/year outside the park. The 205.21 tons/year estimated are considered as the medium, obtained from the lowest estimated with a rate of recovery of 6 years (188.109.17 tons/year) and the highest estimate with a rate of recovery of 5 years (225.73 tons/year).

To ensure the conservation of *Prunus africana* in the mount Cameroon area, following actions should be taken:

- Re-enforce capacities of all decentralised forest units found in the area of mount Cameroon in terms of human resources, logistics, and financial incentives in order to allow them to better control and monitor the exploitation, processing, and transport of *Prunus* products;
- filter the number of companies who are working in the field of *Prunus africana* as to keep those who are interested in sustainable management of the resource;
- address the issue of equity in the trade exchanges on *Prunus africana*. This should ensure that local communities are well motivated to conserve *Prunus africana* in their forests;
- accelerate the implementation of the procedures for the attribution of the *Prunus* Allocation Units (PAU);
- revise the modalities of access to the resource in terms of the selling price in accordance with the current forest law;

taxation of *Prunus* products. The current 10% tax is levied by the Cameroon Government as the regeneration tax required for the sustainable management of the resource;

- take specific measures for sustainable harvesting of *Prunus africana* barks inside the park in conformity with the decision that creates the park;
- develop and implement a fair tracking system to trace *Prunus* products from the forest till the exit points;
- encourage local people to develop *Prunus* plantations;
- assist local people in developing fair farming system that do not harm *Prunus* habitat.
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