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Sustaining *Prunus africana* (Hook.f.) Kalkman (Rosaceae), a CITES listing tree species in the Teza Forest, Kibira National Park, Burundi

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Prunus africana (Hook.f.) Kalkman (Rosaceae)/Pygeum or African cherry is a mountain tree species of the tropical Africa. *Prunus* bark is exported dried, chipped or powdered to USA and Europe to produce an extract used to treat benign prostrate hyperplasia. The plant is considered as vulnerable and is listed in appendix II of the Convention on International Trade in Endangered Species of Fauna and Flora (CITES). This paper aims to estimate the average mass of mature stems of that tree species as a tool for establishing its non-detriment findings in Burundi. The study was carried out in July 2013 in a production forest of 2 800 ha found in the Teza sector, in the south of the Kibira National Park. Stem barks were gathered from a total of 36 mature trees of *Prunus africana* with diameter at breast height of more than 30 cm, known as mature trees. The harvesting of the barks was done according to the recommended sustainable technic which is, “for all trees above 30 cm DBH, only two quarters of the bark are taken from the main stem up to the first branch”. The average mass of the fresh bark of a *Prunus* mature tree is 47.0 kg. The quantity of the dried bark estimated to be harvested in sustainable manner each year in the Teza sector is 24.8 tons/year. This is known as the annual quota. If Burundi authorities agree to allow the exploitation of *Prunus* barks in the Kibira Park, the National Institute for the Environment and the Conservation of Nature (INECN), which is in charge of the management of protected areas in Burundi, can yield about 426 155.7 – 497 181.7 USD/year. And these funds can be used to enhance the strategy of conservation settled within the “Parks for Peace Project” in the Kibira national park.

Key words: *Prunus Africana*, Kibira National Park, mass, sustainable technic, annual quota, Burundi, CITES.

INTRODUCTION

Burundi is a small densely populated country with a topography dominated by hills and mountains interspersed with seasonal and permanent wetlands in the low-lying areas. Overall responsibility for environmental management and protection in Burundi is housed in the Ministry

of Water, Environment, Land Use and Urbanism (Ministère de l'eau, Environnement, Aménagement du Territoire et Urbanisme, MEEATU). Two autonomous institutions with environmental mandates exist under the Directorate General of Environment and Forests: the National Institute

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for the Environment and the Conservation of Nature (INECN) and the Geographic Institute of Burundi (IGEBU). INECN has direct management responsibility for the protected areas, including national parks and natural reserves (Hobbs and Knausenberger, 2003).

Prunus africana (Hook.f.) Kalkman is a mountain tree species of the tropical Africa including the Côte d'Ivoire, Bioko, Sao Tome, Ethiopia, Kenya, Uganda, South Africa, Madagascar, Congo, the Democratic Republic of Congo, Mozambique, Tanzania, Burundi and Cameroon. *P. africana* grows well in the sub-mountain and mountain forests at an altitude of 800 - 3000 m. *P. africana* is an evergreen canopy tree, 30 m tall with thick, fissured bark and straight bole that can reach a diameter of 1.5 m (Vivien and Faure, 1985; Fraser et al., 1996; Tchouto, 1996). The bark is the major source of an extract used to treat benign prostatic hyperplasia, an increasingly common health problem in older men in the western world. Prostate-related diseases increase in prevalence as men age. And as the average age of the world's population increases, the incidences of prostate diseases will increase as well, triggering a corresponding rise in demand for therapies. According to the World Cancer Research Fund International, prostate cancer is the second most common cancer in men worldwide. Around 910,000 cases of prostate cancer were recorded in 2008, accounting for approximately 14% of all new cancer cases in men (World Agroforestry Centre, 2012). The United Nations Food and Agriculture Organization (FAO) reported as far back as 1996 that the demand for the species' bark, which is used to produce treatments for prostate gland disorders, could lead to its over-exploitation (FAO, 1996). In 1997, the global need was about 4 000 tons of dried barks per year for a value of 220 millions of USD. Two hundred kilogram of dried bark yield 5 kg of extract (Cunningham et al., 1997). The trade in dried pygeum bark and bark extract is in the order of 3 000 to 5 000 tonnes a year (Page, 2003) and the main sources are in Cameroon, Madagascar, Equatorial Guinea, Kenya, Uganda and Tanzania. In Burundi, *P. africana* is found in five protected areas including two national parks (Kibira in the North and Ruvubu in the East), and three natural reserves (Bururi, Maragarazi and Monge). The species is also found in the sacred forest of Mpotsa. The species is well known by Burundi peoples who designate it as "Muremera" in Kirundi, the first national language. Here, the species is not only used as a medicinal plant, but also as a of high-value timber together with *Entandrophragma excelsum* (Meliaceae). *P. africana* is one of the plant species that can be used to enhance African Traditional Medicine as discussed by Kamsu-Foguem et al. (2003).

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, stocking, growth and condition of the species and on its ecology, regeneration and subse-

quent protection. Such information is often lacking, incomplete or imprecise making a proper evaluation of the sustainable levels of utilisation, establishment of quota and conditions attached to be difficult. The Scientific Authorities also face obstacles due to inadequately trained and resourced staff. The National Institute for the Environment and the Conservation of Nature (INECN) is the CITES Scientific Authority for Burundi. INECN has recently conducted *Prunus* inventories in the Kibira national park which led to the estimation of the stock of mature trees (Betti et al., 2013). This paper aims to estimate the mass of stem barks of mature *P. africana* in the Teza forest in the South of the Kibira national park as a contribution to making non-detriment findings on *P. africana* in Burundi.

MATERIALS AND METHODS

Study site

The Kibira National Park is a national park in north-western Burundi, overlapping with four provinces and covering 40 000 ha. Kibira National Park lies atop the mountains of the Congo-Nil divide. It extends north from the provincial town of Muramyo to the border of Rwanda where it is contiguous with the Nyungwe National Park. Kibira mountains are up to 2 600 m. The average annual rainfall is up to 1 600 mm while the average temperature is 17°C.

Main vegetation strata include: *Entandrophragma excelsum* (Meliaceae), *Parinari excelsa* (Chrysobalanaceae), *Albizia gummifera* (Mimosaceae) and *Prunus africana* (Rosaceae) stands, *Parinari excelsa* var. *holstii* and *Polyscias fulva* (Araliaceae) stands, *Polyscias fulva* (Araliaceae), *Macaranga neomildredian* (Euphorbiaceae) and *Syzygium parvifolium* (Myrtaceae) stands, *Hagenia abyssinica* (Rosaceae) and *Faurea saligna* (Proteaceae) secondary forest stands, *Philippia benguelensis* (Ericaceae) and *Protea madiensis* (Proteaceae) high-altitude stands on ridges, *Arundinaria alpina* (Poaceae) or pure bamboo stands, stands along *thalwegs* and stands formed by recolonization of previously cultivated and grazed land. The park is dominated by *afromontane* forests, including species such as *Parinari excelsa*, *Entandrophragma excelsum*, *Albizia gummifera* and *Prunus africana*. It is a zone rich in both animal and plant biodiversity: 644 plant species have been found in the park, as well as about 98 species of mammal. Bird life is also rich and varied, with 43 families and more than 200 are species identified (Hobbs and Knausenberger, 2003; Nzigidahera, 2000). More than three-quarters of the water in the country's largest dam – providing more than 50% of the hydroelectric energy consumed comes from this forest. Thus the park, situated as it is on the Congo-Nil ridge, plays a fundamental role in regulating the hydrological system and protecting against soil erosion. The Forest Code promulgated in 1985 (Law 1/02 of 25 March 1985) provides the basis for the various Burundian laws on forests, notably Law 1/010 of 30 June 2000 containing the environmental code for the country. The Kibira National Park was granted legal status in 2000 with Decree 100/007 of 25 January, establishing the park and four nature reserves. The management plan of the Kibira national park drafted in 2008 – 2009 with the help of the Wildlife Conservation Society (WCS) has led to the subdivision of the park into four small management units or sectors (one sector for each province) distributed as follows from south to the north: Teza, Rwegura, Mabay and Musigati. Each sector is divided in subsectors. The KNP has a park supervisor and four sector heads, while each subsector has a forest warden and an assistant.

The INECN and the Parks for Peace Project have established watchdog committees elected by the people at various levels – hills (the smallest administrative unit), sectors, zones and communes. The park supervisor supervises all activities in the park, the sector heads implement them in their respective zones, and the watchdog committees closely monitor the way the park is managed. Thus, the INECN, the local administration, the local population and the watchdog committees are the main actors in park management. Nearly 50 000 people from communes adjacent to the park are involved directly or indirectly in management of the park (Hobbs and Knausenberger, 2003; Nzigidahera et al., 2002; Nzojibwami, 2012). Areas bordering the KNP have always been considered as dense in terms of population, with Musigati and Muramvya being the two most dense councils of the park (Nzojibwami, 2012).

Method

Prunus stem barks were harvested inside the Kibira National Park, in a limit area of 2 800 ha of production forests, in the Teza sector, on July 2013. The method used is the sustainable harvesting, is often recommended for the harvesting of *P. africana* barks by trade companies.

Selection of trees

This study was conducted in July 2013 in the Teza, the south of the Kibira National Park. The study was conducted in the frame of the project “Evaluation du stock d’arbres sur pied de *Prunus africana* dans le pays en vue d’une exploitation durable” supported by the Secretary General of the Convention on International Trade in Endangered Species of Fauna and Flora (CITES) and executed by the National Institute for the Environment and the Conservation of Nature (INECN). The study started one month later after the teams in charge of assessing the abundance of *P. africana* trees in Teza forest (Betti et al., 2013) has finalised their work. The sheets of the teams in charge of counting were used to select the best trees that can allow for better appreciation of the mass of the stem bark of *P. africana* trees. Practically, trees were selected according to their diameter, their accessibility, their healthy and their conformity (only straight stems were selected). Once a given stem was identified in a counting sheet, we noted its geographical data (latitude and longitude) and we went with the global position system (GPS) in the field to take appropriated measures of that stem. A total of 36 *P. africana* mature trees were sampled.

Estimation of the mass of the stem-barks of the mature trees of *P. Africana*

To estimate the mass of the stem barks of *Prunus africana*, we used a direct method, the same method recommended to harvesters in the field to ensure the healthy and conservation of the stand tree in the forest. This method consists of, “for a given tree above 30 cm DBH, only two opposite quarters of the bark taken from the main stem up to the first branch”. We proceeded in four steps: (1) measuring the circumference of the tree, (2) dividing the circumference by 4, (3) harvesting the stem bark of the two opposite quarters and (4) measuring the mass of the stem bark harvested. The circumference of the tree was measured at DBH, which is at 1.30 m above the soil. The obtained value was then divided by 4 to obtain the width of each quarter. The stem bark of the two opposite quarters was then harvested starting from the breast high (1.30 m) to the insertion point of the first big branch. The bark harvested was then weighed, and its thickness measured.

The scale was used to climb on trees. To easily untie the bark from the sapwood, we used a bludgeon. We used a calliper rule to measure the thickness of the bark. Data obtained were recorded in an appropriate sheet precisely with the order number of the line (Figure 1), and the altitude of the tree.

For data analysis, we calculated the average mass of an mature tree, and we estimated the annual quota for the all sector of Teza.

The annual quota (Q_a) of the stem barks of *Prunus* trees is obtained by the formula:

$$Q_a = T_r \times \frac{M_s}{T}$$

T_r : Total number of mature trees estimated in the Teza sector, M_s : average mass of the dried barks of *Prunus* trees harvested on a sustainable basis (kg), T : In this paper, we distinguished the rotation from a small rotation.

The small rotation is the time that separates two consecutive harvesting campaigns on the same tree (6 years), while the rotation is the time that separates two consecutive harvesting campaigns on the same side for the same tree (6 x 2 = 12 years). This time is said to be enough to allow the regeneration of the bark.

RESULTS AND DISCUSSION

Mass of mature trees

Table 1 shows each of the 36 trees, their position (line), the diameter at breast high and the mass obtained. The average fresh mass of an mature (mature) *Prunus* tree in the Teza sector in the Kibira national park is 47.0 ± 21.9 kg. This value is different from the 55 kg found in mount Oku in the north west of Cameroon with the same method (Ondigui, 2001) but it is less as compared to the 69.3 kg found in the Adamaoua region in Cameroon using the indirect method (Betti and Ambara, 2013). Acworth (1999) suggested that an average mature tree of *P. africana* yields 75 kg of fresh bark.

Figure 2 illustrates the relation linking the diameter and the fresh mass of a mature *Prunus* tree in the Teza sector. The curve can be best approximated by the equation $M = 0.0004D^2 + 0.6865D - 2.2243$, M = mass of the fresh bark in kg, and D = diameter at breast high for mature trees (trees with diameter above 30 cm).

Annual quota of stem barks of *Prunus africana* (Rosaceae) in the Teza sector in the Kibira national park

The total surface area of the productive forest assessed in the Teza sector is 2 800 ha. The density of mature *Prunus* stems in that sector was estimated at 2.04 stem/ha while the total number of mature living trees or mature stock estimated was 6 347 (Betti et al., 2013). We used this value (6 347 mature trees) to estimate the total productivity of the stem barks in the Teza sector. The small rotation was estimated at 6 years while the ratio mass of dried bark/mass of fresh bark is 0.5. Table 2

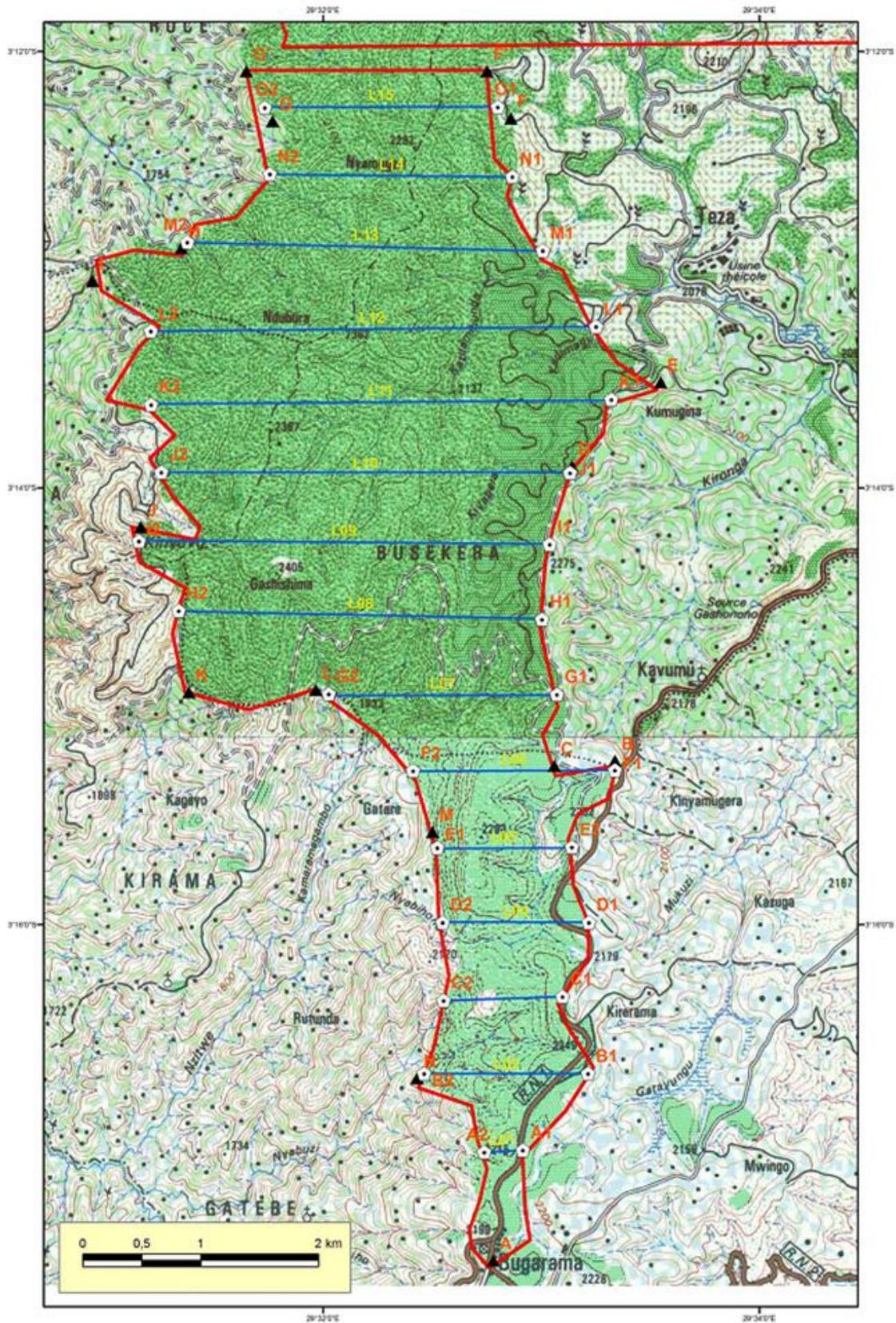


Figure 1. Map showing the disposal of the lines assessed for trees study in the Teza sector, KNP, Burundi. The coordinate system used is WGS84.

Table 1. Mass of fresh bark sampled in the Teza sector, in the KNP, Burundi.

| No. of tree | Line | DBH (cm) | Mass (kg) |
|--------------------|------|----------|-----------|
| 1 | L02 | 89.2 | 58 |
| 2 | L03 | 69.7 | 51 |
| 3 | L03 | 54.8 | 31 |
| 4 | L03 | 73.2 | 41 |
| 5 | L03 | 34.7 | 35 |
| 6 | L03 | 91.4 | 50 |
| 7 | L03 | 40.4 | 17 |
| 8 | L03 | 49.7 | 21 |
| 9 | L03 | 83.8 | 54 |
| 10 | L03 | 41.4 | 36 |
| 11 | L04 | 63.7 | 38 |
| 12 | L04 | 46.2 | 50 |
| 13 | L04 | 51.9 | 48 |
| 14 | L04 | 95.5 | 53.5 |
| 15 | L05 | 62.7 | 75 |
| 16 | L05 | 45.9 | 30 |
| 17 | L05 | 30.6 | 14.5 |
| 18 | L05 | 133.8 | 99 |
| 19 | L05 | 46.5 | 10 |
| 20 | L05 | 69.7 | 67 |
| 21 | L05 | 66.6 | 26.5 |
| 22 | L14 | 108.3 | 70 |
| 23 | L14 | 68.8 | 39.5 |
| 24 | L14 | 95.5 | 96 |
| 25 | L07 | 56.1 | 28.5 |
| 26 | L07 | 65.3 | 38 |
| 27 | L07 | 77.1 | 39 |
| 28 | L07 | 76.4 | 40.5 |
| 29 | L07 | 66.2 | 53.5 |
| 30 | L07 | 47.1 | 23 |
| 31 | L07 | 53.8 | 29.5 |
| 32 | L08 | 81.8 | 65.5 |
| 33 | L08 | 68.2 | 68 |
| 34 | L15 | 89.2 | 87 |
| 35 | L15 | 79.6 | 68 |
| 36 | L15 | 86.0 | 40 |
| Mean | | 68.4 | 47.0 |
| Standard deviation | | 22.0 | 21.9 |

presents the results obtained. The quantity of *Prunus* dried barks that can be harvested in a sustainable manner in the Teza sector is 24 859.1 kg/year. This is considered as the annual quota. Sustainable manner in this paper shows, as explained above, for all mature trees (DBH above 30 cm), harvesting of only two first opposite quarters of the bark from the main stem up to the first big branch, waiting till the bark regenerates and come back 6 years later to harvest the two second opposite quarters left on the tree.

The stock expresses the total number of mature stems found in a given area. A total number of 6347 trees of *P. africana* can be harvested since they have reached the MED which is 30 cm. The Kibira national park is vast (40 000 ha), and the production forest can cover more than 30 000 ha. If the density of 2.04 stems/ha of mature trees was normally distributed in the park, then the total number of the mature *Prunus* trees of the park will be estimated at 61 200, which is almost twice as compared to the 32 498 trees obtained in the mount Cameroon National Park (Betti et al., 2011).

Prunus bark is exported dried, chipped or powdered to USA and Europe to produce an extract used to treat benign prostrate hyperplasia. The extract is also a raw material for the burgeoning health, bio-product, diet supplement and pharmaceutical industry. If the bark is partially stripped according to norms (Cunningham, 1993; Hall et al., 2000) of two quarter panels from a tree of more than 30 cm diameter at breast height (approximate age of 12 to 15 years), it will regenerate and may be exploited at between 5 to 15 year intervals without killing the tree. About 2000 kg of fresh bark are equal to 1000 kg of dried bark, which is needed to make 5 kg of extract.

If we suppose that the relation linking the diameter and the mass of a mature *P. africana* tree obtained in the Teza sector does not change in the whole park, the total quota of the barks that can be found in the whole Kibira national park is 266 347.32 to 310 738.54 kg of dried bark/year or 532 694.3 to 621 477.0 kg of wet bark/year. In Cameroon, the price of fresh bark of *P. africana* at the village level by trade companies around the mount Cameroon national park is about 0.8 USD. If we consider this price for the Kibira National Park, the National Institute for the Environment and the Conservation of Nature (INECN), which is in charged of the management of protected areas in Burundi, can yield about 426 155.7 to 497 181.7 USD/year. This can (1) enhance the cooperation between the park board and villages settled around the park through development projects and (2) contribute to recruiting and equipping forest guards to enforce the control.

Conclusion

The trees study conducted in the Teza sector in the north of the Kibira National Park showed that a mature *P. africana* trees can yield 47.0 kg of wet bark. The quantity of dried bark that can be harvested in sustainable manner without killing the trees is 24.8 tons/year in the Teza sector or 266 347.32 to 310 738.54 kg of dried bark/year for the whole Kibira National Park. This is essential for addressing a non-detrimental report on *P. africana* for that part of the country. If the Government of Burundi authorizes the harvesting of *Prunus* barks in the Kibira National Park, the National Institute for the Environment and the Conservation of Nature, which is in charged of

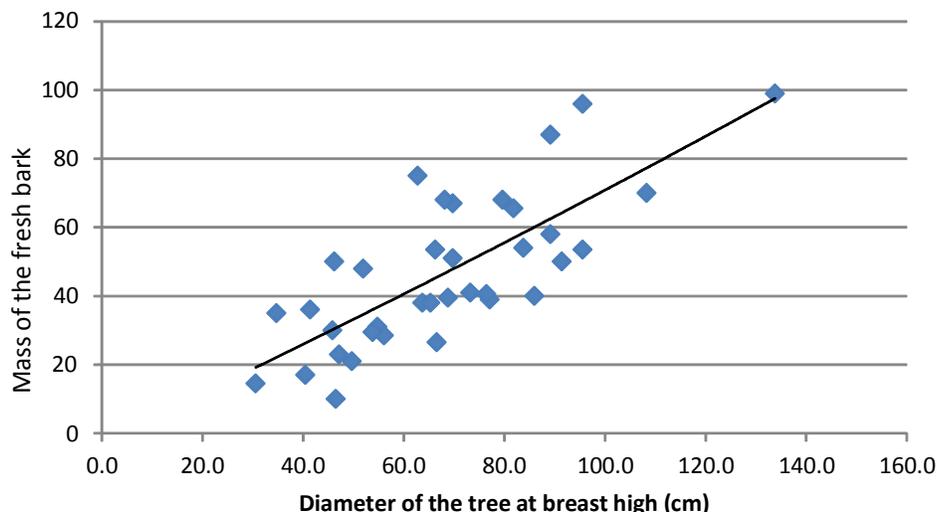


Figure 2. Relation (regression) linking the diameter at breast high and the mass of the wet bark of a mature *Prunus* tree in the Teza sector in the Kibira national Park, Burundi.

Table 2. Annual quota of dried bark of *P. africana* (Rosaceae) estimated for the Teza sector in the Kibira National Park, Burundi.

| Total production area assessed in the Teza sector (ha) | Average density of mature trees (number of stems/ha) | Stock of mature stems | Average mass of dried bark (mass of fresh bark/2) | Small rotation (ans) | Annual quota (kg of dried matter) |
|--|--|-----------------------|---|----------------------|-----------------------------------|
| 2 800 | 2.04 | 6 347 | 23.5 | 6 | 24 859.1 |

the management of protected areas in Burundi, can yield about 426 155.7 to 497 181.7 USD/year. These funds can be used to enhance the strategy of conservation of the Kibira National Park settlements within the “Parks for Peace Project”.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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REFERENCES

Acworth J, Ewusi BN (1999). *Prunus africana*, striving for sustainable and equitable resource management in Cameroon, Mt Cameroon Project.

- Betti JL, Ambara J (2013). Mass of *Prunus africana* stem barks on Tchabal mbabo and Tchabal Gang Daba Mountain Forests, Cameroon. *Afr. J of Env. Sci. Technol.* (7):204-221
- Betti JL, Belinga SJ, Samba D (2011). Stock of *Prunus africana* stems in the Mount Cameroon forests. *Afr. J. Plant Sci.* 5(13):781-789.
- Betti JL, Feruzi M, Rushemeza J, Rurantije A, Nziguymipa L, Ahishakiye J, Mamarivo, Buyiruke E, Ndayishimiye JC, Hakizimana C, Bantegeyahaga E (2013). Mature stock of *Prunus africana* Stems in the Teza Forest, Kibira National Park, Burundi. *Int. J. Agrc. Innov. Res.* 3 (2):317-326.
- Cunningham M, Cunningham AB, Schippmann U (1997). Trade in *P. africana* and the implementation of CITES. German Federal Agency for Nature.
- FAO (1996) “Appendix 6. Forest genetics resources priorities in Africa”. Report of the eighth session of the FAO Panel of experts on forest gene resources; Rome, Italy, pp. 24-25.
- Fraser PJ, Healy JR, Cheek M (1996). Seedling identification. In Glyn D (eds). A strategy for the Conservation of *Prunus africana* on Mount Cameroon. Technical papers and workshop proceedings, 21st and 22nd February, 1996, Limbé Cameroon. Mount Cameroon Project, pp. 1-11.
- Hall J B, O'Brien E M, Sinclair F L (2000). *Prunus africana*: a Monograph. School of Agricultural and Forest Sciences Publication Number 18. University of Wales, Bangor. 104 p.
- Hobbs M Knausenberger W (2003). “Burundi Environmental Threats, and opportunities Assessment (ETOA)/with emphasis on tropical Forestry and Biodiversity conservation” Supplement to the 2003-2005 USAID/Burundi Integrated Strategic Plan.
- Kamsu-Foguem B, Diallo G, Foguem C (2003). Conceptual Graph-based Knowledge Representation for Supporting Reasoning in African Traditional Medicine., “Engineering Applications of Artificial Intelligence (EAAI)”, *Engineering Applications of Artificial Intelligence*, 26 (4):1348-1365.
- Nzigidahera B (2000). Analyse de la diversité biologique végétale nationale et identification des priorités pour la conservation. *Institut*

- National pour l'Environnement et la Conservation de la Nature (INECN)*, Gitega.
- Nzigidahera B, Nzojibwami C, Misigaro A, Manenu (2002). Plan communautaire de conservation du parc national de la Kibira en commune Muramvya. *Institut National pour l'Environnement et la Conservation de la Nature (INECN)*, Gitega.
- Nzojibwami C (2011). Etude de cas d'aménagement forestier exemplaire en Afrique centrale: Le Parc National de la Kibira. Rapport FAO, 2011. <http://www.fao.org/forestry/sfm/68191/en/bdi/>.
- Ondigui BRP (2001). Sustainable Management of a Wild Plant Species for the Conservation of Mountane Forest Ecosystems and the Welfare of Local Communities: A Case Study of *Prunus africana* in the Mount Cameroon Area. In Sustainable Management of a Wild Plant Species. Proceedings of the World Mountain Symposium. Interlaken, Switzerland. P. 9.
- Page B (2003). The political ecology of *Prunus africana* in Cameroon. *Area* 35 (4):357-370.
- Tchouto P (1996). *Prunus* population on Mount Cameroon. In Glyn D (eds). A strategy for the Conservation of *Prunus africana* on Mount Cameroon. technical papers and workshop proceedings, 21st and 22nd February, 1996, Limbé Cameroon. Mount Cameroon Project, pp:12-18.
- Vivien J, Faure JJ (1985). Arbres des forêts d'Afrique Central denses. Ministère des Relations Foreign Trade, Coopération et Développement - ACCT, Paris. p.551.
- World Agroforestry Centre (2012). Unsustainable harvesting of *Prunus africana* tree threatens treatment for prostate disorders. *Transformations*, issue 16.