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D. L. KGATHI AND M.B.M SEKHWELA

ABSTRACT

This paper reviews and assesses the sustainability of the management and commercial exploitation of the Chobe Forest Reserves in Botswana. The inefficient way in which timber was harvested combined with low timber royalties, lead led to the 'mining' of the valuable timber species; *B. plurijuga* and *P. angolensis*. This scenario was worsened exacerbated by the damage of to trees by elephants and the uncontrolled fire damages fires. The high substantial short-term economic benefits associated with the from logging were likely to be unsustainable in the long-term due to environmental degradation. Logging was also associated with limited social benefits due to low employment opportunities and value added to the district. The above problems prompted the Government to halt the logging activities in 1994.A review of the forest policy is on-going, and The fForestry policy is currently being reviewed. Once it is completed, it will provide a the framework of the to review of the Forest Act of 1968. The royalty structure has been changed in order to charge prices that to reflect the scarcity value of timber. These recent developments are supported as they may contribute significantly to the management of the forest reserves. There is need to conserve the forests and to exploit them in a sustainable way. In addition, options for alternative land-use systems which are commensurate with the ideals of sustainable development should be considered. The forest resources need to be conserved since they are natural habitats and sanctuaries to the diverse fauna and flora.

Introduction

Sustainable management of forest resources has been a recurrent theme in the literature on environmental planning and policy (Erskine, 1990; Gregerson *et al.*, 1993; Panayatou, 1993; Seydack, 1995; Geldenhuys, 1996). It has become an issue of worldwide concern, particularly after the adoption of the Forest Principles at the United Nations Conference on Environment and Development held in 1992 in Rio De de Janneiro (Holmberg *et al.*, 1993). Forests have a substantial substantial economic value since they contribute to economic development, preserve biological diversity, and provide recreational values and ecosystem services such as carbon and nutrient cycling (Narendra *et al.*, 1992; Pearce *et al.*, 1994; Geldenhuys, 1996). The contribution of forests to economic development includes the provision of products for the first stage of wood processing such as sawn timber. In addition, such products may be used locally or exported to other countries for the production of second stage products of wood processing such as furniture and paper (Gregerson *et al.*, 1993). Biological diversity is useful to conserve because each tree species is unique and not necessarily substitutable, and it is not known which species will become resources in the future (Bishop, 1978). The ecosystem services provided by forests are very essential for human survival and well being, and hence they are referred to as 'critical natural capital' in the literature on environmental economics (Pearce *et al.*, 1994). The total benefit derived from forests and similar natural environments is known as 'total economic value' (Pearce, 1993).

There has been a shift in forestry policy from the focus on environmental yields of forests to a much broader concept of sustainable development of forest ecosystems. Attempts are being made to achieve good forestry practice and to promote policies consistent with the broader concept of sustainable forest management. This concept is defined as the production of goods and services from forests and trees which that results in "an increase "in welfare that can be sustained over time" (Gregerson *et al.*, 1993; DWAF, 1997). Sustainability of environmental forest management is about the production and use of forests without causing adverse effects such as soil degradation, depletion of water resources, reduction of biological diversity and spread of invasive alien species (Gwaze and Duwa, 2000). Sustainable exploitation of forest resources is one aspect of environmentally sustainable management, and it entails harvesting similar amounts and types of products at periodic intervals indefinitely without substantially impairing the forest's ability to provide its environmental services and its biological quality (Seydack, 1995). Economic sustainability of the management of forest resources is about an efficient production and exploitation of forest resources such that the benefits per unit cost are sufficiently high to be able to contribute meaningfully to the socio-economic progress of a country (Sachs, 1999; Munasinge *et al..*, 1995). Social sustainability of forest management could be defined as the extent to which forestry projects impact on local institutions, and how they affect the empowerment of the local communities and their livelihoods (Gregerson, *et al.*, 19930; Sachs, 1999).

Forest resources may be natural or in the form of plantations. In southern Africa, the main resources for commercial forestry are natural woodlands, and plantations. Natural woodlands are confined to areas with an annual rainfall of 600 mm and above in the savannas, but exclude closed canopy forests by definition (Scholes, 1997). In some countries in the region (eg e.g. Mozambique), indigenous woodlands still supply the bulk of timber for the export market as well as for manufacturing industries, while in other countries (e.g. South Africa), these supplies are mainly provided by commercial plantations. Botswana is one of the countries which depends solely on indigenous woodlands for commercial timber extraction as there are no commercial forestry plantations. So-called forest reserves, comprised of broad-leaved woodlands, were established in the Chobe District in northern Botswana (Figure 1) in order to promote the commercial exploitation of timber. As in other developing countries, sustainable management of these forests and their sustainable exploitation is an issue of major concern in Botswana.

This paper assesses the degree to which the management and exploitation of the Chobe Forest Reserves (CFR) have been in accordance with the ideals of sustainable development. For the sake of clarity, management of forest resources is taken here to include the management of the exploitation of the forests in terms of the practices and policy instruments adopted, and as well as the management of the forests that are not exploited. Information for this paper was mainly obtained from secondary sources

during the period of 2000 to 2001. Limited informal interviews were undertaken with policy-makers in the departments of Crop Production and Forestry (Ministry of Agriculture) and Wildlife and National Parks (Ministry of Trade, Industry, Wildlife, and Tourism), in order to cross-check and update some of the information obtained from secondary sources during 2000-2001. The two sections that follow discuss the historical background of the forest reserves and the sustainability of their exploitation. The third section reviews the management activities after the exploitation of the forest reserves was halted by the Government in 1994.. Policy recommendations are made in the final section.

Historical background of the reserves

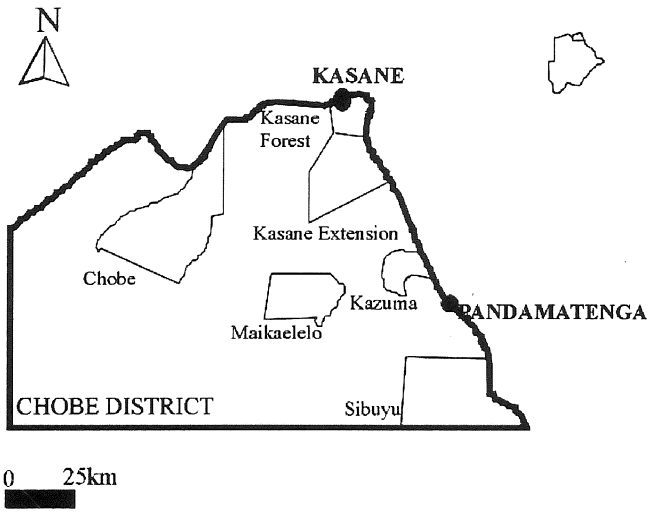
The forest resources in Chobe District have been used in various ways in the past as sources of direct use values associated with indigenous non-marketed and marketed goods and services. Commercial exploitation of these forest resources dates as far back as 1935 when a forestry concession was issued to one company for commercial timber exploitation in the area that is currently part of the Kasane Forest Reserve. Forests in Chobe were exploited in the three periods, 1935 to 1938, 1945 to 1955, and 1983 to 1994 (Silitshena and McLeod, 1998). It is estimated that between 1935 and 1938, more than 40 000 m^3 of *Baikiaea plurijuga* timber was extracted for export to South Africa and Zimbabwe, then known as Rhodesia. The Chobe Concession Limited was also given permission to extract timber from areas such as Ngoma in Chobe District. An assessment of the timber volumes after 23 years without exploitation, revealed that the standing stock of these forests previously logged had not increased significantly, probably as a consequence of elephant and fire damage (Millar, 1987).

The Chobe Forest Reserves were introduced after the promulgation of the Forest Act in 1968, which has since been a legal instrument for the country's forestry policy (Botswana Government, 1968). The Act gives the President of Botswana the power to establish forest reserves on state land. The first forest reserve to be established was the Kasane Forest Reserve in 1968, followed by other reserves in 1981. There are currently about six forest reserves in the Chobe District, occupying a total area of 455 400 ha (1 % of the country's land area, in different parts of the district (Figure 1). They are: Kasane, Kasane Extension, Chobe, Kazuma, Maikaelelo, and Sibuyu forest reserves. The aim of establishing these the reserves is to conserve and manage the forests and woodlands to ensure sustainable commercial exploitation. The reserves are managed by the Government Forestry Division, which issues licenses for their commercial exploitation. Without such licenses, the felling of trees, burning of grass, hunting, grazing of livestock and cultivation are all prohibited, but local people are allowed to collect wood and wild-products for their own use and but not for sale (Millar, 1987).

Exploitation of forest reserves (1983 to 1994) and forest policy

In the early 1980's, two companies were given concessions for logging in the CFR. The companies were Chobe Forest Industries (CFI), owned by a multinational company called Plate Glass Industries (PGI), and Exotic Timber (ET) owned by a parastatal company in Botswana known as the Botswana Development Corporation (BDC) (Millar, 1987). No environmental impact assessment was carried

Figure 1: The study area showing the location of the different Forest Reserves in the Chobe District, Botswana.



out before granting these concessions (Seopane, 1999, pers. comm.). Despite the fact that the areas logged previously had not regenerated sufficiently after a period of 23 years (Millar, 1987), due to elephant and fire damage, and in the absence of (Millar, 1987) and lack of adequate knowledge about growth, yields, natural regeneration, and management of timber tree species, new areas were opened for further exploitation. The impact of fire on *B. plurijuga* and lack of natural regeneration of *Pterocarpus angolensis* DC. had long been established (Carter, 1965; Boaler, 1966 after Calvert, 1986; Wood, 1986), but this was overlooked.

In 1983, ET was given permission to extract 2 500 m^3 of timber annually from the western part sector of Sibuya Forest Reserve and was allocated a sawmill in it. Also in 1983, CFI was on the other hand, granted permission in 1983 to extract between 7 500 to 20 000 m^3 of timber annually in Chobe and Kasane Forest Reserves (Millar, 1987) and it established a sawmill near Kasane (Millar, 1987). The main species harvested by these concessionaires were *P. angolensis* and *B. plurijuga.*

The logging process involved selectively cutting a specified minimum diameter of trees, dependingent on the type of species. The recovery rate of saleable timber was estimated at 26% and 31% for *P. angolensis* and *B. plurijuga,* respectively, with a lot of wood wasted which could have been used to satisfy other wood demands such as fuelwood (Millar, 1987). By 1987, CFI the bigger company had harvested 33 552 m^3 of royalty logs over a period of four years (Table 1), and 70 % of the total tree biomass was left lying on the ground as waste.

Table 1: Amount (m^3) of royalty logs extracted by Chobe Forest Industries (CFI) between 1983 and 1987 from the Chobe Forest Reserves, Botswana

Year	P. angolensis	B. plurijuga	Other species	Total
1983-84	1 488	5 835	300	7 623
1984-85	1 326	6 469	300	8 095
1985-86	3 085	6 338	Nil	9 423
1986-87	4 578	3 822	11	8 311
Totals	10 477	22 464	611	33 552

Source: Millar, 1987

As already noted, logging was suspended in 1994 due to non-sustainable harvesting practices. The degree to which these harvesting practices were sustainable is discussed below, in the forthcoming sections. Nevertheless, it is crucial at this stage to note that the logged areas showed little or no recovery as a result of unsustainable harvesting and environmental practices. The forest policy on which the currently applicable Botswana Forest Act of 1968, is based does not ensure the sustainable exploitation and management of the forest resources. Attempts to revise the forestry policy and subsequently the Forest Act as its legal instrument are on-going. There is already a draft policy which "...places emphasis on the integrated conservation, development, management and sustainable utilisation of the nation's forest resources throughout the country" (Botswana Government, 2001). It recommends that the local communities should have access to the forest reserves and should also actively participate in their management. The policy will provide a framework for the review of the Forest Act of 1968 (Government Botswana, 2001).

How Sustainable was the exploitation?

This section reviews the exploitation and management of the CFR focusing on their sustainability from ecological, economic and social viewpoints. The review adopts Geldenhuys's (1996) guidelines on sustainability as follows: i) sustenance of the natural, physical, and biological components and processes (environmental), ii) sustenance of the main forest products, and the industries and people who rely economically on the forests and their products (economic), and iii) sustenance of the provision of the needs of the people in terms of employment opportunities and forest products (social). Although the forest reserves are not currently being commercially exploited at the moment, a review of the previous logging practices will provide a base basis for the development of a proper framework that can be used to guide the future commercial exploitation of the forest reserves.

Economic sustainability

This section reviews the economic sustainability of the exploitation of the CFR with particular reference to the economic efficiency of the timber royalties and their implications for revenue earnings by the Government, the economic benefits obtained from logging, and the economic viability of salvage logging.

The exploitation of the reserves by CFI and ET was undoubtedly financially viable in the short and medium term. The companies made huge profits as the royalties paid to the Government were very low. The revenue collected by the Government, estimated at P131,046 in 1990, was not sufficient to pay for the recurrent costs of the monitoring of the logging operations (Bailey, 1992). The royalty for *P. angolensis* was P39.68 m^{-3} for logs of a minimum diameter of 35 cm, and P19.84 m^{-3} for *B. plurijuga* logs of a minimum diameter of 30 cm and length of 1.25 cm. Unlike in other countries where royalties are usually paid for the whole tree, the concessionaires paid royalties only for certain parts of a tree, and the remaining parts were extracted without being paid for, or just left on the groundleft as waste (Ntogwa, 1995; Norwegian Forestry Society, 1992). In addition, the setting of the royalty fees was were not based on market forces as was the case in the neighbouring countries (Bailey, 1992). At a time when Zimbabwe had stopped logging its most desired timber species, Botswana had one of the lowest stumpage fees in the region. This resulting in an increased demand for Botswana timber by Zimbabwean companies (Millar, 1987).

Table 2 shows that the total amounts volumes of *P. angolensis and B. plurijuga* timber harvested in 1990 were 3 871 m^3 and 2 476 m^3, respectively (Table 2). Of the total amount of *P. angolensis* harvested, 568.7 m^3 (15 %) was wood for which the royalties were not paid, whereas the royalties were paid for 3 3026.6 m^3, which was 85% of the *P. angolensis* and 88%wood harvested. In the case of *B. plurijuga* , 303 m^3, or 12% of the total wood harvested, was wood for which the royalties were not paid, and the royalties were paid for wood of 2 173.7 m^3, which was 88% of the total wood harvested., respectively. For both species, 52 % of the total wood cut was discarded. The total wood left on the floor as a proportion of the total wood cut was 52 % for both species.

Table 2: Amount (m^3) of wood harvested for the two timber species from the Chobe Forest Reserves in 1990.

Type of Wood	P. angolensis		B. plurijuga		TOTAL	
	ET	CFI	ET	CFI	P. Angolensis	B. plurijuga
Royalty Wood [1] /	1,695.50	1,607.08	71.97	2,101.76	3,302.6	2,173.7
Non-Royalty Wood [2] /	331.48	237.26	2.11	300.61	568.7	302.7
Sub-Total	2,026.97	1,844.34	74.07	2,402.37	3,871.3	2,476.4
Harvestable Branch & Stem Wood@ 52% of Extracted Vol) [3] /	2,195.89	1,998.04	80.25	2,602.57	4,193.93	2,682.8
Total	4,222.861	3,842.38	154.323	5,004.941	8,065.2	5,159.2

1. Royalty wood is that proportion of timber volume harvested for which Royalty was paid.
2. Non-royalty wood is that proportion of total volume harvested for which no Royalty was paid. This typical refers to timber below 35 cm diameter. Elsewhere in the region, royalty is levied on the whole tree – (volumes down to 15cm in diameter).
   There appears to be no sound economic or technical justification for the distinction. Thus in this analysis royalty equal to the residual stumpage plus existing royalty, has been charged.
3. The proportion of potential extractable timber (down to 15 cm) left on the forest floor unharvested, equivalent to 52 percent of total volume.

Source: Bailey (1992)

Although royalties were paid on most wood harvested, their low value translated to small revenue earnings for Government.

The low royalties resulted in the Government obtaining a small proportion of economic surplus from the companies, and therefore loosing. The potential revenue earnings lost were, estimated at P2.5 million in 1990 (Bailey, 1992). The over-exploitation of forests has short-term benefits and may threaten the economic sustainability of forests in the longer term. The Government has, however, revised the royalty rates in 1998 and new rates relate to the whole tree and not to certain parts of a tree, as was previously the case (Table 3). In the future concessionaire's will be charged management and silvicultural fees, in addition to timber royalties in the Chobe District and other areas in Botswana. The management fees are meant to cover the costs of monitoring the forest reserves, whereas silvicultural fees will cover the costs of forest protection and restoration. This new fee structure of fees is more consistent with the ideals of sustainable development, unlike the old structure which that had pitched prices that were far below the scarcity value of the timber.

Table 3: Old and new (1996) timber fees (Pula m^{-3}) in Botswana

TYPE	Old fees	New fees
Undamaged P. angolensis (mukwa)	39.68	210.00
Damaged P. angolensis (mukwa)	39.68	157.50
Undamaged B. plurijuga (mukusi)	19.84	157.50
Damaged B. plurijuga (mukusi)	19.84	105.00
Management fee (to cover monitoring and marking costs f the forest division)	0 .00	5.25
Silvicultural fee (costs of forest protection and construction of fire break)	0.00	3.00

Note: new fees relate to the entire tree instead of the effectively logged wood. There is a provision for a 25% inflation adjustment.

Source: Arntzen and Fidzani (1997).

The majority of the harvested wood was exported to South Africa and Zimbabwe in the form of low-value unprocessed logs (Selitshena and McLeod, 1998). It is estimated that 61% of the harvested *P. angolensis* was exported, and the remaining amount was processed locally into the low value products of such as railway sleepers and mine timber (Selitshena and McLeod, 1998). Botswana is a net importer of timber and its products. It imports expensive timber products from South Africa and Zimbabwe such as furniture and paper (Selitshena and McLeod, 1998), and the total expenditure on timber imports was estimated at P52.4 million in 1989 (Bailey, 1992). A number of studies have expressed concern at the use of timber for the production of low-value products due to their insignificant contribution to the Gross Domestic Product (GDP). and it could be argued that it is worth more in its natural state if put to an alternative use such as ecotourism.

It is suggested here that the multi-purpose use of the forests has a higher total economic value than the single-use option discussed above (Arntzen and Fidzani, 1997; Selitshena and McLeod, 1998). The total economic value of the forest resource is usually categorised into use and non-use values. Use values may be direct or indirect. Direct use values include consumptive uses such as the use of forests for industrial, energy, and construction and traditional (e.g. medicine, food - mopane worms, thatching, etc) purposes, and non-consumptive uses such as the use of forests for recreation and scientific purposes. Indirect use values include the use of forests for ecosystem functions such as carbon sequestration and soil protection. Non-use values include existence, cultural and heritage values (Gregerson *et al.*, 1993; Pearce, 1993).

Due to the unsustainable exploitation of the forest reserves (see below), the Norwegian Forestry Society (1992) suggested that future exploitation should make an attempt to harvest salvageable timber, estimated at 145 000 m^3 in Chobe District. An economic analysis of salvageable timber harvesting in Chobe District was undertaken in the early 1990's (Bailey, 1992). It was assumed that a total of 14 430 m^3 of timber would be harvested in a year, and that fees and royalties would be based on residual stumpage. Two scenarios were presented. The first scenario assumed that there would be an upgrading of logging and milling operations of the CFI, with an additional plant being established at Kasane. The second investment scenario assumed a modest investment in logging and milling, without any secondary processing. The analysis revealed that the first investment scenario would yield a financial internal rate of return (FIRR) of 85% and an economic internal rate of return (EIRR) of 105%, over a period of ten years. The financial net present value (FNPV), calculated at 18.5%, would be P 47,303,016, whereas the economic net present value (ENPV), calculated at 13.5%, would be P71,690 696. which is higher than the FNPV. The second investment scenario would lead to financial benefits in terms of the FNPV of P 2,428,929, calculated at 18.5% and an economic net present value of P 9,542,293, calculated at 13.5% (Bailey, 1992). The above figures suggest that salvage logging has the potential to be economically sustainable. It can contribute to the development of the Chobe District by increasing local value added and generating employment opportunities, particularly if it results in secondary manufacturing of timber products as suggested by the first scenario (Bailey, 1992). The next section notes that the environmental sustainability of salvage logging is questionable, and this suggests that the economic sustainability of the logging industry is also questionable in the long term.

Environmental sustainability

Here the environmental sustainability of the harvesting and management methods adopted by the timber companies is discussed. The Forest Reserves in Chobe District were being harvested at a rate higher than their rate of replenishment. The harvesting practices were found to ignore ecological considerations, and the concessionaires had no post-harvest management approach to enhance regeneration of the harvested species (Norwegian Forestry Society, 1992; Millar, 1987). The Norwegian Forestry Society (1992) found that harvesting rates of *P. angolensis* by logging were greater than would be caused by fire or elephant damage, and further noted very low recruitment and ultimately replacement potential of the harvested stems. The high considerable depletion of the two species was partly attributed to the fact that they were undervalued, as their royalties did not reflect the economic value of these resources. The inefficient way in which timber was harvested combined with low royalties, made the concessionaires wasteful in their extraction of timber resources. These policies and practices were therefore also driving the entire forest ecosystem towards a situation of reduced biological diversity.

The World Bank forestry review mission to Botswana was also critical of the inefficient exploitation of the forestry resources, and called for immediate improvement of the management of the Forestry Reserves, and the revision of concession contracts for better use of the resource (Wagner, 1987). This followed a major international conference on the Zambezi Teak forests held in Livingstone, Zambia, which highlighted the lack of adequate information on the valuable timber species that were being exploited to extinction in southern Africa. The conference made several recommendations, which included, *inter alia*, the need to undertake more research on the valuable timber species and sustainable forestry management (Pearce, 1986). The Government responded in 1992 by commissioning a study that further highlighted the detrimental exploitation of valuable timber species in the wake of inadequate management practices, and recommended halting of timber harvesting in the Forest Reserves (Norwegian Forestry Society, 1992).

While the lower minimum allowable stem diameters for *B. plurijuga* and *P. angolensis* were raised from 35 cm to 49 cm and 39 cm, respectively (Calvert, 1986 and 1993),

in other countries like Zimbabwe and Botswana they remained at 30 cm and 35 cm, respectively (Millar, 1987). According to Calvert (1986), the 35 cm diameter was based on the railway sleepper requirement and not on economic or ecological considerations. The basis for Botswana's lower diameter limit is not explained. Geldenhuys (1993) stated that the diameter information should be used as a guideline for silvicultural and regeneration management systems. Similarly, Stahle *et al.* (1999) were critical of the diameter-based timber harvesting as it is likely to result in the cutting of fast growing trees, ultimately resulting in genetically impoverished growing stock. Seydack (1995) also highlighted the disadvantages of the minimum diameter criteria that included removal of fast-growing trees, effect on seed production if the minimum harvestable diameter is too low in relation to sexual maturation, and lost harvest due to mortality of trees below minimum harvestable diameter. Seydack (1995) and Seydack *et al.* (1995) advocate criteria that are based on the condition of the tree and its remaining life expectancy; the *senility criteria yield regulation system.* According to Seydack (1995), this system pre-empts mortality through the selective harvesting of age-caused stagnant canopy trees, which are accordingly replaced by 'waiting' recruits. This is comparable to salvage logging made reference to in the previous section. *P. angolensis,* although it has a low growth, has been found to be prone to high levels of die die-back, the so-called 'mukwa disease' (Judge, 1986). Seydack (1995) argues that the senility criteria system guarantees sustainability by providing for yields which remain within the turnover capacity of the species involved, and not dependant on silvicultural measures which are virtually never carried out on a sustainable basis.

Recurring fires were also found to have an adverse effect on seedling recruitment for both species, and this adversely affected their natural replacement. The risk of fire was worsened by carelessness in the felling of trees into the crowns of neighbouring trees, thereby facilitating crown damage and increasing the severity of fires as a result of the increased accumulation of fuel loads (Norwegian Forestry Society, 1992). It was also observed that with less than 50% use of the felled stems above 15cm diameter, the large volume carelessly left behind, near live trees also contributed significantly to fuel loads for the late season hot fires, and increased fire impacts on trees and seedlings (Burger, 1993). Heavy fuel loads were observed to lead to prolonged and intense spot burning, which destroyed organic matter, leaving fire-scar patches of bare soil in scattered slash sites so that natural vegetation succession patterns were adversely affected (Norwegian Forestry Society, 1992).

Based on the current practices, which lack proper management and result in adverse environmental impacts, the Norwegian Forestry Society (1992) concluded that the logging levels were not ecologically sustainable. Previously, Millar (1987) had also observed that the logging activities in the forest reserves were not environmentally sustainable, a situation aggravated by inadequate knowledge of methods and intervention strategies to maintain and improve the forests' regeneration potential. Although the Norwegian Forestry Society (1992) proposed salvage logging as perhaps justified from a socio-economic point of view, they maintained this approach was ecologically questionable. They emphasised that such cutting should also include stipulation of maximum permissible logging slash, which should also be spread away from live trees and stumps (Norwegian Forestry Society, 1992; Malaya, 1993).

Other countries in the region with species similar to those in Botswana have experienced a similar problem of non-sustainable harvesting of the indigenous timber forest species. For instance, Wood (1986) recorded the complete loss of *B. plurijuga* (Zambezi Teak) 20 to 40 years after logging in the western of Zambezi Zambia, in Sesheke District. of Zambia 20 to 40 years after logging. This happened despite the realisation of non-sustainable timber extraction in Zambia as early as the 1930s (Mubita, 1986). A similar trend was observed in Zimbabwe in 1925 after exploitation started in 1908, worsened by wastage and fire (Judge, 1986). Logging was, however, continued in Zimbabwe, and it included the harvesting of other timber species such as *P. angolensis,* until 1987 when it was stopped due to a diminished resource base (Gwaze and Marunda, 1998). There is, therefore, a need for coordinated regional studies to address the ecological and silvicultural management needs of the indigenous forest resources whose exploitation has remained largely non-unsustainable in the region.

Further to the above observation, is the fact that debarking and uprooting of trees by elephants, has continued to contribute to increasing tree mortality and fuel load accumulations leading to more intense and hot fires. Already in the early 1990s, there was concern that there were too many elephants in the Chobe District and other areas in Botswana (Ben-Shahar, 1993). Their number in Botswana has increased from 45 449 in 1987 to 120 604 in 1999. Mbaiwa *et al.*, (2003) attribute this to the international embargo imposed by the Convention on International Trade in Endangered Species (CITES) on elephant products in local and international markets. Consequently, the need to reduce elephant numbers has come to be regarded as an indispensable management strategy since they are highly significantly contributing to the depletion of forests and woodlands (DWNP, 1993). As noted by Hachileka (2003, this issue), although the elephant population was down-listed from Appendix I to Appendix II of CITES, the one-off experimental ivory quotas allowed at by the Harare meeting of January 1997, proved to be inadequate in effectively reducing elephant numbers (through controlled culling). At the 2000 CITES , Botswana wanted to maintain its elephant population on Appendix II, and be allowed to trade in registered stocks of ivory of Botswana's origin owned by the Government and subject to a quota of 120 t/year. The proposal was withdrawn due to pressure from Kenya and India to uplift the elephant population to Appendix 1 (DWNP pers comm, 2001).

Social sustainability

This section briefly examines the social sustainability of the exploitation of the CFR with particular reference to their impact on employment generation and local value added. According to Millar (1987), 20 and 230 people were employed by ET and CFI, respectively, in the mid 1980s. The companies did not contribute significantly to employment creation because logging was capital intensive, and they therefore did not substantially empower the local communities that much. The other reason for lack of empowerment was that most of the forest goods were exported in the form of logs, and were not manufactured into second stage products. This suggests that there was an opportunity cost in terms of the loss in employment oppor-

tunities, local value added, and even foreign exchange. Employment generation associated with their production accrued to the countries which did the second stage manufacturing. The low royalties also tended to transfer value added from the Chobe District to the timber companies, and therefore resulted in limited gains. The local communities had also limited access to the forest reserves, and were allowed to collect fuelwood and other veld products. They did not participate in the management of the forest reserves (Selitshena and McLeod, 1998). As already stated, the new draft forest policy encourages more use of, and participation by the local communities in the management of the forest reserves. This will be a departure from the old practice, and it remains to be seen how this idea will be put into practice.

Logging activities in the Chobe Forest reserves were driving the forest reserves towards reduced biological diversity by virtue of their lack of sustainability ethicswork practices, driving the forest reserves towards reduced biological diversity. As noted by Watson and Dlamini (2003, this issue), this actually implies that the benefits derived by people from the forests would be reduced. The important role of forests as sources of the people's livelihoods in Chobe District needs to be acknowledged. For instance, a study undertaken by Anton (1997), revealed that households of the villages Kazungula, Lesoma and Kasane, which are adjacent to the Kasane Forest Reserve, mainly collected fuelwood, thatching grass, and traditional herbs from the forest reserves. The direct use values derived from the Kasane Forest Reserve by the households of the three villages amounted to P956, 546 per annum (Table 4). The total use value of fuelwood per household was P2,919 per annum in Kazungula village as compared to P508 in Kasane village. The higher use value of fuelwood in Kazungula village reflected its increased scarcity (Anton, 1997). Other components of the total economic value of the use of the Kasane Forest Reserve such as existence, option, and recreational values were not valued, suggesting the total economic value of the Kasane Forest Reserve should be higher than suggested by Table 3.

Table 4:

Forest Reserve	Value Item	No of Households Surveyed	Total Value Of Forest Benefits/ Household (Pula)	No of Households in Settlement	Total Annual value of Benefit (Pula)
Kazungula	Fuelwood	7	2 919.31	134	391 187.54
Lesoma	Thatching grass	7	833.98	99	82 564.02
Kasane	Fuelwood	94	507.67	951	482 794.17
Grand Total					956 545.73

Source: Anton (1997)

The management of the forest reserves since 1994

The high total economic value associated with the forest reserves shows the need to conserve them. After the logging activities were suspended in 1994, the Government formulated a management plan that was based on the technical study undertaken by the Norwegian Forest Society (1992). The major aspects of the management of the forest reserves included the construction and upgrading of fire-breaks and the re-demarcation of the boundaries of forest reserves. These activities were expected to lead to the control of fire, which is a major cause of the environmental degradation of the forest reserves. During the period 1994 to 1995, 88.5 km of new firebreaks were constructed in the reserves, with a length of 88.5 km, and the upgraded and maintained fire-breaks were 789.6 km long (DLDS, 1997). It was expected that the entire fire-break network when completed in all the forest reserves would cover a distance of 1500 km when completed (DLDS, 1997).

The re-demarcation of boundaries of the forest reserves and opening of boundary firebreaks was started in 1995. By March, 1997, the exercise of the re-demarcation of boundaries was completed in all the forest reserves, except Chobe and Maikaelelo (Figure 1). However, the opening of boundary firebreaks had been completed only at Sibuyu forest reserves and almost completed at Kasane Extension (DLDS, 1997).

Forest inventories were undertaken in 1996 in 55 plots established in 1991 by the Chobe Forests Inventory Project (DLDS, 1997) in Kasane and Kasane Extension Forest reserves only. Overall, the inventories in these forest reserves revealed that the degradation of the forests had worsened since 1991. The number of all trees abundance had decreased at both Kasane Forest Reserve (-32.6 stems ha^{-1}) and Kasane Extension Forest reserve (–60.8 stems ha^{-1}) (Table 5). Similarly, the volume of all the trees had also decreased by 6.2 m^3/ha and 7.2 m^3 ha^{-1} at both Kasane and Kasane Extension, respectively) (Figure 1).

Table 5: Summary of the results on the monitoring plots over 5 years (1991-1996) in Kasane and Kasane Extension.

Parameters	Kasane	Kasane Extension
Increase in Tree Density (Stems ha^{-1})	-32.6	-60.8
Increase in Tree volume (m^3 ha^{-1})	-6.2	-7.2
Increase in Dominant Height (1991-96)	14.0	13.2
Increase in Regeneration ha^{-1}	298.0	-290
% of Trees ha^{-1} (elephant.damage.)-1996	9.0	11.0
% of Trees ha^{-1} (fire damage)-1996	72	69.0

Source: DLDS, 1997

However, the regeneration of the trees had increased (+298 stems ha^{-1}) at Kasane Forest Reserve, but had decreased (–290 stem ha^{-1}) at Kasane Extension Forest Reserve. The increase in regeneration at Kasane was attributed to a decrease in the occurrence and intensity of fires during the five year period (DLDS, 1997). The inventory also revealed that more trees had been damaged by fire rather than by elephants. For instance, the proportions of the trees damaged by fire were 72% at Kasane and 69% at Kasane Extension, whereas the proportions of the trees damaged by the elephants were respectively 9% and 11% in the two reserves. Silitshena and McLeod (1998) also note that fire accounts for 55% of the damage of *B. plurijuga*, whereas elephants account for 18% of the damage of *P. angolensis* in the Chobe forest reserves CFR with very little damage recorded to *B. plurijuga*. These findings highlight the environmental problems associated with the elephants as already stated above, and the difficulty they pose to sustainable management of the forest reserves.

The results of the inventory relating to the previously logged species of *P. angolensis* and *B. plurijuga* shows that the density for these species also decreased during the period 1991-96 (Table 6). The volume for *P. angolensis* also decreased by 0.1 m^3 ha^{-1} and 0.2m^3 ha^{-1} in the two forest reserves of Kasane and Kasane Extension, respective-

ly, whereas that of *B. plurijuga* increased by 0.2 m^3 ha^{-1} at Kasane and remained constant at Kasane Extension. As in the case of the results for all the species, regeneration of the two species has also increased during the five yearfive-year period. *P. angolensis* was significantly more prone to damage by elephants rather than other tree species in the two reserves, whereas *B. plurijuga* was more damaged by fire rather than by elephants, like other trees in the plot.

Table 6 : Summary of the results on the monitoring plots over 5 years (1991-1996) according to species

Paramters	P. Angolensis		B. Plurijuga	
	Kasane	Kasane Ext.	Kasane	Kasane Ext.
Tree Density (Stems ha^{-1})-1991-96	-0.3	-1.5	-2.9	-1.5
Tree Volume (m^3 ha^{-1})	-0.1	-0.1	0.2	0.0
DBH (1991-96)	2.7	8.6	0.4	0.3
Regeneration/ ha (1991-96)	0	15.2	569.9	87.0
% of Trees ha^{-1} (eleph.damage)	80	80	2	0
% of Trees ha^{-1} (fire damage)	60	100	86	90

Source: DLDS, 1997

Despite attempts by the Government to manage the forest reserves in a sustainable way since 1994, the inventory undertaken in 1996 revealed that the situation was worse than in 1991 when the first inventory was undertaken. This could be due to the fact that vegetation takes a long time to recover from the fire damage by fire. The inventory also revealed showed that fires continued to damage trees in the forest reserves, but since there was an increase in regeneration in most of the plots in the Kasane Forest Reserve, one could say that the introduction of fire-breaks was beginning to show positive results. However, the damage to trees by elephants will continue to be a problem if their population remains as high as it is.

Concluding remarks

This study has revealed that the policies and practices adopted for the management of the Chobe forest reserves had adverse impacts on environmental sustainability, and limited positive impacts on social and economic sustainability. The low royalties of commercial timber harvesting tended to result in economic surplus being transferred from the Chobe District to the timber harvesting companies. The low royalties also made the concessionaires wasteful in their extraction of timber resources. The above situation was worsened by the increasing frequency in the recurrence of fires, which had an adverse effect on seedling recruitment and damage of to trees by elephants. The Government halted the exploitation of the forest reserves in 1994 and developed a new management plan in 1995 outlining the a strategy for the alleviation of the effect of fire on the forest reserves. Following the formulation of the plan, new fire-breaks were constructed and the old fire-breaks were upgraded and maintained. However, an inventory undertaken in 1996 revealed that the forest reserves were more degraded than they were in 1991, indicating that the new management strategy of the management of the forest reserves had not yielded expected results as yet.

There is a need for proper research involving the monitoring of the harvested sites, together with experimentation on various aspects of different silvicultural practices and an investigation on of the applicability of unconventional and newly developed yield regulation systems highlighted above. Sustainable practices, based on the experiences of other countries, should be examined as part of a regional effort to enhance sustainable forestry practices in the savannas of southern Africa

The damage to the reserves by fire and elephants needs to be given the immediate attention it deserves. Botswana should carry out a detailed study of the destructive impacts of elephants on vegetation in preparation for the next meeting of CITES. Resumption of any type of logging, be it salvage as suggested, should be controlled to reduce the high fuel load due to slash, and consider maximum use of all wood harvested. Replacement planting, care and management of seedlings for every logged live stem must be part of any agreement on the extraction of healthy forest trees. There should also be proper post-harvest management to ensure seedling establishment and stump regeneration. In addition, an attempt should be made to ensure that some of the wood products are locally manufactured to produce second stage products (e.g. furniture, paper etc) so that the value added should benefit Botswana. The mining of forest resources should be discouraged, and there should be a long term policy objectives.

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