CHAPTER 6

DISCUSSION AND CONCLUSIONS

6.1 Introduction

In this chapter, a brief summary of results is given. Secondly, a comparative analysis of the results with other findings in Botswana and elsewhere is made. The policy implications of the findings are also given. Finally, conclusions and recommendations are made at the end of the chapter.

6.2 Summary of results

The composition of wild herbivores varied significantly with elephant constituting the highest population during 2003. Due to their high numbers they had the highest composition value which was estimated at US$19.38/ha. Similarly, the direct use value of elephants was the highest (US$0.059/ha) of all the wild herbivores. However, this does not imply that elephants were the most hunted animals or had the highest hunting quota allocation during 2003. The high direct use value is attributed to the highest market price placed on them. Herbivores with the highest hunting allocation were the duiker, the steenbok and warthog. Such animals have faster reproductive cycles and can replace their population within a short time. The functional value of wild herbivores may be considered a true estimate of the use value since these values were derived from the actual number of animals that were allocated for hunting.

The Okavango Delta ecosystem is characterized by high floral diversity, which is a function of the diversity of its habitats. The floristic diversity is greater than some of the world greatest biomes. The compositional values of the vegetation of the Okavango Delta were not computed. However, given the high plant species diversity, these values are expected to be significant.

Of the estimated direct use values of vegetation (river reed, thatching grass, wild fruits, fuelwood and palm tree leaves), river reed had the highest direct use value of US$29.0/ha, while palm leaves had the lowest direct use value of US$0.31/ha. Considering all the direct use values in the study, which are inclusive of water, the highest direct use value was that of water which was estimated at US$19.98/ha.

Among the estimated indirect use values of the Okavango Delta (honey production, carbon sequestration, livestock grazing and milk production), the greatest value was derived from milk production (US$8.5/ha), and the smallest was derived from honey production (US$0.015/ha).

The willingness to pay towards the conservation of the Okavango Delta as stated by households indicates the monetary sacrifices people would make to have the Okavango Delta preserved from possible ecosystem change as a result of water abstraction. The value per hectare for households and tourists were estimated at US$0.06 and US$16.67, respectively.

6.3 Discussion

6.3.1 Composition value for wild herbivores

The value of the composition of wild herbivores was estimated at over P1.4 billion (US$294.8 million) or P133.5 (US$27.24) on per hectare basis during 2003. The estimated value of the composition of wild herbivore species during 2003 was higher than estimates made on some similar studies in the southern Africa region. In the Rooibos Bushveld area of the Kruger National Park, South Africa, Blignaut and Moolman (2004) estimated the total value of tradable mammals of wildlife species at R167 million (US$2 6475 483). Though the value of the tradable mammalian wildlife species estimated by Blignaut and Moolnam (2004) was lower, the value per hectare of R1024.7 (US$ 153.28) was greater than the value from this study. The differences in the value per hectare may

be due to three factors. Firstly, the differences in per hectare values may be due to differences in the sizes of the two areas and the distribution of animals (density). The size of area of the Okavango Delta is almost 10 times the size of the Roibos Bushveld area, and because of the smaller area of the Rooibos Bushveld area, the average densities of animals are higher than the average densities in the Okavango Delta area. Secondly, the differences could be due to the variation in the market price of individual animals. However, these differences are expected to be smaller as the market prices of animals in Botswana are derived based on the average prices of South Africa, Zimbabwe and Namibia. The third factor could be the differences in the compositional structure of animals in the two areas. In South Africa, animals with a higher market price, such as the rhino are auctioned, while they are not traded in Botswana because they are protected.

The compositional value represents the revenue that the country would gain if all the selected wild herbivores were traded at the prevailing prices. The value, however, is a partial value of the total value of wild herbivores as there are also non-consumptive and existence values. The sustainability of production of the compositional value depends on the management of the wild herbivores. The compositional value provides the resource management basis for the following year. That is, it is the value of the standing stock at a given time. Since this value is known, decisions regarding the future utilization of wildlife can be made based on full information of the stock value. Part of the compositional value can be allocated for consumptive use such a safari hunting, while the other part can be allocated to non-consumptive use such as wildlife viewing. This does not however, imply that biologically determined harvestable levels should not be used for hunting quota allocation, but rather, each allocation would be accompanied by its economic value.

The value per hectare of wild herbivores also has important policy implications in the conservation and sustainable utilization of wildlife resources. The value per hectare is a function of the density and the market price of the herbivores. Lower returns per unit of land may be due to low densities suggesting that the stocks of animals may be increased

to achieve optimal utilization of resources. However, the carrying capacity of the land should not be exceeded.

6.3.2 Direct use value of herbivores

The direct use value of wild herbivores represents a flow service (hunting), valued at P7 266 300 (US$1 484 688.52) using hunting license fees paid by non-citizens. Though the number of elephants in the hunting quota for 2003 was not necessarily high, their contribution to direct use value was highest. Their high contribution was mainly due to the high price paid for each animal. Sustainable derivation of direct use value of wild herbivores will be determined by harvesting only the surplus or growth, and not the resource base. Harvestable surplus should be from each animal species because each species plays a role in the animal community. Thus, the value derived from elephant can not compensate for lost value of other species.

Sustainable direct use value will also depend on whether or not the habitat for these species is degraded. Thus, conservation and sustainable use are key to sustained utilization of these resources for the current and future generations.

6.3.3 Direct use value of vegetation

Results have shown that vegetation (reed, thatching grass, fuelwood, fruit trees and palm leaves) provide subsistence and income values to households in the Okavango Delta. The average annual household income of US$47.34 for river reed was much higher than the average annual household income of river reed of some wetlands in the region. For instance, Turpie et al. (1999) estimated the annual income of river reed for a household in Barotse Floodplain and Chobe Caprivi Wetlands at US$0.22 and US$29.00/ha, respectively.

The average household direct use value of wild fruits estimated at US$114.92 (USD$5.33) compared well with that found by Twine et al. (2003) in Mametja area in

Limpopo Province in South Africa, which was estimated at R1 026 (US$153.5). The household average direct use value of fruit collection was also higher than the values obtained in the Chobe Caprivi wetlands. Turpie et al. (1999) estimated the annual direct use value of wild fruits per household in these wetlands at US$9.64, while the total value for all households was estimated at US$30 196. On per hectare basis, the value of Chobe Caprivi wetlands were US$0.0099/ha.

The average direct use value of fuelwood per household was estimated at US$38.62 during 2003. This value was smaller than the value of fruit collection and reed collection in this study, but greater than the household value of R 8.7 (US$1.30) obtained by Twine et al. (2003) in Mametja area in Limpopo Province of South Africa. The total direct use value of fuelwood was estimated at more than US$5 million, with a value per hectare of US$1.35/ha.

Thatching grass in the Okavango Delta provided an average annual household direct use value of P232 (US$47.34) during 2003. This value was higher than the direct use value of thatching grass of US$0.023 in the Barotse flooplain, and US$20.79 in the Chobe Caprivi wetlands (Turpie et al., 1999). It was also higher than the direct use value of US$1.30 obtained by Twine et al. (2003) in Mametja area in Limpopo province of South Africa. The per hectare value of US$0.8 from this study was also greater than the per hectare value of US$0.099 in the Barotse floodplain and the per hectare value of US$0.24 in the Chobe Caprivi wetlands (Turpie et al., 1999).

Palm leaves provided an annual average household direct use value of P118.8 (US$24.24) from this study. This value was more than the corresponding value of US$1.36 in the Barotse floodplain wetlands and the value of US$2.27 in the Chobe Caprivi wetlands (Turpie et al, 1999). Similarly, the direct use value per hectare of US$0.31 from this study was higher than the corresponding values of US$0.025/ha in Chobe Caprivi wetlands, and US$0039/ha in the Barotse floodplain (Turpie et al., 1999).

Although the direct use value per hectare of vegetation reported in this study makes it possible to compare these values with the values obtained from studies undertaken in other parts of the world, variations still exist. Firstly, it is not possible to estimate the exact size of the area used and the amount of plant product extracted. Secondly, the use of plant products is not always separated according to the rights of use among the villagers, as people from other places, even urban areas, sometimes visit the areas to extract plant products (see Gram, 2000). Thus, the values per hectare in this study should be considered 'rough estimates' because of the difficulty in estimating the extent and the amount of floral products extracted. Not withstanding these methodological limitations, these values show the revenue from saleable products from the wild. The values show that people, especially the poor, depend on the services of nature, even though the products from which these services are derived outside the realm of market system.

These values provide an important source of information where policy makers are faced with several land use options. For instance, if the government of Botswana supported commercial maize production in the same area where these resources also grow, the values could be compared to the values of commercial maize production per hectare in the same area. If respective values for each resource or the aggregated value is higher than the value of commercial maize production, the decision to convert land into commercial maize production should be abandoned, and the land should be conserved to support the growth of these resources.

6.3.4 Direct use value of water

The direct use value of water from this study was estimated at more than US$2 million. However, this value does not represent the true value of the benefit of water because some use value of water is not accounted for. Secondly, while the structure of the water consumption tariff is designed to encourage water conservation by emphasizing the minimum basic water requirements and thereafter paying more for every extra cubic metre of water consumed (Government of Botswana, 2001), it does not take into account all the costs of supplying water to the consumers. The price of water delivered (water

consumption tariff) is lower than what the market price should be, and therefore does not provide the true potential revenue of this resource. The lack of information on the stocks of groundwater adds to this undervaluation problem because if depletion of groundwater is occurring, it is not being accounted for in the structure of water consumption tariffs. The total price of water should reflect the investment cost, operation and maintenance cost as well as external costs of depletion. There is need for policy on correct water pricing, given the scarcity and limited options for augmenting water supply, to meet the needs of the growing rural population. The water pricing policy should aim at bringing water consumption tariffs closer to market prices. It is only through correct resource allocation that sustainable utilization can be achieved.

6.3.5 Non-consumptive use value of tourism

In this study, the value of tourism in Moremi Game Reserve, which included expenditure on travel, was estimated at over P82 million (over US$16 million) during 2003. The aggregate cost per visitor was estimated at US$167.86. The value in the current study was higher than the aggregate recreational value of some of the well known tourist destinations in Africa such as Lake Nakuru National Park in Kenya. Navrud and Mungatana (1994) estimated the recreational value of 88 528 non-resident visitors and 52 803 resident visitors of Lake Nakuru National Park in 1991. The aggregate recreational value for non-resident and residents visitors was estimated at US$13.7-US$15.1 million, while that for non-resident visitors and residents was estimated at US$10.1-US$10.6 million and US$3.6-US$4.5 million, respectively. While the total recreational value for this study was greater, its value per hectare of US$34.33 was smaller than that for Lake Nakuru National Park of US$76.1-US$83.9. Similarly, the value of tourism per hectare in Moremi Game Reserve was lower than the corresponding value for the Rooibos Bushveld area of Kruger National Park in South Africa which was estimated at US$96.66/ha (see Blignaut and Moolman, 2004). The value of tourism per hectare from this study compares well with the value of tourism in the Olango Islands in the Philippines, where the value of on-site expenditure was estimated at US$40-US$50/year (White et al., 2000).

Given the importance of tourism in export earning, employment creation and overall contribution to economic development, the Government of Botswana should continue conserving wildlife resources which are the key resources driving tourism in the Okavango Delta. For sustainable tourism development, part of the returns from tourism should be re-invested in the management of tourism resources as well as in the improvement of delivering tourism services. Thus, the tourism product should be of high quality so that Moremi Game Reserve remains a preferred tourism destination. It should, however, be ensured that the tourism carrying capacity is not exceeded as this may lead to environmental degradation. Customers paying for a tourist experience expect a high standard of environmental quality, but in the face of a declining environmental quality, it is expected that tourists would visit other places of interest with better environmental quality. Thus, an important lesson for policy is that tourism should not solely be driven by the realization of high revenues from the large number of tourists, but must be sustainable in the sense that high revenues are obtainable with little or no environmental damage.

6.3.6 Indirect use values

6.3.6.1 Honey production

Honey production provides additional income and source of food for farmers. The average production of 12 kg per hive was within the production range of 10-15 kg per hive of the Bas Congo Region of the Democratic Republic of Congo (Lathan, undated). The value of honey production during 2003 was estimated at P41 760 (US$8 521.13) or P0.1/ha (US$0.02/ha) which was the smallest of all the indirect use values from this study. The production of honey depends, to a large extent on the sources of pollen and nectar for maintaining the bee colony throughout the rainy season. Whenever there is a shortage of suitable forage during the rainy season, the production of honey should be expected to decline, leading to a decline in economic value.

Under unfavourable environmental conditions, the value of honey production was estimated at US$6 390.35. Since production levels of honey depend on the condition of

the vegetation, it follows that the loss of plant biodiversity or the occurrence of unfavourable environmental conditions will inevitably lead to a reduction in the production of honey, and the standard of living of those who depend on honey as a source of food and income. Forest policies should therefore emphasize the conservation of vegetation species which are important sources of pollen and nectar so that not only does income derived from beekeeping becomes sustainable, but also that the functioning of bees as natural pollinators is not affected.

6.3.6.2 Livestock grazing

Based on the number of livestock units, the growth of livestock units and the prices of beef biomass (Pula/kg), the value of a grazing for Tswana cattle breed and a cross breed between the Tswana and Brahman was estimated at just over P3 million (US$623 942.66), while that for a pure Tswana breed only was estimated at P2.9 million (US$608 520). The results seem to indicate that the returns from a cross breed are slightly higher than those for keeping a pure breed only. The per hectare values of a cross breed and pure Tswana breed were estimated at US$1.54 and US$1.46, respectively. Both of the values of grazing per hectare were greater than values for cattle grazing in the Chobe Caprivi wetlands of US$0.84/ha (see Turpie et al., 1999). This is in spite of the fact that the values for the Chobe Caprivi wetlands included the value of milk.

Grazing value provides essential information in the management of grazing resources. High grazing values in open grazing lands may be associated with the high productivity of a range. A high ratio of number of livestock units to the size of the grazing land, may lead to overgrazing, low productivity of the range, poor condition of the animals and low economic values. Thus, if the carrying capacity has been exceeded, the quality of the product (for example, beef) is also expected to decline. One of the predisposing factors to poor productivity of the range is drought. Policies on grazing should therefore address the correct distribution of cattle within grazing resources while considering the limits imposed by adverse environmental conditions.

6.3.6.3 Milk production

A assuming that there were 17 064 lactating Tswana breed of cattle and the same number of Jersey breed of cattle, the total value of milk production was estimated at P31.9 million (US$6.5 million). Assuming also that all breeds of cattle (34128) were of the pure Tswana breed only, the value of milk was estimated at P17.4 million (US$3.5 million). Though milk is generally considered to be a secondary product of livestock and consumed mostly during the wet season in Botswana (Arntzen, 1998), it appears that the returns to milk production in both scenarios are higher than returns from beef production. However, it is common knowledge that beef production is highly subsidised by government. Given that most of the households in the Okavango Delta have to diversify their livelihood strategies due to the multi stranded income strategies and the subsistence orientation production activities (Schudder et al., 1993), it would appear rational for households to keep both beef and dairy breeds of cattle.

6.3.6.4 Carbon sequestration

The value of carbon storage per hectare (US$0.34/ha/year) from this study is much smaller than that found in other species-rich ecosystems. For instance, in the tropical forest, Pearce and Moran (1995) cited in Myers (1996) reported higher values of carbon storage to the value of US$1 000 to US$3 500/ha/year, and those of the Brazilian Amazonia to the value of US$46 billion.

Since vegetation converts carbon dioxide from the atmosphere into carbon in plant tissues (leaves roots, stems) during the process of photosynthesis, it therefore follows that a reduction in the vegetation density would lead to the buildup of carbon dioxide in the atmosphere. It Botswana, tree species such *Colophaspermun mopane* provide good fuelwood and building materials, and the high demand of such species predispose them to over-exploitation. If exploitation of resources leads to a reduction in the density of vegetation, thene carbon storage value is expected to decrease, leading to increases in the concentration of carbon dioxide in the atmosphere. The policy implication of reduced value of carbon sequestration is that government intervention in the form of improving

the management and utilization of vegetation resources is necessary. This is because the carbon sequestration service values are of great interest for domestic and international policies. Conservation strategies that would contribute towards the reduction of the buildup of carbon dioxide in the atmosphere should be supported or introduced. These include among others, the introduction of licenses on the cutting of certain tree species or a tax associated with the quantities and/or volumes of trees cut.

6.3.7 Non-use values

Non-use values are un-marketed in nature. In this study, they were solicited by the willingness to pay for the preservation of the Okavango Delta to prevent or mitigate water abstraction. The average willingness of households to pay was estimated at US$9.84, while that for tourists was estimated at US$214.08. On per hectare basis, the willingness of households to pay was US$0.6/ha, and that for tourists was estimated at US$1.12/ha. Minimum estimates for willingness to pay were also derived based on the scenario that there was no threat of water abstraction, and the values were US$36 302.36 for households, and US$2 640 676.8 for tourists.

The sample results obtained in the first scenario were comparable to values obtained in other studies where wetland resources are also facing human threat similar to the Okavango Delta. In Morocco, where the Merja Zerga lagoon is facing threat of over-exploitation, Benessaiah (1998) estimated non-use values of the lagoon by asking 250 visitors how much they were willing to contribute to a state project to avert the threat to the lagoon. The average willingness to pay was a one-time contribution of US$19 per person, which is more than the one-time average households' contributions from this study, but less than the average contribution for tourists. However, Benessaiah (1998) indicated that his findings should be considered a minimum value because the willingness to pay for the population living outside the area (national and international) was not taken into account.

In Kenya, Navrud and Mungatana (1994) also solicited the willingness of residents and non-residents to pay to prevent pollution of Lake Nakuru. The contingent valuation scenario indicated that lake pollution would harm the flamingo birds that were the centre of tourist attraction. The average annual willingness to pay per person was estimated at US$73 for residents and US$20 for non-residents. These results show that the average willingness to pay to prevent pollution was more than the average willingness to pay by households to prevent water abstraction, and slightly higher than that for tourists in this study. In a similar study in Namibia, Barnes et al. (1997) estimated the willingness of tourists to contribute to a wildlife conservation fund and obtained a value of N$144 (US$21.56) which was less than the willingness of tourists to pay in this study. The willingness of households to pay for the conservation of Zambezi wetlands of US$35.06 (see Turpie et al., 1999) was more than that for households in this study.

The willingness of households to pay reflects local people's preference for having the Okavango Delta undisturbed. If the Okavango Delta is left undisturbed, it will continue to provide goods and services to the people. If disturbed, and depending on the nature of disturbance, the Okavango Delta may not provide all or some of the goods and services that it provided before. Simply put, the willingness to pay shows the people's monetary sacrifice to have the Okavango Delta free from disturbance.

The expressions of the willingness to pay for the preservation of the Okavango Delta also imply bequest value held by value attributers. The current generations using resources of the Okavango Delta may not only be attaching a monetary value on the current utilization of the Okavango Delta, but also on its use by the future generations. Thus, they would like to see their way of life and culture that has co-evolved with the wetland to continue from present to future generations. This is the concept of intergenerational equity.

The expression of the willingness to pay by households to avert water abstraction from the Okavango Delta may also be an indication that they did not approve of the proposed move to extract water upstream of the Okavango Delta. It may also suggest that they were not involved in the project consultation process from the beginning. That is, the

value of the Okavango Delta to local people was not considered in the proposal to abstract water. Local resource users should therefore be involved in order to understand their perception of how the intended project(s) would impact on resources that sustain their livelihood. It is also equally important to note that the conservation of a resource represents an essential link between indigenous culture (including livelihood strategies) and the value that riparian communities place on the resource (Turpie et al, 1999). Thus, it is not only the economic values that matters but also the social and cultural values of the people. However, these values are difficult to quantify.

The non-use values for the conservation of an ecosystem also imply that biodiversity should be conserved. If disturbed, part of the biodiversity may be lost, and may in turn lead to reduction in the provision of ecosystem services such as recreation and other direct use values. One of the main reasons that biodiversity should be conserved is because its future value is not known, and therefore, its conservation implies that it has a quasi option value. Though difficult to value and appreciate, non-use values represent an important value of a wetland resource. Lack of the estimation of non-use values for resources such as wetlands can lead to their conversion to provide more direct use values. Policy planners should therefore start appreciating the existence value of resources, especially that current generations should not compromise the future generation ability to meet their own needs.

6.3.8 Comparison of the value of Okavango Delta with some specific land uses in Botswana

The value per hectare of certain components of total economic values can be compared to the value per hectare of other land uses in the country. For example, Barnes et al. (2001) evaluated the economic viability of certain land use in some parts of Ngamiland District in Botswana. Some of the evaluated agricultural based land uses were traditional livestock production (the rearing of livestock, mainly cattle and goats, on a small scale for the production of milk, meat, draft power, manure and as a store of value), cattle post livestock production (keeping of cattle as a store of value and to produce meat and milk),

and commercial livestock production (the keeping of cattle in commercial ranches mainly for meat production).

The estimated value per hectare for milk production of US$8.5/ha from this study was less than the gross financial income/ha of US$17.55 for traditional livestock production, but greater than the gross financial income/ha of cattle post livestock production (US$5.51/ha), and commercial livestock production (US$7.55/ha). Traditional livestock is characterized by lower production costs of inputs. The cost of labour, the main production input, is usually very low. The value of livestock grazing per hectare (US$1.46) was smaller than the values of all the three agricultural land use types.

The value of milk production per hectare and livestock grazing per hectare can also be compared to wildlife based land utilization types. These are community wildlife use in low quality areas, community wildlife use in high quality areas and commercial tourism (Barnes et al., 2001). The value of milk production per hectare was less than the financial gross income/ha for commercial tourism of US$33.87/ha, but greater than the gross financial income/ha for community wildlife use in low quality areas (US$0.19/ha), and community wildlife use in high quality areas (US$2.38/ha) (Barnes et al, 2001). While livestock keeping and wildlife based tourism have comparative advantages in Botswana, the comparison of results of this study to those of other studies seem to indicate that livestock production does not yield as much returns as tourism in the Okavango Delta. The results therefore provide a basis for evaluation of land use related policy where livestock would compete for resources with other land uses.

6.3.9 The expected impact of water abstraction on total economic value

As had been shown in the previous chapter, the value of the Okavango Delta is over P1.4 billion (US$294.8 million) worth of composition values and over P185.5 million (US$37.5 million) worth of goods and services (functional values). The estimated economic values from this study could be considered to represent the total economic value of selected resources in the Okavango Delta in the absence of a water abstraction project (without project scenario). The ecological impacts of water abstraction were anticipated by project planners to be small in spatial extent and localized, and therefore, would not have stopped the project from proceeding (Republic of Namibia, 1997). It was also argued that the anticipated impacts would be lessened as they would be spread across the whole aerial extent of the Okavango Delta. It is expected however, that, through ecological processes, the value of certain resources would be reduced by some magnitudes if the project was implemented (with project scenario). The quantified marginal economic changes resulting from water abstraction would reflect the economic impact of the project in the first year. The estimated economic values might drop further due to cumulative effects of the anticipated water abstraction project. If the flood extent reduction could lead to a reduction in the density of a water-dependent resource such as reeds, the value per hectare could decrease with the cumulative yearly water abstraction.

The anticipated water abstraction might also have a greater economic impact in terms of the loss of biodiversity. Since the willingness to pay for the preservation of the Okavango Delta also implies the conservation of biodiversity, an environmental impact assessment that does not take into account the non-use values would not reflect the real situation in terms of the economic losses to be expected. For instance, a loss in one vegetation or animal species might have significant effects on the future economic value of biodiversity. If the future economic value of such an animal or plant species could be determined, it may as well be found that its value would be significantly greater than the total non-use values.

6.4 Conclusions

The purpose of this study was to attempt to quantify economic values of some selected resources in the Okavango Delta by using the framework of total economic value (TEV). Based on these findings, this study found that there is over P1.46 billion (US$294.8 million) worth of the composition values of herbivores and over P185 million (US$37.5 million) worth of goods and services of selected resources in the Okavango Delta. These values represent initial estimates of costs to society if these resources are lost. The estimated values can be used to raise awareness among decision makers of the economic benefits of conserving and sustainably managing the Okavango Delta. Thus, the estimated values provide a strong argument for policy makers to preserve the Okavango Delta because it provides goods and services upon which many communities and economies depend**.** If this interdependence is not fully recognised in the sustainable management of the Okavango Delta, those who depend on the Okavango Delta for a living will be disadvantaged.

The composition values of wild herbivores were comparable to other areas in the region, but with some variation. Composition values can be used in management decisions in allocating the different uses of wildlife. Together with other values of wildlife, this information can be very vital where decisions are to be made between converting the ecosystem into other land use types or conserving it. The values of wildlife help to prioritise pricing policy for the sustainable utilisation of wildlife. With appropriate pricing, the economic returns from wildlife utilisation should be compared to other land uses, such as livestock farming. Improper pricing leads to inefficient resource allocation and therefore, a proper pricing policy in the management of these resources is crucial for their conservation and sustainable utilisation.

The productivity of the Okavango Delta as well as the economic values derived from harvestable vegetation resources was comparable to other wetlands in the region, such as the Chobe Caprivi Wetlands and Barotse Wetlands. The per hectare values of river reeds, wild fruits, thatching grass and palm leaves in the Okavango Delta were slightly higher than the corresponding values in these wetlands. However, these differences should be

interpreted with caution as they may be due to the methods used to estimate the values. For instance, there are difficulties associated with estimating the exact size of the area over which the resource was measured, as well as in measuring the quantities of resources harvested. On this basis, comparative analysis on productivity, which leads to economic valuation using market prices, should be backed by field experiments.

Better estimates of resource values can be achieved if full natural resource inventories are undertaken at national level. Resource inventories should be undertaken periodically to monitor stock level changes as well as the underlying causes of these changes. Information from resource inventories can assist in identifying which resources are under increasing threat through their use. If indications are that resource levels are declining due to over-exploitation, appropriate measures can then be taken to reverse the current trend. For instance, if over-harvesting leads to scarcity of some of the resources, it may be appropriate for the resource management authority to introduce harvesting permits to control over-exploitation.

The value of carbon sequestration obtained was lower than that estimated in species-rich ecosystems, such as tropical forests. While the carbon sequestration value does not have direct implications on households, it has implications for global policies on climate change. The value of carbon sequestration should be compared to other benefits of other woodlands, such as timber production or clearing land for agricultural production (see Kundhlande *et al*., 2000). The government will have to strike a balance between meeting the increasing food needs from agriculture**,** and forests.

Milk production yielded the greatest value of all indirect use values in this study. The value in this study was found to be higher than the value of livestock grazing. It was also higher than the estimated values from other wetlands in the southern African region, such as the Chobe Caprivi wetlands. Though the value of livestock grazing is smaller than those for milk, it provided important information for decision making in the management of grazing resources, seeing that livestock provides important foreign earnings for the country. Owners of livestock should ensure that range deterioration does not occur, lest

the standard of living of those who depend on cattle may fall. As put by Bhatia *et al.* (1998) 'strategies for range management should aim to maintain rangeland productivity, protect and improve biodiversity, promote livestock production and improve the standard of living of the people.'

Water is an extremely scarce resource in Botswana, so much so that it has become a serious development constraint in many parts of the country. The value of water obtained in this study does not include the cost of water supply and groundwater depletion. These costs are not reflected in the structure of the water consumption tariff. The emphasis of a water pricing policy in Botswana is on meeting the minimum basic water requirements of humans. However, there is a need for financial cost recovery in this policy of water demand management. The policy should recognise that the supply of water (though being subsidised by government) and the environmental cost of water abstraction from aquifers are important parameters in water pricing.

The total value of tourism in the present study was comparable to most tourist destinations. However, the values of resources per hectare were, in most cases, smaller. The values for tourism provide essential information in comparing the performance of the tourism sector in 2003 and in other years. There is a need to determine the tourism carrying capacity of the Moremi Game Reserve, and the cost thereof. This will help establish a relationship between ecological limits of the Moremi Game Reserve and sustainable economic benefits from tourism. For example, the Government of Botswana's position that tourism should operate under the deliberate '*low volume high value'* is not based on any information on environmental costs of tourism.

The existence of the Okavango Delta is highly valued by local households and tourists. The stated non-use values of the Okavango Delta represent the people's monetary sacrifice to have the Okavango Delta free of disturbance. This is in light of the potential water development projects that possibly threaten the ecological integrity of the Okavango Delta. If the resources of the Okavango Delta are used sustainably, they will be available to future generations.