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Economic valuation of selected direct and indirect use values of the Makgadikgadi wetland system, Botswana

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ABSTRACT

Economic valuation of wetlands aims to investigate public preferences for changes in the state of the wetland and the natural resources it constitutes in monetary terms. It provides a means of quantifying the direct and indirect benefits that people derive from wetlands. In addition, it informs management planning and practice about resource options, optimal allocation and also provides information for conservation of the resource. The Makgadikgadi wetland is a unique system that mostly consists of dry pans during most of the year. This study aimed at estimating the value of groundwater recharge and community-based natural resource management (CBNRM) activities within the Makgadikgadi wetland and how these goods and services contribute to the local and national economy. The study used the Total Economic Valuation approach, which considers both the direct and indirect use values of the resource. In essence, the study concentrated on one direct use value (use of resources through CBNRM) and one indirect use value (groundwater recharge). With regard to CBNRM, three community-based organisations (CBOs) were selected for the study and static and dynamic cost–benefit models for these CBOs were developed. The groundwater recharge value was largely determined through desktop review and interviews with stakeholders. The results indicate a small positive contribution of CBOs towards the economy of Botswana and a high potential for communities to derive substantial benefits from the projects because currently benefits realised by communities are limited. CBOs involved in joint venture partnerships with tourism and hunting enterprises benefit more from utilising the wetland's resources. Groundwater recharge often occurs in areas away from the physical location of the wetland and may not be easily attributable to the wetland. However, the study assessed the value taking into consideration the various sectors which rely on the groundwater resource. The groundwater recharge value is significant (BWP 9–10 million) but lower when compared with the value generated by the Okavango delta (BWP 16 million). Given future increases in water demands, groundwater abstraction will exceed recharge, thus hampering the availability of the resource for the future generations and maintenance of the environment.

1. Introduction

Wetlands are among the earth's most important and productive resources and have been termed the "kidneys of the landscape and biological supermarkets" (Barbier et al., 1997). They play a key role in the hydrological and chemical cycles and support biodiversity and food webs and are an important source of water for water and nutrients necessary for biological productivity (Thompson, 1996). They also provide important ecological services such as carbon sequestration, water purification, flood attenuation and wildlife habitat. For instance, the Okavango delta provides a refuge for wildlife, which is vital for tourism in and around the delta. Wetlands also support livelihoods of local people. For example, in the wetlands of Kilombero Valley in Tanzania, agricultural production is an important livelihood activity where households mainly grow rice, maize, bananas, cassava and vegetables (Kangalawe and Liwenga, 2005). In addition, about 72% and 56% of households around the Makgadikgadi wetland area are engaged in crop and livestock farming (CAR and DEA, 2010). Wetland management, therefore, requires attention to ecological integrity, social well-being as well as economic efficiency. In practice, market failure, poor policy interventions and human activities such as land clearing, burning and overexploitation of wetland resources lead to wetland losses and threaten the future of wetland ecosystems. Barbier (1993), Barbier et al. (1997) and Turner et al. (2000) indicate that a number of wetlands around the world have deteriorated due to infrastructure developments and agriculture. In the United States of America, a considerable 54% of the country's wetland areas have disappeared due to agriculture. Losses have, in turn, negative impacts on com-

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munities that rely heavily upon these resources as well as the economies large. Southern Africa has globally important wetlands such as Barotse flood plain (Zambia), eastern Caprivi wetlands (Namibia) and the Okavango delta (Botswana). This article focuses on the Makgadikgadi wetland system in Botswana.

For sustainable wetland management, it is important to understand the value of the resource in both qualitative and quantitative terms so as to guide their sustainable utilisation and management. Economic valuation aims to estimate the values of services and goods provided by the wetland resources (Barbier et al., 1997; Emerton et al., 2004). The values include use and non-use values as well as current and option values. Valuation demonstrates economic importance of wetlands and supports better decision-making regarding wetlands (Emerton, 1998; Turpie et al., 1999). Valuation fits into the paradigm of Integrated Water Resources Management (IWRM), one of which principles is that water – and by extension a wetland – is an economic good. It is important to recognise that wetlands have an economic value given the benefits they generate to communities and national economies. Therefore, managing the resource is a way of achieving efficient and equitable use and promoting conservation of wetlands. Economic valuation is also highly recommended in the 1997–2002 Ramsar Strategic Plan, which was approved during the 1996 Conference of Parties to the Ramsar Convention (Barbier et al., 1997).

This article shows some of the values of the Makgadikgadi wetland system (MWS) in Botswana. The MWS is a largely ephemeral inland palustrine salt wetland system, one of the largest wetlands in southern Africa (Ecological Support Services, 2002). The Government realised the need for an integrated and holistic management approach that covers the key economic sectors (mining, agriculture and tourism) and the major natural resources (land, water, minerals, wildlife and flora). This has led to the preparation of a Makgadikgadi Framework Management Plan (MFMP) in 2010.[1] As part of the plan preparation, various resource users and uses needed to be adequately documented and understood through a livelihood analysis and an economic valuation. The latter is well placed to reveal this significance and facilitate the balancing of resource utilisation and conservation for the current and future generations. The article focuses on two use value components,[2] which are vital to the wetland's long-term sustainability. Firstly, the value of community-based tourism was estimated for the three operating community-based organisations (CBOs): Nata Conservation Trust (NCT), Gaing-o Community Trust (GCT) and Xhauxhwatubi Development Trust (XDT). Secondly, the indirect use value of groundwater recharge was estimated. Such recharge is vital to the wetland's integrity and the sustainability of economic activities such as mining and tourism. Groundwater recharge value was assessed primarily because of the crucial role of groundwater in the Makgadikgadi area as it is the major sources of water in this area. The overall MFMP project assessed other indirect use value components: carbon sequestration, wildlife refuge as well as science and education (DEA and CAR, 2010).

2. Study area

The Makgadikgadi wetland system (MWS) is located in the north-eastern and central parts of Botswana (Fig. 1). The catchment area of the MWS is vast as it extends into Zimbabwe through the Nata River system; it is also linked to the Okavango River basin through the Boteti River. The study area with surrounding villages is around 36,000 km^2. The wetland system is composed of two seasonally inundated salt pans (Ntwetwe and Sua Pans). There are many small pans, which are part of the wetland system. The two major pans constitute 8000 km^2 and 6000 km^2, respectively. These pans are surrounded by grasslands, tree and bush savannah as well as mophane woodlands, and they are fed by rainfall and inflow from five seasonal rivers, the main one being the Nata River (McCulloch et al., 2008). Rainfall is highly variable, and average annual rainfall is 400 mm. In terms of groundwater, the Makgadikgadi wetland has mostly shallow wells and minimal deeper saline brine (Ecological Support Services, 2002). The quality of groundwater resources is variable, and in some areas, it is very saline. The Makgadikgadi is endowed with a variety of ecological habitats, which provide for a diversity of flora and fauna including woody vegetation, short bush and tree savannah and various grass species as well as small to large mammals and aquatic animals. When flooded, it attracts a variety of water birds including the severely globally threatened species such as the water crane, lesser flamingos and the white pelicans (McCulloch, 2003).

The MFMP area has a population of about 51,000 (CSO, 2001) with an estimated population of 57,118 in 2010 (CSO, 2005). The communities rely on arable and livestock farming as well as collection of veld products such as mophane worms and wild fruits. Employment opportunities are limited. Social welfare programmes also play an important role in availing income for the communities. Tourism plays a significant role in the Makgadikgadi as the wetlands provide pristine tourism areas and abundant biodiversity, which offer opportunities to expand tourism in the region. However, the livelihood benefits of tourism are still very limited. The Makgadikgadi and Nxai Pan National Park, the Nata Bird Sanctuary and the Flamingo Sanctuary offer a vast array of wildlife and bird species some of which are regarded as being rare. Other wildlife endowed areas are the Wildlife Management Areas (WMAs), which are also utilised by the communities. Human wildlife conflicts frequently occur in the MWS and negatively impact on rural livelihoods.

There are nine CBNRM projects in the area, but only three of these are currently operational. These are briefly discussed as follows:

- Nata Conservation Trust (NCT) has been in existence for almost two decades and encompasses three villages being Nata, Sepako and Maposa on the western side of the Makgadikgadi Pans. The trust is mainly engaged in the sustainable utilisation and management of the Nata Sanctuary. The sanctuary operates like a tourism entity, generates revenues for the trust and creates employment for the local communities.
- Gaing-o Community Trust (GCT) was established in 1997 by the community of Mmatshumo to preserve and manage Lekhubu Island. The island has a high archaeological and tourism value and is a national monument. The trust engages in activities such as camping and guided walks but potential exists for further tourism development.
- Xhauxhwatubi Development Trust (XDT) operates in Phuduhudu village and has user rights for hunting and photographic tourism in NG49. Hunting is the major commercial activity, while commercial photo safaris have largely remained underdeveloped but there are plans to revive this activity in the near future. The community engages a private company through joint venture agreements for the utilisation of the hunting area.

3. Methods

The study adopted the Total Economic Valuation framework within which direct and indirect use values were analysed.

[1] The research was carried out as part of a wider research project, the Makgadikgadi Wetland Framework Management Plan (MFMP), Botswana. The main objective of the FMP project is 'to improve people's livelihoods through wise use of the wetland's natural resources'. This project was carried out by the Centre for Applied Research (www.car.org.bw) in partnership with the Department of Environmental Affairs www.envirobotswana.gov.bw), Ministry of Environment, Wildlife and Tourism, Gaborone.

[2] Direct uses refer to livestock, crop production, tourism and wildlife. Indirect uses include wildlife refuge, carbon sequestration, science and education, groundwater recharge and water purification.

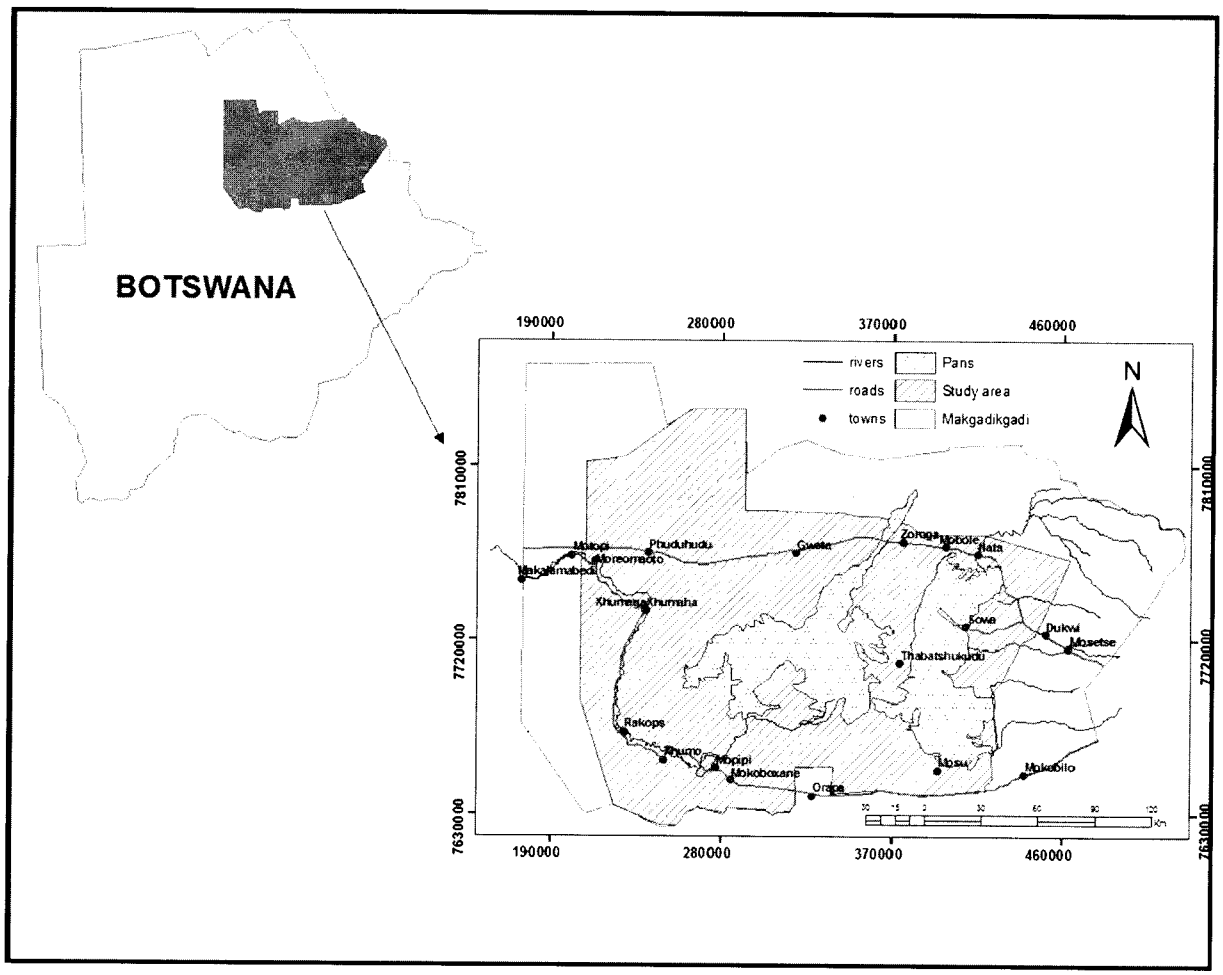

Fig. 1. Map showing the location of the Makgadikgadi wetland.

3.1. Estimation of the direct use value of the wetland's resources to the CBOs

Focus group discussions and interviews were undertaken with the communities, village leaders and trust members. These were used to gain insights on how the wetland is utilised, how the trusts operate, their activities, challenges, benefits and prospects for the future. Structured and semi-structured interviews were held with the chiefs, members of the trusts and representatives from government departments. The data from the FGDs were analysed using financial and economic enterprise models.

Development of the Community-Based Organisations' enterprise models requires the assessment of financial information of the CBOs. Financial reports of the trusts and information from project facilitators and donors provided data used in the financial and economic analyses of the wetland. For the NCT, records dated as far as 1992 and therefore the data attained were fairly substantial for utilisation in the development of the CBO models. For GCT, data were only available for 1 year (2009). Donor funding data were available for a number of years (1997–2010).

Enterprise models were developed based on those of Barnes (2008), Barnes et al. (2001, 2002) and Turpie et al. (2006). They largely follow the models developed for the CBNRM programme in Namibia and those in the Okavango Ramsar site. The enterprise models consist of financial and economic models clearly detailing static, dynamic, budget and cost–benefit excel spread sheet models. These models are purely based on empirical data and assumptions brought together through interviews with the trust operators and resource users as well as through assessment of their financial records. The CBO enterprise models measure both the financial and economic efficiencies of the projects. The former is measured so as to assess the profitability of the project from the project and investors' perspective. In addition, the financial profitability is measured from a point of view of the community itself, that is, how much they are accruing from a project as a community. Measuring economic efficiency, on the other hand, considers contribution of the project to gross and net national incomes, economic rate of return as well as the economic net present values in economic prices. Ultimately, these would show the economic value of these projects as an investment based on the costs and benefits that are directly associated with the projects and their use of the wetland's resources.

Static budget models depict an annual income statement for the enterprise at full production. The static *financial* models, therefore, measure the annual financial net profit attained while the enterprise was at full production. These take into account depreciation on owned capital, interest and amortisation on borrowed capital, government fees, rentals and royalties received by the CBOs. The static *economic* models, on the other hand, measured the annual change in value added to the gross national income (GNI). This was calculated as gross output less intermediate expenditures, leaving all the income earned by the enterprise's internal factors of production including the labour, land, capital and entrepreneurship involved in the enterprise. The value added thus included the annual profits, salaries and wages, payments to and of capital, rentals, royalties and taxes resulting from the enterprise activities all measured at their opportunity cost to the nation. Calculation of GNI as a measure of *national* as opposed to *domestic* income consid-

ered foreign inflows and outflows. The most important measure for the static budget models as indicated was the GNI, but also measured was the net national income (NNI), which was GNI less depreciation.

In order to value the inputs and outputs so as to reflect opportunity costs, shadow pricing was applied. Shadow pricing, as applied in the economic analysis, involved adjustments for unemployment, excess demand for foreign exchange and domestic transfers. Thus, the economic values were measured from the perspective of society.

The *dynamic* cost–benefit models in this case measure financial and economic returns over 5-, 7- and 10-year periods. In appraising projects, the resultant measures are the Internal Rate of Return (IRR) and the Net Present Value (NPV). The NPV analyses the overall value or viability of a project, taking into consideration the time value of money at the opportunity cost of capital or discount rate. The IRR is the discount rate at which the NPV is equivalent to zero. Therefore, should the NPV be negative and the IRR less than the discount rate, then the project is deemed as being non-viable, earning less than the next best investment. Moreover, the higher the IRR, the more attractive the project is. The benefits and cost flows were in constant prices, excluding inflation, and they were discounted at a real rate of 10% for both financial and economic models. The 10% discount rate is the preferred rate in Botswana (MFDP, 1996). All capital expenditures were included, and depreciation or appreciation of capital value was accounted for in the asset residual value in the final year of the cost–benefit analysis.

The models were tested through a sensitivity analysis by changing some variables. This was undertaken in order to determine the robustness of the models and the strength of the conclusions that could be attained from them.

3.2. Groundwater recharge value

For this component, four sectors were identified as being the major groundwater users in the Makgadikgadi area. These include livestock farming, domestic use by households, mining and wildlife. For livestock, data were attained from two sources, i.e. the Departments of Veterinary Services and the 2006 Agricultural Census. Assumptions were made to estimate the livestock numbers in the specific MWS area. In estimating the water consumption by livestock, daily water requirements per head of livestock were used as designed by the Ministry of Local Government. For each type of livestock, the water requirements have been estimated by multiplying the number of animals in that category with the water consumption. It has been assumed that livestock drink from groundwater resources during 9 months of the year; during the rainy season, livestock drink water from surface water resources.

With regard to mining, two mines abstract groundwater in the area. BotAsh (soda ash and salt) has its own well field and buys potable water from the Dukwi well field from the Water Utilities Corporation. For BotAsh, average water abstractions have been estimated based on the annual abstraction data from CSO (2009). The mine accounts for 11% of the abstraction from Dukwi well field with an estimated recharge of 33% of the total water usage by BOTASH mining activities. In regard to the Orapa diamond mine, two well fields fall within the project area. Since most groundwater is mined, only a quarter of the water abstractions from these well fields have been considered for the recharge value.

For the wildlife sector, nine boreholes within the Makgadikgadi National Park are currently operational. Daily pumping rates have thus been considered, and the total rate was multiplied by 365 days to derive the annual abstraction from the boreholes.

For the settlements, the information required was water consumption data and the number of people occupying the area. Population Census data of 2001 were updated to 2009 using an annual growth rate of 2.1%. In the absence of actual water consumption figures for each settlement, design figures for water supply systems were used (Table 1).

Table 1
DWA design manual recommendations. Source: SMEC and EHES (2006)

	Litres per person per day
House connections	60
Individual yard connections	125
Communal standpipes	30

The recharge rate has been assumed to be 65% of the total groundwater abstraction for domestic use.

For this study, the water costs have been estimated based on those from the Maun Groundwater Development Project and those used in the economic valuation of the Okavango wetland (Turpie et al., 2006). A value of P2.75/m^3 was used as the unit value of groundwater in the Makgadikgadi area.

The overall groundwater recharge value of the Makgadikgadi wetland was, therefore, estimated by multiplying the sum of the recharge/abstractions amounts from each sector by the unit value of groundwater. A sensitivity analysis was undertaken to determine the effects of changes in the livestock numbers, changes in the unit price of water and the percentage changes in groundwater recharge as a result of mining activities.

Generally, the study relied considerably on secondary data sources to augment the primary data obtained through FGDs and interviews.

4. Results and discussions

4.1. MWS users, goods and services

The major users are the local communities, particularly the farmers and the natural resource harvesters. Both arable and livestock agriculture are major activities around the wetland and play a significant role in improving the livelihoods of the locals. However, farming is undertaken mostly for subsistence purposes. Communities also engage in harvesting of natural resources, and the harvesters range from the youth to the elderly women and men. As remarked by Turpie et al. (2006) on the value of the Okavango delta, wetland resources form a critical part of rural livelihoods. Natural resource users mostly collect wild foods, plants, grasses, firewood and medicinal plants. Fishing is not common because the wetland is dry for most of the year. The wetland area is endowed with minerals including diamonds and soda ash. Mines contribute significantly to the local and national economy through income and employment generation. The MWS is also an important area for tourism as it possesses rare biodiversity, especially flamingos (McCulloch et al., 2007). Wildlife resources and salt pans are also attractive for tourism. Through the CBNRM programme, communities are involved in tourism activities associated with the wetland system.

The MWS directly and indirectly supports most people living in and on the peripheries of the wetland in various ways through the goods and services it provides. The focus group discussions with the resource users revealed that for the direct benefits, agriculture, especially livestock farming, is most important. Dryland farming is a common livelihood activity and is practised by about 75% of the households in the study area. Although not quantified, to a lesser extent, some households practice floodplain flood recession (*molapo*) farming in areas that are seasonally flooded. (common around Rakops and Mopipi areas). Moreover, 56% of households undertake livestock farming as a way of sustaining their livelihoods.

4.2. Direct use value for community tourism

4.2.1. Financial models

Table 2 gives the results of the financial models for the three CBOs whereby the financial returns and losses to the CBOs were determined for each project investment. The financial returns for XDT are more favourable than the other two trusts. Although the trust incurs substantial financial costs, including investment costs, the net income generated is significant. It must be noted that (XDT) benefits from favourable natural resource conditions and the area have considerable wildlife tourism potential. GCT and NCT both generate negative net present values and low rates of return. The direct economic gross value added to national income by the three CBOs in the MWS amounts to some BWP 990,000.

The community financial values (Table 3) indicate the return for the community on their own investment in the CBNRM project. The table shows that the GCT and XDT derive positive returns on their investments. They also achieve a higher rate of return on investments. The annual cash income that may accrue to the NCT is very small and the communities thus have little investment incentives. This concurs with the communities' view, expressed during focus group discussions, that they do not gain much from the project. Communities are hopeful that the expected joint venture with a commercial tourism operator will lead to more investments and community benefits.

Currently, CBOs do not distribute benefits to individual households but only to the wider community at large. This is primarily because there are no benefit distribution mechanisms in place and there is poor community involvement in decision-making regarding net revenue distribution. At present, most benefits accrue to trust employees. Donor and government funding is the most dominant feature of the community financial analysis; this is due to the fact that the projects rely on external funds, especially for capital expenditures. Therefore, the returns accrued by the communities would be considerable if the subsidies attained are substantial although in the long run, this situation is unsustainable. On the ground, the communities expressed little interest in the projects because currently they do not derive substantial benefits. Support for the projects is, therefore, crucial to ensure that the intended objectives of CBNRM (improved livelihoods and poverty reduction) are achieved. In essence, government, civil society and the private sector should play a role to support the CBOs.

Table 2
Financial values for the operational CBOs in the MWS (BWP, 2010).

	NCT	GCT	XDT
Total financial capital	1,117,960	1,595,084	1,791,507
Capital investment per hectare	49	275	159
Financial gross income	167,598	444,980	1,271,750
Fixed financial costs	228,971	354,092	511,222
Variable financial costs	29,748	130,510	140,574
Annual net cash income	−91,122	−39,622	619,953
Financial rate of return	7.41%	6.16%	14.60%
Financial net present value[a]	−294,813	−627,322	820,855

[a] Using a discount rate of 10%, this rate is an officially accepted figure as per the Ministry of Finance and Development Planning (1996).

Table 3
Financial returns to the community (2010).

	NCT	GCT	XDT
Annual community cash income (BWP)	−27,733	86,397	849,953
Cash income (BWP/ha)	−1.21	14.90	75.35
Financial rate of return (%)	11.55%	17.59%	34.12%
Financial net present value (BWP)	147,901	796,613	2,505,170

4.2.2. Economic models

The economic analysis measures the value of the CBO activity or enterprise for the society as a whole, and this was measured in terms of the change caused in the national income. The results indicate, therefore, that the projects are economically efficient and contribute positively to the national economy of Botswana (Table 4). In the analysis, the return in national income excludes donor contributions from outside the country. This return, thus, reflects the direct use value of the projects. XDT has more capital requirements and generates the highest returns to the national economy as indicated by the net present value of BWP 2,326,946 compared with BWP 77,000 and 181,000 realised by NCT and GCT, respectively. The three projects accrue a positive rate of return despite the fact that NCT and GCT have negative gross and net value added. This is due to the high initial costs of the projects, which exceeded the benefits. However, over a 10-year period, the net benefits increasingly become positive because the CBOs do no longer incur substantial capital costs. The residual value of the assets in the final year is large enough to counteract the losses incurred during the stated period. This thus leads to a positive economic rate of return.

For the sensitivity analysis, changes were made to the Nata Conservation Trust CBO models and the variations were in effect to the capital expenditures, the increase in income as well as a change in the discount rate. A 50% variation in the capital expenditures affects the economic and financial viabilities of the project in a significant way. According to Table 5, a 50% decrease in the capital expenditures results in an increase in the rate of return economically and financially, whereas the viability is weakened after considerable changes in the capital costs. This severely affects the project's financial viability as compared to the economic and community's perspectives. In fact, the rate of return from the point of view of the community fairs higher; thus, the results clearly show that economic and community returns are highly sensitive to changes in capital expenditures.

From the models developed, the financial and economic values derived indicate the potential significance of the trusts in terms of the revenues generated from resource uses within and around the MWS. Furthermore, the models also illustrate the incentives for communities to manage their resources sustainably through CBNRM. Despite the wide range of potentially high revenue generating activities that the CBOs are engaged in as well as the significant donor funds, the communities do not (yet) receive substantial benefits from these projects particularly at household level. Some of the contributing factors to such skewed distribution of benefits are mismanagement of the financial resources and poor governance. The latter is known to be a major challenge for most CBOs in Botswana (Arntzen et al., 2003; Rosemeijer, 2003; von Malitz, 2007).

4.3. Groundwater recharge value

Some wetlands hold water over a wide area such that where it contributes to groundwater recharge it consequently becomes

Table 4
Economic values for the three operating CBOs in the Makgadikgadi area (BWP, 2010).

	NCT	GCT	XDT
Total economic capital	1,027,812	1,474,320	1,656,321
Total economic capital per hectare	45	254.19	146.84
Annual gross value added	−28,550	133,927	920,772
Annual net value added	−110,012	−12,091	757,139
Economic rate of return	10.81%	11%	27%
Economic net present value	77,312	180,912	2,326,942
Number of jobs created	9	10	14
Economic capital cost per job	114,201	163,813	184,036

Table 5
Effects of change in capital expenditures for the Nata Conservation Trust.

	IRR (%)			NPV (BWP)		
	Economic	Project	Community	Economic	Project	Community
Capital expenditure						
50% of base case	18.72	13.06	21.58	577,164	253,955	696,669
Base case	10.81	7.41	11.55	77,312	−294,813	147,901
150% of base case	6.55	4.07	6.82	−422,542	−843,583	−400,869

Table 6
Livestock water consumption in the Makgadikgadi (Mm^3/annum).

	Cattle crush (2009)	Agricultural statistics (2006)
Cattle	2.08	2.76
Goats	0.03	0.18
Sheep	0.06	0.01
Donkeys	0.04	0.11
Horses	0.07	0.03
Total	2.28	3.08
9 Months ground water consumption	1.71	2.31

Table 7
Groundwater recharge value of the Makgadikgadi.

Consumption/recharge by sector (m^3) (2009)	Cattle crush (9 months)	Agricultural statistics (9 months)
Domestic	495,833	495,833
Livestock	1,708,407	2,313,515
MNP	78,665	78,665
Mining	837,642	837,642
Total consumption (Mm^3)	3.12	3.73
Total groundwater recharge value (BWP million)	8.58	10.25

available for abstraction and hence water supply for the surrounding areas. The Makgadikgadi wetland system also provides this service. There are various sectors that rely on groundwater in the Makgadikgadi, and these are as follows: settlements (for domestic and commercial utilisation), livestock, mining and to a small extent wildlife. The value of recharge by sector is discussed in this section.

4.3.1. Settlements

The total annual groundwater abstraction for the settlements is estimated at 0.76 Mm^3 for 2009.

At an assumed recharge rate of 65% of the groundwater abstraction, the groundwater recharge associated with settlements is estimated to be 0.5 Mm^3 per annum.

4.3.2. Livestock

Agriculture forms a critical part of the economy of Botswana, and livestock is essential to this activity. A significant proportion of the rural dwellers (about 68%) are largely involved in livestock keeping for various purposes including sales, household consumption, gifts and drought power. Its importance is additionally enhanced by its cultural function. Using the cattle crush and agricultural census data, livestock water consumption is estimated in Table 6. The higher estimate based on the census is due to the higher livestock numbers.

4.3.3. Wildlife

DWNP in conjunction with the KCS developed nine boreholes and five watering holes in the Makgadikgadi National Park to increase access to water for the survival of wildlife within the park. The hourly water abstractions from the boreholes is 53.88 m^3, and assuming that the boreholes pump water at least 4 h a day, the total annual water abstractions are estimated at 78,645 m^3. These boreholes have been installed with solar pumps, and therefore, when the solar power is insufficient, pumping is very limited, hence the low number of pumping hours. Since this estimate is low, the recharge level has, therefore, been assumed to be equivalent to the recharge.

4.3.4. Mining

BotAsh and Orapa diamond mines rely solely on groundwater for the production and processing of minerals. BotAsh uses process water from its own well field within the Makgadikgadi and obtains potable water from the Dukwi well field through WUC. Abstraction is on average around 0.6 Mm^3 /per annum with an estimated recharge of 0.2 Mm^3. On the other hand, the Orapa diamond mines also source water from their own well fields. The estimated abstraction rate from these well fields is 1.36 Mm^3/annum with an estimated recharge of 0.34 Mm^3 (a quarter of the abstraction). Groundwater depletion around the mines is common especially around the Debswana mines; hence, the 25% assumption has been applied as accruing to the recharge.

In the light of the estimated abstraction and recharge levels by the various sectors, the annual groundwater value was estimated. Considerations have been made with respect to the numbers of livestock and the period of time they consume water in a year. Using the data from the Department of Veterinary services, the MWS is estimated to give a groundwater recharge service of BWP 8.6 million (Table 7). The livestock sector is the largest water user followed by the mining sector. Together, these sectors account for above 80% of groundwater consumption.

5. Concluding remarks

It is important to assess the economic values of the Makgadikgadi wetland given the various goods and services provided. The study demonstrates that community's use of resources around the wetland through CBNRM projects is limited. However, the existing projects are economically viable but financially they are not (except Xhauxhwatubi Trust, which derives significant income from its hunting joint venture partner). Currently, the communities do not accrue many benefits from these projects, and where revenues are generated, the beneficiaries tend to be those who are employed by the CBO but not the community at large. Moreover, these community projects are highly donor dependent, and they cannot yet sustain themselves. Hunting and tourism-based projects generate high values both financially and economically largely because of the resources royalties and rents derived from leasing of land and high value hunting quotas. CBNRM is not pronounced, as demonstrated by the only three operating CBOs in the area; therefore, there is potential for further development of CBOs given the availability of resources within the wetland and the willingness from the communities. The study demonstrates that if developed prop-

erly, CBNRM in the Makgadikgadi can be viable and sustainable in both short and long run and hence could potentially improve the livelihoods of the local communities and enhance poverty reduction.

Mining and the livestock sectors are undoubtedly the highest water users in the region. The groundwater recharge value is high given the demand for groundwater in the area. The groundwater recharge value for the wetland is lower if compared with the BWP 16 million value estimated for the Okavango delta in 2006. The discrepancy is largely related to the sizes of the two systems, temporal variability of ecosystems that the wetlands encompass as well as the population and livestock numbers. Of concern, however, is the ongoing groundwater mining around the well fields. This is mostly in regard to diamond mining and BotAsh activities. Given future increases in water demands, groundwater abstraction will exceed recharge, thus hampering the availability of the resource for the future generations and maintenance of the environment.

The study, therefore, recommends that:

1. Given their vital role in ensuring poverty reduction and sustainable rural development, CBOs need support to improve their performance and focus more on poverty reduction and sustainability. Support should come from government, civil society and constructive partnerships with private companies. Hunting revenues are essential for the financial performance of CBOs. In addition, community water resources management projects should be encouraged to enhance understanding and realisation of benefits of IWRM. Capacity building of CBOs in water resources management should therefore be promoted.
2. Direct and indirect use values of the wetland should be recognised in national wetlands strategies, natural resource management, IWRM policies and strategies as well as economic and development procedures. These values could be reflected, for instance in the prices of products and services derived from the wetland. In essence, inclusion of values in decision-making would facilitate informed coordination, sustainable utilisation and management of the resources within and around the wetland area.
3. Groundwater recharge should be enhanced so that the wetland can support the ecosystem and human activities adequately. Groundwater mining should be kept to a minimum, and water demand management techniques should be encouraged and recharge enhancing land use practices stimulated.

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