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Wildlife conservation and utilisation as complements to agriculture in southern African development

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Abstract

Empirical evidence concerning the economics of various land use alternatives in the semi-arid and arid parts of southern Africa is reviewed. Their potential to contribute to livelihoods, national income, and non-use economic values is investigated. Traditional livestock keeping/agropastoralism, commercial livestock production, commercial wildlife utilisation and wildlife conservation are examined. The findings suggest that, in different settings, each of these land uses can make a positive contribution to national income. Each has an important complementary role to play in development. Each land use category and its components can be allocated to spacial niches at local and national scale, which are likely to maximise the economic value of land allocation. Factors that determine this optimal land allocation include resource constraints (land suitability, markets, stock, inputs), the prevailing spacial distribution of social and tenure systems, and the spacial distribution of non-use economic values.

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1. Introduction

The aim of this paper is to review empirical evidence concerning the economics of various land use alternatives in southern Africa and their potential to contribute to rural development. In particular, the potential for wildlife utilisation is examined, and focus is on the semi-arid and arid parts of the region, Namibia, Botswana, parts of South Africa and Zimbabwe, where agricultural land uses are extensive in nature. In particular, results of research in Botswana, Namibia and elsewhere are presented.

Rural land tenure is split between traditional common property, on communal lands, and private property on commercial lands. Traditional agro-pastoralism and pastoralism are practised on communal land, and commercial agriculture is practised on commercial farms. Within the dual economies prevalent in the region, commercial farms are linked to markets in the modern sector, and agro-pastoralism contributes to the subsistence sector. Historically the latter was neglected in favour of the former, but modern development efforts place emphasis on the traditional economy.

We can examine land uses according to the following major categories:

- commercial livestock production on private land, yielding direct use values from the rangelands in the form of livestock products, mainly beef,

- traditional livestock keeping/agro-pastoralism on communal land, yielding a range of direct use values, including meat, milk, draft power, manure, and store of value, as well as some non-use values,

- wildlife conservation on public land; yielding non-use values to society, including option and existence values,

- commercial wildlife use/production on public communal and private land, yielding a wide range of direct use values from the land; tourism, wildlife products, etc.

The questions we need to be asking are: how rational economically is the current allocation of land between these alternative land uses, in particular between wildlife and livestock? Can wildlife compete with livestock in the development process? What can be done to improve the economic efficiency of allocation of land to various uses?

2. Land use alternatives

2.1 Commercial livestock production

Medium to large scale privately owned or leased farms or ranches produce livestock, either breeding and rearing for slaughter, or purchase of growing stock and finishing for slaughter. Produce, mainly meat, is mostly marketed through the national marketing agencies. Bekure (1982) and Barnes (1998) in Botswana, Barnes and de Jager (1996) in Namibia, examined the economic viability of investment in commercial beef ranching using cost-benefit models. It is capital intensive and has generally low profitability. Speculative purchasing and growing-out of beef animals for slaughter tends to be more profitable than beef breeding and rearing for slaughter.

Analysis in Botswana (Barnes 1994, 1998) showed that in 1991 investment in commercial beef production in the south eastern Kalahari enjoyed a net subsidy (mainly through market grade-price cross-subsidisation). Research in Zimbabwe at the same time (Jansen *et al*. 1992) showed extensive beef producers to be effectively taxed. When commercial livestock budget and investment models are converted to economic (shadow) prices, the contribution to national income per unit of investment is found to be positive but low, while the contribution per unit of

land is commonly moderate. Research has shown that extensive commercial livestock production can be environmentally sustainable, while remaining financially profitable (Fourie *et al.* 1987).

2.2 Traditional livestock keeping/agro-pastoralism

This is the prevalent form of agricultural land use on communal land and consists of small- scale, risk-averse, low-input, livestock husbandry. It yields a range of direct use values, mostly from non-market and non-cash products, including milk, live animal sales/gifts, meat, draft power, manure, and store of value, as well as some cultural non-use values. Commonly associated with this is low-input, low-yielding, small-scale, crop production, drawing on draft power from the livestock. Livestock are mostly cattle with some goats, and crops are mostly millet, sorghum and/or maize. Crop production occupies localised areas, mostly associated with wetlands and/or suitable soils, while livestock are grazed over wider areas, usually within a tenure system tending towards open access. Most of the values produced are consumed by the household, so that these activities tend to be cash consuming rather than cash earning (Flint 1986).

Several workers have attempted to determine the values associated with this form of land use but, due to its small-scale, non-market, subsistence characteristics, valuation has been difficult. All studies seem to have focussed only on the value of the activity to the household. Flint (1986) found, in a detailed study at Pelotshethla near Kanye in semi-arid south-eastern Botswana, that incomes from agro-pastoralism were secondary to non-farm income, and that the potential for agro-pastoralism to boost rural incomes or employment was modest. Nevertheless, he did conclude that arable and livestock income remained a significant and often crucial component of household income. With livestock he found that the median herd size of 20 tended to result in a negative cash balance for households, and that a herd size of 30 or more was necessary for a positive one. Another study in Central District, Botswana, by Bailey (1982) had very similar findings. There was some inconclusive evidence from both studies that, given the small-scale system involved, herd sizes of between 40 and 50 result in maximum efficiency of input use. The cultural non-use values associated with traditional livestock keeping include the “prestige value” perceived by owners and society for livestock ownership. These might help explain why very small herds, apparently inefficient in terms of use values, are kept by many.

Ashley and LaFranchi (1997) assembled data for the Caprivi region in north-east Namibia, and concluded that livestock were important for household livelihood strategies, as they provided a range of benefits complementary to those from other sources. Livestock acted as a drought buffer, a store for reserves and investment, and provided inputs to production, cultural and intangible assets, as well as some food and cash.

Traditional livestock keeping involves less capital than commercial livestock production and its private profitability, in terms of the benefits described above, is moderate. Almost no attempts have been made to measure the economic (shadow-priced) value of the activity. Applying some shadow pricing criteria to the budgets of Flint (1986) indicates a small positive contribution to national income (gross value added) at the median cattle herd size of 20 head. The indication is thus that traditional livestock keeping generally has positive economic use value, but that this is low or moderately low per unit of land.

Traditional livestock keeping has been widely regarded as ecologically unsustainable, resulting in land degradation through vegetation change and erosion. The tendency for open access to grazing on communal land, and the emphasis on live animal values, results in high stocking rates, and intensive use of rangelands. However, irreversible losses of productivity, associated with this intensive use of rangeland have never been scientifically measured. Biot (1988, 1993), Abel *et al.* (1987), Abel and Blaikie (1989), Scoones (1990, 1993), Abel (1993) and others have generated strong evidence, on the contrary, that in much of semi-arid southern Africa, these systems are resilient and productivity decline is negligible or very slow. These intensive grazing systems do result in displacement of wild ungulates, and thus loss of diversity (Barnes, 1998).

2.3 Commercial wildlife use/production

Commercial wildlife use takes place on leasehold/private, communal and public lands. It involves a wide range of activities or potential activities, including wildlife viewing tourism, safari hunting tourism, community wildlife use, game ranching, intensive ostrich and crocodile production and elephant culling. Consumptive products include meat, hides, skins, ivory and live sales. In recent years some research has gone into determining the direct use values of commercial wildlife use in southern Africa (Child 1988; Jansen *et al*. 1992; Bond 1993, 1995; Barnes 1995a, 1995b, 1998). This involved the development of financial and economic budgetary and investment models for different wildlife use activities using empirical data.

The economic characteristics of wildlife use activities are varied. They range from low-input, small-scale, labour intensive subsistence use of low-density, free-ranging wildlife, to capital-intensive farming enterprises with captive breeding and rearing. Activities involve free-ranging wildlife populations on communal and public lands, but some (game ranching, cattle ranching, ostrich and crocodile farming) require leasehold or private land. Tables 1 and 2 show some of the characteristics, and, for comparison, include commercial livestock production. The different activities differ widely in the efficiency of their use of land, capital, labour and management. They are also affected differently by transport costs. The private (financial) profitability of these activities varies widely. The economic (shadow priced) rates of return, as well as the contribution of national income per unit of land, vary even more widely, from low to very high.

For livelihoods among rural communities on communal land, commercial wildlife use activities contribute much needed cash and, as such, are often complementary to other household coping strategies such as livestock keeping and crop production (Ashley and LaFranchi, 1997). The environmental compatibility of commercial wildlife use varies very widely, with tourism activities on the one (compatible) extreme and intensive farming activities on the other (incompatible) extreme. All types of use can be environmentally sustainable (Barnes 1998).

Table 1: Comparative results from financial and economic cost-benefit models for typical wildlife/rangeland use enterprises in Botswana (1991 prices)

	Measure of financial or economic worth			
	Internal rate of return (over ten years)		Economic net present value (pula, @ 6% over ten yrs)	
Wildlife/rangeland use	**Financial (percent)**	**Economic (percent)**	**per square kilometre of land**	**per P'000 initial capital**
Wildlife viewing	18	28	10,177	1,551
Safari hunting	16	38	694	2,230
Community use, high-value area*	26	67	589	5,225
Community use, low-value area*	15	17	22	931
Game ranching	6	7	600	44
Cattle ranching	9	2	<0**	<0
Ostrich farming	18	19	2,301,548	950
Crocodile farming	18	11	2,565,398	525

* Community-based wildlife use projects in high-value area (Chobe enclave) and low-value area (Ngwaketse)
** Net present value negative

2.4 Wildlife and forest conservation

This land use alternative, manifested in public protected areas (national parks, game reserves and forest reserves) overlaps with commercial wildlife utilisation. It can be used to generate some direct use values but is often maintained simply for its non-use value to society, which is made up of *option* and *existence* values (Pearce and Turner, 1990). Option values (the value perceived in society of preserving the resource for later possible use) and existence value (the value perceived by society in simply preserving the resource, even though it may never be used) are *economic* values. They are very difficult to measure, and are reflected as willingness to pay, which can potentially be captured. They are commonly high in developed societies and are probably not very high in rural Botswana.

Table 2: Comparative resource use efficiencies and requirements for typical wildlife/ rangeland use enterprises in Botswana (1991 prices)

Wildlife/rangeland use	Measure of resource use efficiency and requirements			
	P'000 capital* /square km.	**Gross value added**/P'000 capital**	**Labour hours/ P'000 capital**	**Management hours/ P'000 capital**
Wildlife viewing	6.56	462	50.15	4.18
Safari hunting	0.31	512	41.76	6.96
Community use, high value***	0.11	1,066	114.79	17.22
Community use, low value***	0.02	418	235.19	35.28
Game ranching	13.78	137	7.17	1.43
Cattle ranching	7.61	95	12.90	2.58
Ostrich farming	2,422.61	265	12.94	0.81
Crocodile farming	4,884.85	378	20.06	2.41
Elephant cropping	0.60	660	43.51	10.88
Product processing****	2,904.79	153	168.69	6.75

* Initial capital requirements in economic prices
** Gross value added to the national income per annum
*** Community-based wildlife use projects in high-value area (Chobe enclave) and low-value area (Ngwaketse)
**** Medium-scale tanning enterprise

Although little research has been done on the economic non-use values associated with wildlife conservation in southern Africa. Work by Holland (1993) and Oellerman *et al.* (1994), both in South Africa, Barnes (1996, 1998) in Botswana, and Barnes *et al.* (1997) in Namibia, all found strong evidence of willingness to pay for wildlife preservation among visitors to wildlife areas. This suggests that there are significant positive economic values associated with conservation in Botswana and the Caprivi, and that these could be captured and converted to national income. Since these are likely to be significant, and we don't know what they are yet, development should be planned to minimise loss of these values. They are likely to be highest in the more attractive and richest natural areas, which areas also tend to yield the highest direct use values for commercial wildlife use (Barnes, 1998).

3. Development and land use

It is not intended, here, to delve into rural development policies and strategies. It is simply assumed that interventions that result in improved rural livelihoods, as well as increased national income, can be good for development. It is further assumed that the interventions that do this in communal land are especially good. The discussion focuses on how investment in different land uses and in land use allocation can enhance these effects.

Some 30 percent of Botswana's land surface is allocated to wildlife conservation and use. In 1991, this wildlife estate was the subject of a linear programming analysis, aimed at determining the combination of wildlife use activities which can optimise income within the broad policy and land allocation framework in place at the time (Barnes 1994, 1998). An objective function to maximise the overall gross value added (in economic or shadow prices) among ten different wildlife and rangeland use activities on the wildlife estate, within a set of 24 constraints to expansion of these activities. Constraints included capital, labour, management, land stock, feed and raw materials. The analysis assumed expansion of various resource and land uses on the wildlife estate over a period of 15 years. The model did not incorporate price effects and thus the rate of expansion of activities was restricted to that for overall demand. In addition to the various wildlife use activities, commercial livestock production was included in the model, but unfortunately traditional livestock keeping was not. Variations were run which maximised net present value (the value of investment) in economic terms, instead of gross value added. Sensitivities were also run with the less rigid constraints (capital labour and management).

Some results of this analysis are presented in Tables 3, 4, and 5. In Table 3, the allocation of capital need to maximise gross value added is shown, while in Table 4, the allocation of capital needed to maximise net present value is shown. In both tables a series of models are depicted at differing (expanding) levels of available capital, labour and management resources. The results in tables 3 and 4 suggest that emphasis should be placed on non-consumptive tourism, safari hunting, community wildlife use programmes (in higher value wildlife areas), and the intensive production of ostrich and crocodile. As the availability of capital, labour and management increases, the full range of other uses, within their constraints, should be developed. Table 5 shows the results in terms of value added and land requirements for the different activities. Of interest here is that non-consumptive wildlife generates 78 percent of the economic value, but that it requires only 17 percent of the land. Not shown in the table is the finding that, if all activities were fully expanded, optimally within the current constraints, then only 12 percent of all land allocated to wildlife in Botswana would be generating more than 10 pula[1] per hectare in gross value added. This indicates that a large proportion of wildlife land has poor justification for its maintenance through direct use values. This land is mostly in the Kalahari, has low wildlife diversity and numbers and has relatively uninspiring scenery. The areas generating high direct use values are those suited to use through tourism, i.e. areas with scenic and biological diversity as well as high wildlife densities.

[1] The Botswana pula was worth 0,47 US dollars, or 1.34 South African rand at the time of the study

Table 3: Optimal allocation of *capital* to maximise *gross value added* in *all* wildlife use and/or livestock production on land allocated to wildlife in Botswana at different levels of availability of capital, labour and management (pula '000,000, 1991)

	Level of availability of capital, labour and management							
Constraint or wildlife/rangeland use	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Capital (P'000,000)	50	100	150	200	250	300	350	400
Labour (number)	1,500	3,000	4,500	6,000	7,500	9,000	10,500	12,000
Managers (number)	100	200	300	400	500	600	700	800
Wildlife viewing	42.66	88.81	134.95	181.09	227.23	255.81	255.81	255.81
Safari hunting	-	-	-	-	-	6.02	12.15	12.15
Community use, high*	-	-	-	-	-	1.35	1.35	1.35
Community use, low*	-	-	-	-	-	-	1.89	3.20
Game ranching	-	-	-	-	-	-	8.57	8.57
Cattle ranching	-	-	-	-	-	-	15.82	52.63
Ostrich farming	-	-	7.72	11.58	15.44	29.49	44.44	44.44
Crocodile farming	7.33	7.33	7.33	7.33	7.33	7.33	7.33	7.33
Elephant cropping	-	-	-	-	-	-	0.90	0.90
Product processing**	-	-	-	-	-	-	1.74	1.74
Totals	49.99	96.13	150.00	200.00	250.00	300.00	350.00	388.13

* Community-based wildlife use projects in high-value area (Chobe enclave) and low-value area (Ngwaketse)
** Medium scale tanning enterprise

Table 4: Optimal allocation of *capital* to maximise *net present value* in *all* wildlife use and/or livestock production on land allocated to wildlife in Botswana at different levels of availability of capital, labour and management (pula '000,000, 1991)

	Level of availability of capital, labour and management							
Constraint or wildlife/rangeland use	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Capital (P'000,000)	50	100	150	200	250	300	350	400
Labour (number)	1,500	3,000	4,500	6,000	7,500	9,000	10,500	12,000
Managers (number)	100	200	300	400	500	600	700	800
Wildlife viewing	17.39	63.54	109.68	155.82	201.96	248.11	255.81	255.81
Safari hunting	12.15	12.15	12.15	12.15	12.15	12.15	12.15	12.15
Community use, high*	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35
Community use, low*	-	-	-	-	-	-	3.20	3.20
Game ranching	-	-	-	-	-	-	8.57	8.57
Ostrich farming	19.07	22.96	26.82	30.68	34.54	38.40	44.44	44.44
Crocodile farming	-	-	-	-	-	-	7.33	7.33
Totals	49.96	100.00	150.00	200.00	250.00	300.00	332.86	332.86

* Community-based wildlife use projects in high-value area (Chobe enclave) and low-value area (Ngwaketse)

Table 5: Optimal combinations of *all* wildlife use and/or livestock production, to maximise gross value added, on land allocated to wildlife in Botswana, with unlimited availability of capital, labour and management, expressed in terms of number of enterprise units, values generated and land requirements (1991)

	Measure of allocation between activities			
Wildlife/rangeland use	**Number of enterprises**	**Gross value added* (pula'000,000)**	**Net value added* (pula'000,000)**	**Land required** (ha'000,000)**
Wildlife viewing	182	118.27	92.52	3.891
Safari hunting	22	6.22	5.38	3.908
Community use, high***	4	1.44	1.33	1.200
Community use, low***	19	1.33	1.00	13.256
Game ranching	6	1.17	0.82	0.062
Cattle ranching	69	5.02	3.18	0.693
Ostrich farming	18	11.79	10.90	0.002
Crocodile farming	3	2.77	2.51	0.000
Elephant cropping	1	0.59	0.36	3.996
Product processing****	6	0.27	0.18	0.000
Total wildlife only	261	143.85	115.02	26.314
Total wildlife and livestock	330	148.87	118.20	27.008

* Gross value added to the national income per annum, net value added is gross value added less depreciation
** Includes 300 hectares for crocodile farming and 100 hectares for product processing
*** Community-based wildlife use projects in high-value area (Chobe enclave) and low-value area (Ngwaketse)
**** Medium-scale tanning enterprise

Another important finding is the low potential for commercial livestock ranching in the wildlife estate. Optimal allocation of resources on this land would only include some 700,000 hectares of commercial livestock production (2.3% of the land being used). The dependence, for viability, of commercial livestock production on being near to markets, and good transport systems means that it is best sited in less remote areas. In Botswana, commercial livestock production clearly does not threaten wildlife use, economically, on wildlife land.

Work carried out in Caprivi region, Namibia, described by Ashley and Barnes (1996) and Ashley and LaFranchi (1997) and Barnes (1995a, 1995b) tends to corroborate the findings. Here tourism activities were found to have high value and high potential to contribute to the rural development process in the region. As contributors to the livelihoods of rural communities, commercial wildlife use activities are able to contribute much need cash and, as such, are often complementary to other household coping strategies such as livestock keeping and crop production.

It is relevant to examine how these activities can fit together in a spacial context. Barnes (1998) provides a clue. One can envisage a hypothetical gradient from one extreme; most remote, lowest human disturbance and highest biodiversity, to another extreme; least remote (peri-urban), highly disturbed and low biodiversity. One can draw a series of hypothetical *rent-bid diagrams* (as described by Barlowe 1986) depicting the net economic value of all the different wildlife use and livestock production activities along this gradient. These are shown in Figure 1. There will be zones in which the different activities tend to emerge as having highest value. For example, the intensive animal production systems (ostrich, crocodile) are most efficient near to urban centres, while non-consumptive tourism is most efficient in areas that are remote and least disturbed. What emerges is a series of zones along the gradient, in which the different land uses are most suited, technically and economically.

We can also lay these activities out along the same gradient according to their negative impacts on biodiversity, or their negative effects on wildlife non-use, or option and existence values. This is shown in Figure 2. The result is a very similar spacial allocation of activities. This suggests that there is an allocation of land, which, while maximising the combined contribution to national income, also minimises damage to non-use economic values.

4. Conclusion

Several points emerge from the above discussion on the economics of alternative land uses and these can contribute to the development of economically rational policy on land use in the areas of concern.

Commercial livestock production, as a land use in the drier parts of southern Africa, has an important positive economic contribution, but away from the less remote parts this contribution is marginal. Commercial livestock production does not have the economic potential to displace wildlife in most remote parts of the southern African region.

Traditional livestock keeping/agro-pastoralism is a very important contributor to rural livelihoods and appears to have a positive economic contribution. It is suited to moderately remote and less remote areas, but its economic value, including both direct use value as well as cultural non-use values, still requires full measurement and analysis. The nature of the economic tradeoffs between traditional livestock keeping and wildlife land uses needs further study.

In southern Africa, wildlife conservation, mostly in protected areas, may well have positive economic returns on land where non-use values are high, or potentially high. This is likely to depend largely on whether in the future such values can be appropriated by the countries involved and converted into national income.

Commercial wildlife utilisation has high economic efficiency in specific areas within southern Africa, particularly close to or in areas where wildlife conservation is practised. It is emerging as an important, complementary component of the rural development process. However, expansion of these high value uses is constrained, by physical conditions, resource availability, and markets. In the context of national economies, commercial wildlife use will only replace livestock to a limited extent.

All four different land use categories fit within spacial niches, in which they are economically efficient, and can contribute to national income, livelihoods, and the national development process. The total economic value of the spacial mix of land uses can be maximised if development takes place within a spectrum of land use zones in which economic use values are optimised and in which loss of non-use values is minimised. It can be concluded that wildlife has a complementary, rather than competitive role to play, in relation to agriculture.

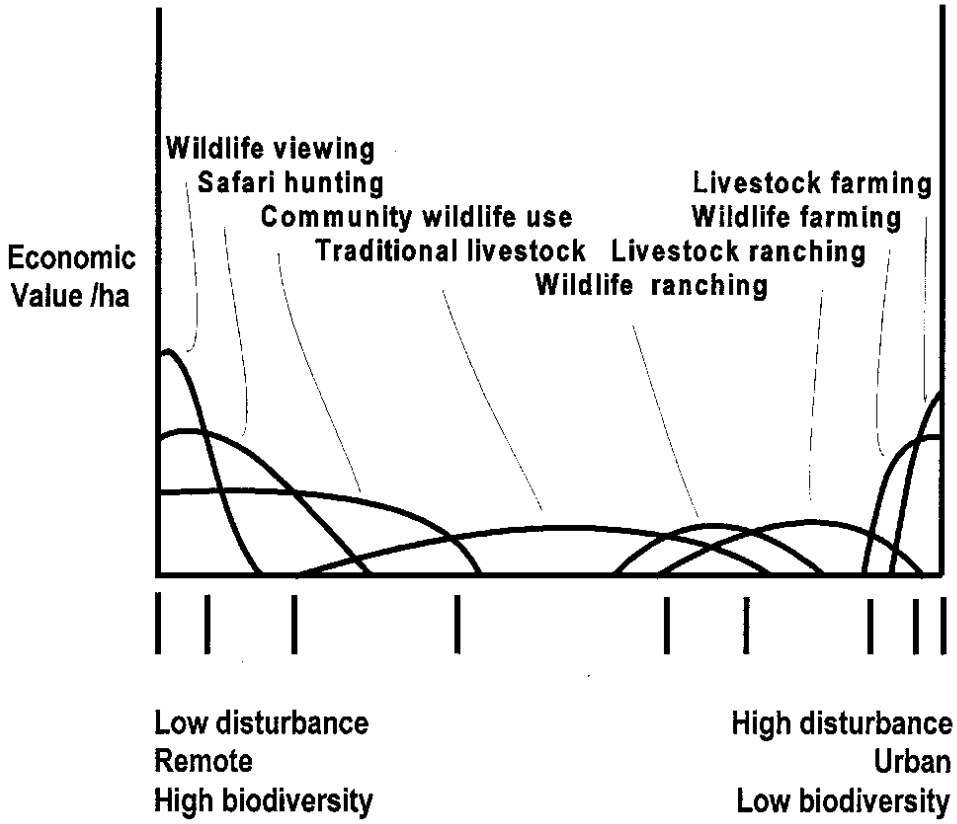

Figure 1: **Hypothetical land rent triangles for different wildlife and rangeland land uses in Botswana, along a gradient of environmental quality, showing zones where specific activities are economically superior in terms of use value.**

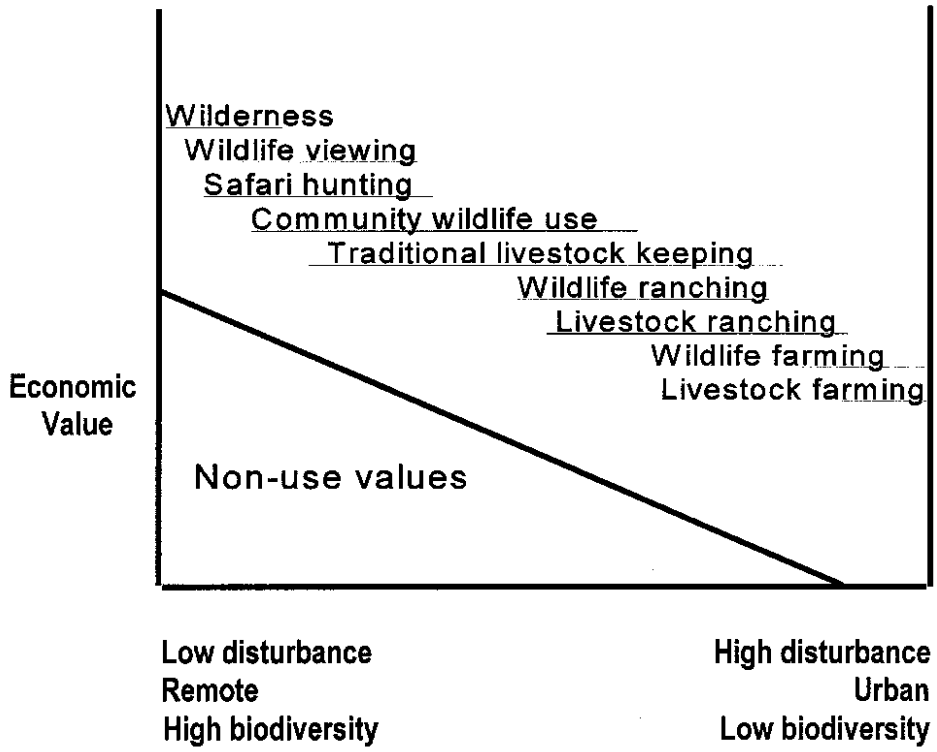

Figure 2: **Hypothetical spread of different wildlife and rangeland land uses along a gradient of environmental quality in Botswana, showing the relationship with likely non-use values for wildlife.**

References

Abel, N.O.J. 1993. Reducing cattle numbers on southern African communal range: is it worth it? In: R. H. Behnke, I. Scoones and C. Kerven (Eds.). *Range Ecology at Disequilibrium: New Models of Natural Variability and Pastoral Adaptation in African Savannas.* London: Overseas Development Institute, pp.173-195.

Abel, N.O.J. and Blaikie, P.M. 1989. Land degradation, stocking rates and conservation policies in the communal rangelands of Botswana and Zimbabwe. *Land Degradation and Rehabilitation* 1: 101-123.

Abel, N.O.J., Flint, M.E., Hunter, N.D., Chandler, D. and Maka, G. 1987. Cattle-keeping, ecological change and communal management in Ngwaketse. Addis Ababa: I.L.C.A., Gaborone: Integrated Farming Pilot Project, Ministry of Agriculture, and Norwich: Overseas Development Group, University of East Anglia.

Ashley, C. and Barnes, J. 1996. Wildlife use for economic gain: the potential for wildlife to contribute to development in Namibia. Research Discussion Paper No. 12, Directorate of Environmental Affairs, Ministry of Environment and Tourism, Windhoek, Namibia.

Ashley, C. and LaFranchi, C. 1997. Livelihood strategies of rural households in Caprivi: implications for conservancies and natural resource management. Research Discussion Paper No. 20, Directorate of Environmental Affairs, Ministry of Environment and Tourism, Windhoek.

Bailey, C.R. 1982. Cattle husbandry in the communal areas of eastern Botswana. Ph.D. Thesis, Cornell University, Ithaca, New York.

Barlowe, R. 1986. Land resource economics: the economics of real estate. Englewood Cliffs, New Jersey: Prentice Hall.

Barnes, J.I. 1994. Alternative uses for natural resources in Botswana: wildlife utilisation. In: S. Brothers, J. Hermans and D. Nteta (Eds.). *Botswana in the 21st Century*. Gaborone: The Botswana Society, pp. 323-336.

Barnes, J.I. 1995a. Current and potential use values for natural resources in some Namibian communal areas: a planning tool. Unpublished Working Document, Directorate of Environmental Affairs, Ministry of Environment and Tourism, Windhoek, Namibia.

Barnes, J.I. 1995b. The value of non-agricultural land use in some Namibian communal areas: a data base for planning. Research Discussion Paper No. 6, Directorate of Environmental Affairs, Ministry of Environment and Tourism, Windhoek, Namibia.

Barnes, J.I. 1996. Economic characteristics of the demand for wildlife viewing tourism in Botswana. *Development Southern Africa* 13: 377-397.

Barnes, J.I. 1998. Wildlife economics: a study of direct use values in Botswana's wildlife sector. PhD Thesis, University of London.

Barnes, J.I. and de Jager, J.L.V. 1996. Economic and financial incentives for wildlife use on private land in Namibia and the implications for policy. *South African Journal of Wildlife Research* 26: 37-46.

Barnes, J.I., Schier, C. and van Rooy, G. 1997. Tourists' willingness to pay for wildlife viewing and wildlife conservation in Namibia. Research Discussion Paper No. 15, Directorate of Environmental Affairs, Ministry of Environment and Tourism, Windhoek, Namibia.

Bekure, S. 1982. The economics of commercial ranches. In: R.K. Hitchcock (Ed.). Botswana's first livestock development project and its future implications. National Institute of Development and Cultural Research, University College of Botswana, Gaborone, Botswana, pp. 209-216.

Biot, Y. 1988. Forecasting productivity losses caused by sheet and rill erosion in semi-arid rangeland: a case study from the communal areas of Botswana. Ph.D. Thesis, University of East Anglia, Norwich.

Biot, Y. 1993. How long can high stocking densities be sustained? In: R.H. Behnke, I. Scoones and C. Kerven (Eds.). Range ecology at disequilibrium: new models of natural variability and pastoral adaptation in African savannas. London: Overseas Development Institute, pp. 153-172.

Bond, I. 1993. The economics of wildlife and land use in Zimbabwe: an examination of current knowledge and issues. Project Paper No. 36, WWF Multispecies Animal Production Systems Project, Harare.

Bond, I. 1995. Wildlife and livestock as options for landuse in Zimbabwe. In: J.A. Bissonette and P.R. Krausman (Eds.). *Integrating people and wildlife for a sustainable future*. Bethesda: The Wildlife Society, pp. 203-206.

Child, B. 1988. The role of wildlife utilisation in the sustainable economic development of semi-arid rangelands in Zimbabwe. D.Phil. Thesis, University of Oxford.

Flint, M.E.S. 1986. Crop and livestock production in the Pelotshetlha lands area: the main report of the IFPP Phase 2 Farm Management Survey (2 volumes). Lobatse, Botswana: Integrated Farming Pilot Project, Ministry of Agriculture.

Fourie, J.H., de Wet, N.J. and Page, J.J. 1987. Veldtoestand en neiging in Kalahari-Duineveld onder n'ekstensiewe veeboerderystelsel (Veld condition and trend in Kalahari Duneveld under an extensive stock production system). *Journal of the Grassland Society of Southern Africa* 4: 48-54.

Holland, J.D. 1993. A determination and analysis of preservation values for protected areas. Ph.D. Thesis, University of Natal, Pietermaritzburg.

Jansen, D.J., Bond, I. and Child, B. 1992. Cattle, wildlife, both or neither: results of a financial and economic survey of commercial ranches in southern Zimbabwe. Project Paper No. 27, WWF Multispecies Animal Production Systems Project, Harare.

Oellermann, R.G., Darroch, D.A.G. and Klug, J.R. 1994. Valuing preferences for wetland preservation: a Wakkerstroom case study. *African Journal of Range and Forage Science* 11: 89-95.

Pearce, D.W. and Turner, R.K. 1990. *Economics of natural resources and the environment*. London: Harvester Wheatsheaf.

Scoones, I. 1990. Livestock populations and the household economy: a case study from southern Zimbabwe. Ph.D. Thesis, University of London.

Scoones, I. 1993. Why are there so many animals? Cattle population dynamics in the communal areas of Zimbabwe. In: R.H. Behnke, I. Scoones and C. Kerven, (Eds.). Range ecology at disequilibrium: new models of natural variability and pastoral adaptation in African savannas. London: Overseas Development Institute, pp. 62-76.

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