21 Beyond Fences: Wildlife, Livestock and Land Use in Southern Africa

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Introduction

The formerly open rangelands and savannahs of the world are increasingly being enclosed by boundaries that demarcate smaller and smaller parcels of land. The resulting changes in the scales at which these landscapes are managed have impacts on both ecological and social processes, and ultimately on system health and human health and well-being. A One Health approach provides a novel conceptual framework within which to examine the issue of fragmentation in southern African rangelands.

Fences of one sort or another now dominate southern Africa's landscapes. Veterinary cordon fences, separating domestic livestock and large wild mammals, are a major feature in many parts of the region (Gadd, 2012). The rapid transition from vast open landscapes with few natural barriers to ones fragmented by roads, railways and multiple boundaries demarcated by fences is, in evolutionary terms, a very recent development. Wire fences first appeared in the region less than 140 years ago. In South Africa, fences demarcating farm boundaries became a legal requirement in 1912 (Salomon *et al*., 2013); however, in the last two decades there have been moves to dismantle fences in order to re-establish wildlife migration routes in several larger conservation landscapes. Groups of farmers on private land have formed conservancies and removed intervening fences that once demarcated internal farm boundaries (e.g. Lindsey *et al*., 2009). Southern Africa is now tentatively experimenting with a return to open rangelands in selected areas, the most prominent example being the development of transfrontier conservation areas (Osofsky *et al*., 2005; Andersson *et al*., 2013).

A move to more open rangelands will require developing a range of social, policy and legal instruments (i.e. institutions) to effectively manage large open landscapes. New methods and approaches will be needed to manage what are essentially common property regimes with varying forms of land tenure, property and resource access rights. Managing the transmission of infectious diseases at a potentially more open human–livestock–wildlife interface will also be a challenge. These issues arise whether it involves a few farmers joining properties to develop a conservancy, or a transfrontier conservation area (TFCA) that encompasses state, private and communal land.

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Managing diseases across international boundaries is also an important consideration in the development of transfrontier conservation areas.

This chapter outlines the context and explores the implications of these transitions from open to closed, and closed to open, landscapes in relation to human health and livelihoods, animal and ecosystem health, and disease management.

Ecological and Historical Context

Southern Africa[1] is predominantly a semi-arid to arid region with some 60% of its 3.4 million km² receiving less than 600 mm of rainfall a year, with high spatial and temporal variability. The result is that extensive domestic animal production systems, rather than cultivation, predominate in more than half of southern Africa. Most of southern Africa's protected wildlife areas occur in the drier parts of the region.

The region carried a rich diversity of large mammals for millions of years, with localized areas carrying 20 or more species of ungulates, ranging in size from the diminutive dik-dik weighing about 5 kg to elephant bulls weighing as much as 5000 kg. This assemblage formed an important component of the livelihoods of autochthonous Khoi-San hunter-gatherers. Approximately 2000–2500 years ago, Bantu migrants from the north brought cattle, sheep and goats to southern Africa (e.g. Denbow and Wilmsen, 1986). Multispecies systems of ungulates, a mixture of wild and domestic herds, shaped the region's open rangelands for about 2000 years. However, substantial areas where tsetse flies, the vectors of trypanosomiasis, occurred were not accessible to domestic stock. The advent of European exploration, settlement and colonial occupation between 1600 and 1900 resulted in the introduction of alien human and animal diseases along with excessive exploitation of wildlife. Introduced human diseases included measles and smallpox, while introduced animal diseases included rinderpest, bovine tuberculosis and canine distemper. The rinderpest pandemic that swept through the region in the 1890s decimated herds of domestic livestock and the remaining, overhunted wildlife populations (Mack, 1970).

The switch from open multispecies systems to closed single-species animal production systems began with the establishment of colonial boundaries and land apportionment based on race. Land reserved for European settlers was divided into farms of varying sizes with freehold title. Reserves under traditional common property regimes were established for Bantu and Khoi-San people. Boundaries between these land tenure regimes shifted with time and changing political dispensations as elaborated, for example, by Murphree and Cumming (1993) for Zimbabwe. With the advent of private ownership of farms, and the subdivision of what were formerly open common-property grazing lands, came the erection of fences to establish farm boundaries and paddocks within farms to control predators. Subdividing and fragmenting formerly open rangelands to manage domestic species (cattle, sheep and goats) inevitably altered ecological processes and plant–herbivore interactions, resulting in long-term implications for biodiversity, ecosystem health and sustainability. Dean and Macdonald (1994) examined the long-term changes that occurred in semi-arid rangelands in the Cape Province of South Africa under livestock farming between 1911 and 1981. In many areas livestock carrying capacity declined by more than 50% during this period. Declines in rangeland productivity for livestock, often accompanied by severe bush encroachment and loss of grazing for cattle and sheep, have occurred elsewhere in the region (Scholes, 2009; Eldridge *et al*., 2011). These changes represented losses of ecosystem services and system health in ecological, social and economic terms with inevitable impacts on human health and well-being in rural areas.

Enclosed Landscapes, Fences and Disease Management

Following the rinderpest pandemic of the late 1800s, there was a slow recovery of wild and domestic ungulates. Game reserves began to be established for wildlife (Cumming, 2004) and livestock were imported into the region to boost the recovery of domestic animal populations. As recovery gained momentum, so did the incidence of animal diseases and their spread from wild to domestic animals and vice versa. The inevitable next step of using fences to separate wild and domestic ungulates soon followed (D'Amico Hales *et al.*, 2004). By the 1960s game-proof cordon fences to control the movements of wildlife and livestock in southern Africa spanned nearly the entire subcontinent from west to east (Fig. 21.1). Formerly open systems were closed and fragmented. Fences were used, in combination with game elimination, to control the spread of tsetse fly (*Glossina* sp.), the vector of trypanosomiasis of livestock and humans, and as a means of separating wildlife from livestock in order to control foot and mouth disease (FMD) and protect subsidized commercial beef export markets. The control measures used are examples of decisions that were made to protect a single sector, with consequences for alternative land uses and the environment, as the following examples from three countries in southern Africa illustrate.

Large-scale game elimination and pesticide applications to control tsetse fly

The most prolific use of fences for the control of tsetse fly and trypanosomiasis, which causes nagana of domestic stock, occurred in Southern Rhodesia (now Zimbabwe). The rinderpest pandemic in the 1890s resulted in the decimation of large mammal populations on which tsetse fly feed. As a result, tsetse fly populations collapsed and only survived in a few isolated pockets in Zimbabwe (e.g. Jack, 1914). By the 1920s, however, tsetse began to spread into their former range and threaten cattle production in both commercial and traditional farming areas. Based on the drastic effect of rinderpest on the wild hosts of tsetse fly, the government introduced a programme of game elimination to contain the

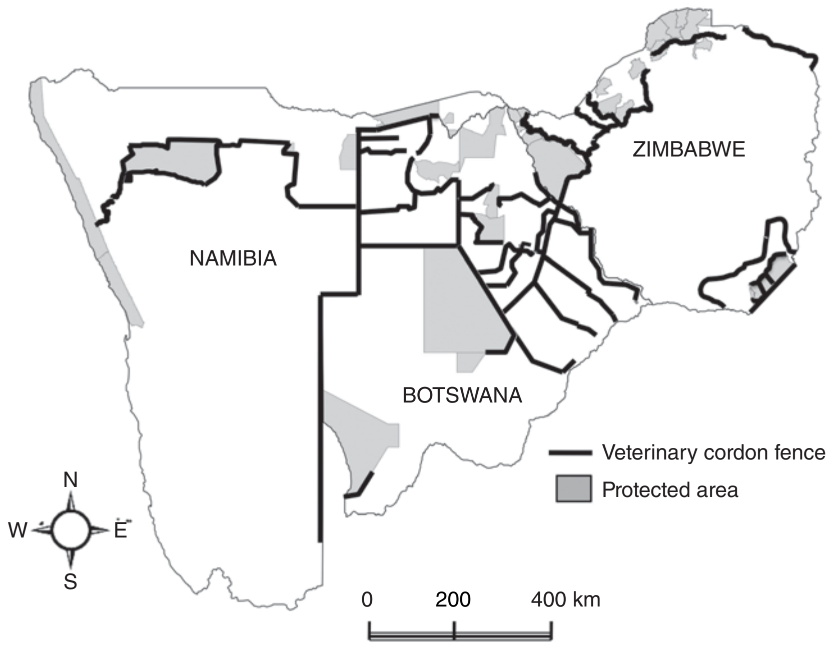

Fig. 21.1. Map of the major veterinary cordon fences used in southern Africa between 1950 and 2010. Some fences in Botswana have been decommissioned. Fences used in tsetse control operations in Zimbabwe have been removed and those used to control FMD have mostly fallen into disrepair (redrawn and modified from maps developed by R.B. Martin).

spread of the fly (Jack, 1923). Child and Riney (1987) provided an analysis of the numbers and species of animals killed on hunting operations between 1919 and 1961. A total of some 660,000 animals of 36 species were killed. Early hunting was directed at the full spectrum of large mammals, including black rhinoceros and elephant, in the designated areas. Tsetse control hunting and the use of game fences also occurred in Botswana[2] between 1942 and 1967 in the southern parts of the Okavango Delta to prevent tsetse fly spreading southwards to Maun (Child *et al*., 1970).

Once techniques had been developed to identify the species on which recently engorged tsetse flies had fed (Weitz, 1963), hunting in Zimbabwe could be restricted to the six primary hosts of tsetse flies, namely warthog (*Phacochoerus africanus*), bushpig (*Potamochoerus porcus*), bushbuck (*Tragelaphus scriptus*), kudu (*Tragelaphus strepciceros*), buffalo (*Syncerus caffer*) and elephant (*Loxodonta africana*). A second phase of selective hunting to halt the spread of tsetse fly began in the 1960s. Fenced corridors, approximately 20 km wide, were established along the advancing fly front. The six primary host species of tsetse fly were eliminated from these corridors. The game elimination corridors, together with adjacent cattle-free buffer zones, served to separate tsetse-infested areas in the Zambezi and Limpopo valleys from livestock farming areas.

In the early 1970s tsetse control switched from elimination of their hosts to the selective application of DDT to resting sites of the fly (e.g. Pilson and Pilson, 1967; Robertson *et al*., 1972), followed by aerial spraying of endosulfan, and the very successful use of odour-baited traps known as targets (Vale *et al*., 1988). Despite site-selective application of DDT, the overall amounts used were high and the pesticide found its way into rivers and the food chain. High levels of DDT and its derivatives were recorded, for example, in the eggs and eggshells of fish eagles nesting on Lake Kariba, and in mothers' milk.

In terms of its objectives, the tsetse and trypanosomiasis control programme in Zimbabwe was very successful. More than 25,000 km^2 of land was reclaimed in order to protect commercial livestock production. Remote and sparsely populated areas of the country were opened for smallholder agriculture and livestock keeping and were rapidly settled by immigrants from elsewhere in the country (Cumming and Lynam, 1997). However, whether these agriculturally marginal areas can now sustain ecosystem health and human well-being, avoid desertification and cope with climate change remains to be seen.

Subsidized beef markets and foot and mouth disease control

Botswana,[2] a semi-arid country of some 600,372 km^2, was mostly an open system almost devoid of fences, but since the building of the first veterinary cordon fences in 1954 and 1955, and the 300 km Kuke fence in 1958, the management of FMD in the country has been dominated by fences. The fences serve to control animal movements and so create and maintain FMD-free areas to meet the requirements of a subsidized beef export industry (Osofsky *et al*., 2008; Gadd, 2012). Whilst successfully meeting the requirements of the beef industry, the fences contributed to the collapse of populations of wild ungulates by interfering with their seasonal movements and blocking access to water in dry years (Osofsky *et al*., 2008; Gadd, 2012). For example, between 1978 and 2003, formerly abundant mobile populations of wildebeest and red hartebeest in the Kalahari system in western Botswana declined by an order of magnitude (Perkins, 2010). Wildebeest declined from 315,000 to 16,000 and hartebeest from 293,000 to 45,000 as a result of fragmentation of their range by game fences. Similar impacts occurred in the Makgadikgadi system as a result of cordon fencing (Perkins, 2010). Fencing around the western, southern and south-eastern edges of the Okavango Delta presently constrains seasonal dispersal of wild ungulates from the delta at the onset of the rainy season. The result is increased pressure on habitats within the delta that may be contributing to the decline of several antelope species (e.g. Mbaiwa and Mbaiwa, 2006; Hamandawana, 2012). However, without those fences inroads by cattle would likely exacerbate degradation.

The impacts of veterinary cordon fences on wildlife populations and their habitats have resulted in a foreclosing of options to diversify land uses involving wildlife and nature-based tourism. As Perkins (2010) has stated:

> The network of veterinary cordon fences in Botswana means that the protected areas have not maintained ecosystem integrity and functioning such that the Government is now locked into expensive and risky forms of manipulative wildlife management … such as fencing and borehole provision. Ironically, the spectacular loss of wildlife in the Kalahari and Makgadikgadi ecosystems, precipitated by the requirements for disease control fencing by the EU beef subsidy, has in turn given rise to a number of often donor-assisted projects to seek ways to try and improve rural livelihoods and achieve sustainable development.

In other words, system health and human well-being have been compromised. Gadd (2012) provides a comprehensive assessment of the wide range of ecological impacts that have resulted from veterinary cordon fencing in southern Africa.

Moving Beyond Fences to Open Systems?

The last two decades have seen a rise in nature-based tourism as an economic driver in land-use change, new potential approaches to disease control and ongoing shifts in subsidized beef export markets that have affected the financial returns from livestock. These changes, combined with increasing conservation concerns, have resulted in a reconsideration of the value of wildlife-based land use and the need to re-establish large, open landscapes. One result has been the creation of private conservancies by amalgamating properties, dismantling internal fences and jointly managing wildlife resources. Notable examples are the development of the Save Valley and Bubye Valley conservancies in south-eastern Zimbabwe, each of which covers more than 3000 km^2 (Lindsey *et al*., 2009). New developments in conservation planning have provided a sound scientific basis for examining trade-offs between alternative land uses to meet conservation and other targets in larger landscapes (e.g. Margules and Pressey, 2000). Progress in conserving areas of exceptionally high biodiversity in the Eastern and Western Cape Provinces of South Africa provides good examples of the application of sound conservation planning to establish large conservation landscapes (e.g. Knight *et al*., 2006; Rouget *et al*., 2006). However, the most ambitious 'beyond fences' initiative in southern Africa is the development of transfrontier national parks and conservation areas.

Developing Transfrontier Conservation Areas

A primary conservation reason for developing Transfrontier Conservation Areas (TFCAs) is to re-establish ecological processes such as large mammal migrations and historical dispersal routes across environmentally artificial national boundaries. Larger conservation areas are also able to conserve a greater number of plant and animal species and are likely to be more resilient to changing climates.

TFCAs include national parks, game reserves, hunting areas and conservancies, embedded within a matrix of land under traditional communal tenure (Osofsky *et al*., 2008; Andersson *et al*., 2013). As a result, TFCAs provide opportunities for biodiversity conservation and sustainable development (e.g. Cumming *et al*., 2013a) and ten terrestrial TFCAs are presently being developed within southern Africa or along the Kunene–Zambezi Rivers (Fig. 21.2). Most of them face resource management issues associated with human well-being (Cumming *et al*., 2013b), as well as disease problems at the interface between wild animals, domestic animals and people (Table 21.1).

The economic rationale for developing TFCAs is based on the realization that southern Africa's charismatic large mammal fauna provides a major local and international tourist attraction. Nature-based tourism is an area in which southern Africa has a high comparative advantage and it contributes as much, if not more, to gross domestic product (GDP) than the livestock industry (Cumming, unpublished data). With a livestock industry growing at about 2% per annum and a tourism industry growing at between 5 and 15%

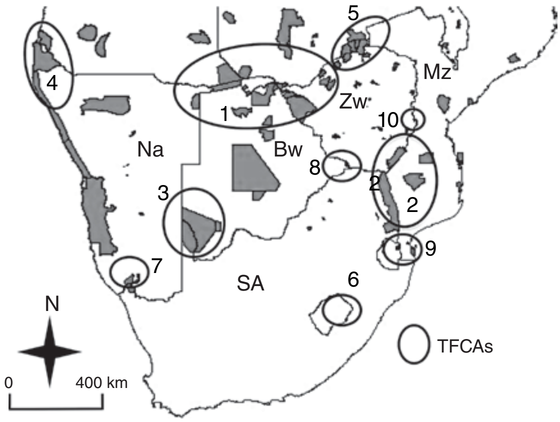

Fig. 21.2. Map of southern Africa showing the location of terrestrial transboundary conservation areas presently being developed. The names of the TFCAs, in order of declining size, are as follows: 1, Kavango Zambezi; 2, Great Limpopo; 3, Kgalagadi Transfrontier National Park; 4, Iona-Skeleton Coast; 5, Mana Pools-Lower Zambezi; 6, Drakensberg-Maloti; 7, Ai-Ais-Richtersveld; 8, Greater Mapungubwe; 9, Lebombo; 10, Chimanimani (see Table 21.1).

per annum, increasing interest is being shown in wildlife-based land use throughout the region.

Open landscapes and the wildlife/ livestock interface

Given southern Africa's long history of investment in fences as a means of separating wild and domestic animals to control disease, it is not surprising that shifting from closed to open landscapes and removing fences is a major issue in implementing TFCAs. It was in this context that the Wildlife Conservation Society's AHEAD (Animal & Human Health for the Environment And Development) initiative convened a 2-day multi-disciplinary forum in partnership with IUCN at the World Parks Congress in Durban, South Africa, in September 2003. The full proceedings of the forum (Osofsky *et al*., 2005) included abstracts, papers and outputs of working groups. The AHEAD programme recognized from its inception that developing an integrated One Health approach[3] (Osofsky *et al*., 2008; Barrett and Osofsky, 2013) in practice is constrained by: (i) the challenges of obtaining funding support for broadly based exploratory and innovative research and development initiatives that might lead to science-based approaches to managing system health; (ii) markedly different policies and practices between countries; (iii) narrow disciplinary training of professionals and limited resources and outlets for interdisciplinary research and collaboration; (iv) competing single resource policies and decisions (e.g. between livestock production and wildlife conservation/tourism); and (v) severe constraints on transboundary research, including movement of researchers between countries.

The AHEAD-GLTFCA Initiative

One of the working groups formed at the 2003 AHEAD launch meeting focused on interdisciplinary research and development issues associated with the interface between wildlife, livestock and human health and well-being in the Great Limpopo Transfrontier Conservation Area (GLTFCA). The GLTFCA straddles the Limpopo River and includes parts of Mozambique, South Africa and Zimbabwe. It covers an area of approximately 90,000 km^2 and includes, within its still ill-defined boundaries, national parks, game reserves, safari areas, private conservancies, commercial farms, communal lands occupied by small-scale farmers, and a biosphere reserve. The landscape is thus highly fragmented, resulting in an extensive interface between

Table 21.1. Important diseases of wildlife, domestic animals and humans and their distribution in the transfrontier conservation areas (TFCAs) being developed in southern Africa (revised from Cumming and Atkinson, 2012).

		Disease														
		Foot and mouth disease	Bovine tuberculosis	Brucellosis	Canine distemper virus	Contagious bovine pleuropneumonia	African trypanosomiasis[a]	Malignant catarrhal fever	Anthrax	Rabies	Rift Valley fever	African Swine fever	African horse sickness	Theileriosis	Heartwater	Echinococcosis and cysticercosis
TFCA	Area km^2	WD	WDH	WDH	WD	D	WDH	WD	WDH	WDH	WDH	WD	WD	WD	WD	WDH
1. Kavango Zambezi	444,000	+	+	+	+	?	+	+	+	+	+	+	+	+	+	+
2. Great Limpopo	87,000	+	+	+	+	–	+	+	+	+	+	+	+	+	+	+
3. Kgalagadi TFP	37,256	?	–	+	+	–	–	+	+	–	+	+	+	–	–	+
4. Iona-Skeleton Coast	32,000	+	–	–	–	–	–	–	+	–	+	?	?	–	–	?
5. Lower Zambezi-Mana Pools	25,000	+	–	+	+	–	+	–	+	–	?	+	?	+	+	+
6. Drakensberg-Maloti	13,000	–	–	+	–	–	–	–	+	+	?	?	?	–	–	?
7. Ai-Ais-Richtersveld	6,681	?	–	–	–	–	–	–	+	–	?	–	?	–	–	+
8. Greater Mapungubwe	4,872	+	–	+	+	–	–	+	+	+	+	+	+	+	+	+
9. Lubombo	4,195	+	+	+	–	–	–	+	+	+	?	?	+	+	+	+
10. Chimanimani	2,056	+	?	?	?	–	–	–	?	+	?	+	?	+	+	?

[a]In southern Africa two *Trypanosoma* subspecies are involved, one of which causes nagana of domestic stock and the other causes human sleeping sickness

W, may infect wildlife; D, may infect domestic animals; H, may infect humans; +, reported from one or more countries involved in the TFCA and likely to be present in the TFCA; –, not reported from the countries involved in the TFCA and unlikely to be present; ?, status uncertain.

people, livestock and wildlife (Cumming *et al.*, 2007; Andersson and Cumming, 2013). Several contagious and vector-borne diseases, both introduced and indigenous (Table 21.1), are present. The northward spread of bovine tuberculosis through Kruger National Park across the Limpopo River and into Gonarezhou National Park in Zimbabwe is of particular concern because of its potential spread to livestock and people in areas where HIV-AIDS is prevalent (Caron *et al.*, 2003; Osofsky *et al.*, 2008; De Garine-Wichatitsky *et al.*, 2010).

Internal and external constraints to change in the status of health (human, animal and environmental) in the GLTFCA exist. The main internal constraints identified include: (i) the complex patterns of land tenure and land use, with overlapping jurisdictions governing both resources and human and animal health; (ii) the high ethnic diversity, historical displacements and population growth; (iii) little consultation with people at local levels; (iv) a lack of baseline information against which to measure progress; and (v) no generally agreed development objectives that are shared across spatial scales and institutional levels by governments, districts, villages, and/or households.

The AHEAD Kavango Zambezi TFCA Initiative

The importance of the Kavango Zambezi (KAZA) TFCA to the region was reaffirmed in August 2011 when the presidents of Angola, Botswana, Namibia, Zambia and Zimbabwe signed a binding Implementation Treaty formally and legally establishing a transboundary area spanning over 444,000 km^2. The KAZA TFCA, located in the Okavango and Zambezi river basins includes, for example, the Caprivi Strip, Chobe National Park, the Okavango Delta (the largest Ramsar site in the world) and the Victoria Falls World Heritage Site. KAZA is also home to many of the world's most charismatic mega-vertebrates, including the largest contiguous population of elephants (approximately 250,000) on the continent. A key economic driver behind TFCAs like KAZA is nature-based tourism, a sector in which southern Africa enjoys a global comparative advantage, as noted.

The WCS-AHEAD programme extended its activities to the KAZA TFCA in 2010. The programme has been focused on facilitating interdisciplinary communication and policy reform relating to transboundary animal diseases within SADC and across agencies responsible for developing the TFCA. Key developments have been the recognition by the SADC Livestock Technical Committee of the potential importance of multispecies systems in relation to the development of TFCAs, and promulgation of the:

> Resolution by the Southern African Development Community (SADC) Calling for Adoption of Commodity-Based Trade and Other Non-Geographic Approaches for Foot and Mouth Disease Management as Additional Regional Standards for Trade in Animal Products

which includes 'The Phakalane Declaration on Adoption of Non-Geographic Approaches for Management of Foot and Mouth Disease' (http://www.wcs-ahead.org/phakalane_declaration.html).

The final section of the three-page declaration is as follows:

> Now, therefore, be it resolved that the Southern African Development Community hereby:
>
> *Recommends* the adoption of commodity-based trade and other non-geographic approaches such as compartmentalization for foot and mouth disease control as additional regional standards for the livestock and wildlife sectors, where applicable;
>
> *Recommends* to Member States that they utilize commodity-based trade and other non-geographic approaches as needed to bolster trade, first and foremost, within the region itself, and with other African partners;
>
> *Recommends* that Member States identify and address their needs to implement non-geographic approaches in terms of institutional, infrastructural, and human capacity;
>
> *Recommends* that SADC work together with the OIE, FAO and other international organizations to formalize the implementation guidance needed for certification, auditing

> and thus wider international acceptance of appropriately prepared livestock-derived commodities by potential importing countries within the SADC region and around the world. This needs to be done in partnership with the private sector and with national veterinary services, the latter having both official responsibility and expertise critical for safe and successful deployment of any animal disease control strategies;
>
> *Recommends* that SADC Member States and their appropriate government agencies responsible for livestock agriculture, veterinary services, and wildlife conservation and production work together and in partnership with the private sector and civil society organizations to promulgate context-appropriate approaches to transboundary animal disease management and wildlife utilization policies that mitigate conflicts at the wildlife/livestock interface.
>
> *Recommends* that Member States seize upon the socioeconomic as well as conservation opportunities offered by SADC's collective vision for transfrontier conservation areas as facilitated by strategic alignment and realignment of selected veterinary cordon fences, while simultaneously expanding access to regional and international markets for animals and animal-derived products via adoption of the above-described enlightened and practical disease control policies and practices.

The WCS-AHEAD programme, in conjunction with WWF, has also supported a study of land-use options in relation to FMD control in Namibia's Caprivi. The Caprivi Region of Namibia (recently renamed the Zambezi Region) lies at the heart of the 440,000+ km^2 KAZA TFCA and an experiment in producing exportable meat from within an FMD-infected zone is underway. The pilot effort tests the potential to release the TFCA from the need for geographically defined FMD-free zones based on veterinary cordon fences. Eastern Caprivi includes national parks, forest reserves and communal agro-pastoral small-scale farming areas, together with several communal land conservancies. Fences within the Caprivi Strip are largely absent and livestock and wildlife share the available range. The Caprivi shares boundaries with Angola, Botswana and Zambia. Game fences occur along parts of the Botswana border. In the past, livestock owners were able to market their livestock through an abattoir in Katimo Mulimo that exported beef to South Africa. More recently, frequent outbreaks of FMD in the area have severely curtailed exports and alternative 'non-geographic' options for disease control to allow beef exports are being explored (Penrith and Thomson, 2012; Barnes, 2013; Cassidy *et al*., 2013). The studies by Barnes (2013) and Cassidy *et al*. (2013) explored various scenarios for wildlife, livestock and disease (FMD) management in the eastern Caprivi, namely: (i) community wildlife conservancies and the status quo in terms of geographical separation of cattle and wildlife; (ii) application of value-chain disease-risk management and commodity-based trade[4] in line with World Organisation for Animal Health (OIE) guidance allowing the export of appropriately processed de-boned beef; (iii) development of community wildlife conservancies as for scenarios (i) and (ii) but with the addition of cooking meat as part of processing; and (iv) the introduction of fenced FMD-free compartments within the Caprivi. The results of a thorough economic analysis of the four options indicated that commodity-based trade was the most efficient at both national and local levels (Fig. 21.3) and offers the greatest potential to optimize economic and environmental trade-offs, maximize economic returns and effectively integrate livestock- and wildlife-based enterprises.

As Barnes (2013) concluded:

> initiatives aimed at introduction of CBT [commodity-based trade] as part of a value chain approach to sanitary risk management offers significant economic potential. At the same time, this approach can assist in meeting other TFCA objectives such as maintenance of diverse ecosystems with greater biodiversity across large, connected landscapes – reducing risk to natural systems and providing greater resilience in the face of, for example, natural catastrophes, disease outbreaks and climatic challenges.

Cassidy *et al*. (2013), using a comprehensive multi-criteria decision analysis (MCDA) framework, examined an essentially similar set of development options and scenarios for the Caprivi. Their analysis, using 18 criteria, was

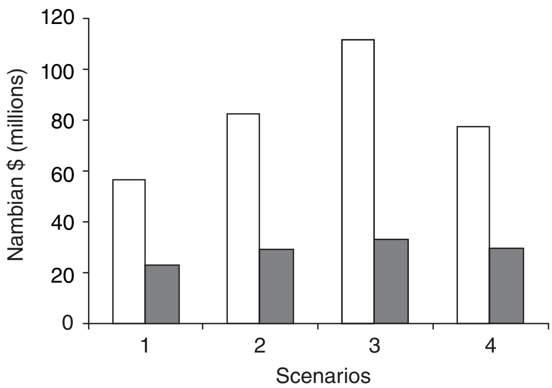

Fig. 21.3. Annual contributions to net national income (open columns) and to private incomes (filled columns) for four policy option scenarios (Namibian dollars, 2012). Scenarios: 1, status quo; 2, commodity-based trade of deboned steak; 3, commodity-based trade of deboned steak and cooked meat; 4, fenced foot and mouth disease-free areas (data from Barnes, 2013).

able to include an additional range of social and environmental factors. They reached similar conclusions to the analysis by Barnes (2013). Overall, the analysis yielded positive net flows for scenarios based on commodity-based trade (scenarios 2 and 3) and negative net flows for the status quo and fenced FMD-free compartments (scenarios 1 and 4).

Open Landscapes, Health and Multispecies Systems

The nascent moves in southern Africa towards a return to open landscapes raise several ecological, social and economic questions. In the context of One Health, a key question is whether open landscapes and multispecies systems in arid and semi-arid rangelands are likely to result in improved livelihoods and healthier people, healthier wild and domestic animals and healthier ecosystems. An equally important question is: how feasible is it to establish multispecies systems given present land tenure and land-use systems? Clearly, areas with high and reliable rainfall and rich soils that can sustainably support intensive agriculture will be excluded from consideration. It is within the drier savannahs and arid rangelands that cover some 60% of southern Africa (and include most of the region's TFCAs) that the development of open systems may be most appropriate.

The ecological basis for maintaining open, multispecies systems in African savannahs is well established. African savannahs support a higher diversity of ungulate species than any other biome or continent. This diversity is functionally linked to the characteristically high spatial heterogeneity and plant species diversity of African savannah ecosystems (du Toit and Cumming, 1999). In turn, the range in body size and feeding strategies within intact ungulate communities (usually 20 or more species) has strong feedbacks on rangeland structure and function. Replacing this tightly coupled system, which evolved over millions of years, with one or two species of livestock at high densities has been responsible for the loss of plant species diversity and rangeland degradation over extensive areas (e.g. Dean and Macdonald, 1994; Milton *et al.*, 1994). Associated with reduced diversity and heterogeneity is declining resilience in the face of highly variable spatial and temporal patterns of rainfall, frequent droughts, and increasing aridity as a result of climate change.

Many wild ungulates move seasonally to take advantage of widely distributed key resources. Seasonal variability in access to water is a key driver of movement, resulting in dry-season concentrations at water points but with dispersal during the wet season. Spatial and seasonal changes in the availability of food and key nutrients, such as phosphorus required by pregnant and lactating animals, may also drive migrations such as those of the wildebeest in the Serengeti. Access to spatially dispersed key nutrients, such as sodium, calcium and phosphorus, may play an important role in the seasonal movement and migration of ungulates (Murray, 1995). Migratory species tend to occur in numbers that are an order of magnitude greater than sedentary species (Fryxell *et al.*, 1988) as a result of their ability to take advantage of key resources, move to fresh pastures, and escape predators that are not able to follow them.

In southern Africa both wild and domestic animal seasonal dispersal patterns and migrations have been greatly curtailed by fences and changes in land use. However, it is possible for migrations to be re-established, as the recent removal of cordon fences separating the Makgadikgadi and Chobe components of the KAZA TFCA in Botswana has shown (Bartlam-Brooks *et al.*, 2011). Zebra have re-established an annual migration that preceded the living memory of the current zebra population, involving a round trip of approximately 500 km between the Nxai Pan and Chobe National Parks. Some consideration is now being given to the potential advantages of re-establishing herding in the management of livestock on communal rangeland in South Africa (Salomon *et al.*, 2013) and northern Namibia (Namibian Economist, 2011). The ecological, socio-economic and system health ramifications of restoring animal migrations and seasonal movements over larger landscapes have still to be more fully researched – as does the question of where in the region they may be re-established to best advantage.

The social and cultural features relating to multispecies systems have not, to our knowledge, been specifically investigated. On private land in southern Africa landowners control the management of livestock and wildlife within the constraints of national policy and legislation. On communal land stockowners manage their herds but the legal use of wildlife is generally controlled by the state. However, in this case, both grazing and wildlife are common property resources. As such both resources may be subject to the 'tragedy of the commons' (Hardin, 1968) or instead be managed under adaptive co-management regimes that sustain resources and achieve an equitable distribution of benefits through community-based natural resource management programmes (Suich *et al.*, 2009). Few, if any, of these programmes cover large landscapes. In addition, appropriate institutions to manage multispecies systems in landscapes covering a diversity of tenure (and national) systems, such as occur in TFCAs, are yet to emerge.

The financial and economic viability of wildlife-based land use on private ranches in southern Africa is well established and is evidenced by the rapid increase in game ranching in the region over the last 50 years (e.g. Jansen *et al.*, 1992; Van Schalkwyk *et al.*, 2010). Community-based natural resource management focused on benefits from wildlife-based tourism has experienced varying levels of success (Cumming *et al.*, 2013a). Arguably the most successful programme has been in Namibia, where 71 community wildlife conservancies (that include wild and domestic ungulates) have been registered. Wildlife populations and associated returns to both local and national economies from conservancies have shown continuing growth over a period of 15 years (e.g. Suich *et al.*, 2009; Van Schalkwyk *et al.*, 2010). However, in Namibia and elsewhere in the region, many key issues related to resource management and equitable distribution of returns from common property resources to individuals and households remain to be resolved. Cumming *et al.* (2013b) review many of the constraints and issues being faced in realizing both conservation and improved livelihoods for rural people in the development of TFCAs in southern Africa (see also Suich *et al.*, 2009 and Torquebiau and Taylor, 2009). Despite the difficulties facing the development and extension of wildlife and multispecies systems as recognized, productive forms of land use in the region, their economic contribution is significant.

Zoonotic and non-zoonotic diseases and their influence on health in southern African rangelands, in the sense of improved human, animal and ecosystem health, is a central issue in moving beyond fences and towards open landscapes in TFCAs and elsewhere (Osofsky *et al.*, 2005, 2008). The interactions between disease management at the human–animal interface and the livelihoods of rural people are complex (Fig. 21.4). They are greatly influenced by cross-scale dynamics of export markets, global pricing structures and subsidies for commodities such as beef, and by global economic trends that affect the ability of tourists to visit wildlife areas.

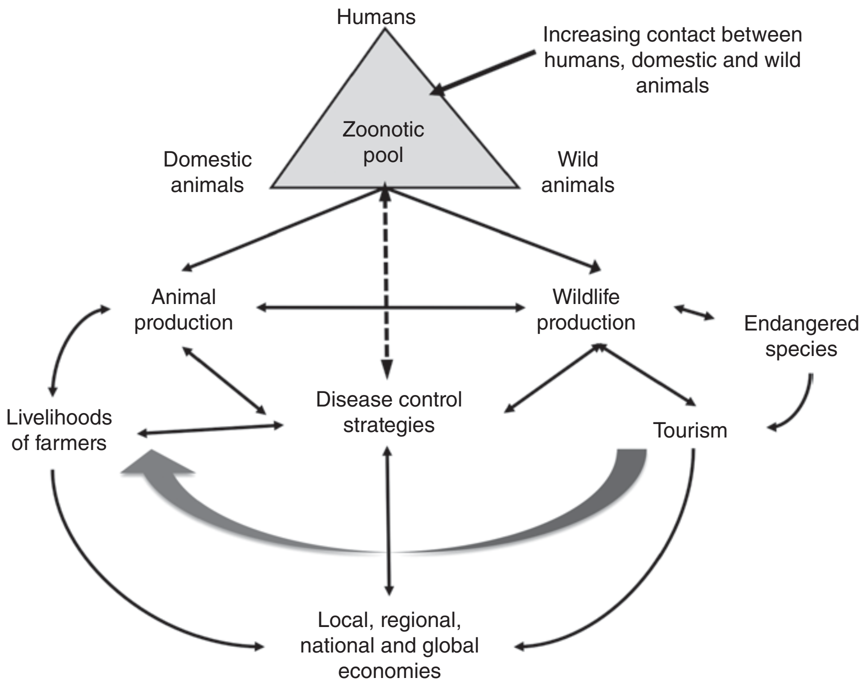

Fig. 21.4. Diagram showing the linkages between wild and domestic animals and humans and the central role of disease management strategies in influencing land use, livelihoods and economies at different scales (modified after Cumming *et al.*, 2007).

Concluding Comment

Perhaps the greatest contribution that a One Health approach has brought to the debate about land use, fences and disease management in southern Africa is the importance of interdisciplinary and cross-sectoral approaches to resolving critical issues of development, system health and sustainability. In part, key debate and dialogue has been fostered by the AHEAD initiative in its involvement in the Great Limpopo and Kavango Zambezi TFCAs and is reflected in the following key questions that need to be addressed at the scale of large landscapes (revised from Cumming *et al.*, 2007).

1. What types and patterns of land tenure will enhance system health, productivity and resilience (sustainability) of the social-ecological system (SES) of the landscape or TFCA in question?
2. What is the state and trend of the five capitals (natural, human, social, financial and physical) in each land-use/land tenure component of the landscape/TFCA and how might these change and influence system health under differing development scenarios?
3. How will the biodiversity, environmental, social and economic trade-offs and opportunity costs of alternative patterns of land use influence adaptability and resilience of the SES?
4. What cross-subsidies exist within the system and how vulnerable are they to disturbance or shocks?
5. What are the levels of external subsidy to the landscape/TFCA system and how dependent is the system on, or vulnerable to, external subsidies?
6. How do external subsidies support or hinder the development of self-organization, adaptability, transformability and resilience of the SES?

There is little doubt that large, open landscapes that simulate or restore the functional integrity of southern Africa's rangelands are greatly undervalued. A recent comprehensive study of land use in the UK, in which the full value of ecosystem services was included, revealed the bias (and thus weakness) that is inherent in valuing rural land only in terms of its agricultural value (Bateman *et al.*, 2013).

While southern Africa does not have at its disposal the depth of detailed information that is available in the UK, the region would do well to move towards a much more in-depth analysis of the value of alternative (and potentially complementary) land-use options.

Notes

[1] In the context of this chapter southern Africa refers to the area south of the Kunene–Zambezi rivers and includes Botswana, Lesotho, part of Mozambique, Namibia, South Africa, Swaziland and Zimbabwe.
[2] Formerly Bechuanaland, a British Protectorate until independence in 1966.
[3] The collaborative effort of multiple disciplines – working locally, nationally and globally – to attain optimal health for people, animals and the environment (AVMA, 2008).
[4] While there is no single accepted definition of commodity-based trade (CBT), it is considered to represent an array of alternatives that can be used to ensure that the production and processing of a particular commodity or product are managed so that identified food safety and animal health hazards are reduced to appropriate risk levels. OIE Terrestrial Animal Health Code guidelines now recognize a disease management scenario under which commodity-based trade, a non-geographic approach to disease management, could be effectively implemented.
[5] In this context 'health' refers to animal, human and ecosystem health – the One Health concept.

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