

A decade of biodiversity conservation and use in South Africa: tracking progress from the Rio Earth Summit to the Johannesburg World Summit on Sustainable Development

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This paper analyses key achievements, gaps, constraints and opportunities within South Africa's biodiversity sector since the Rio Earth Summit in 1992, and some of the difficult trade-offs faced in attempting to marry the country's pressing development needs with those of conservation. A suite of diverse issues is examined, including threats to biodiversity, such as those from habitat transformation, alien invasive species, overexploitation and genetic engineering; the difficulties of 'mainstreaming' biodiversity at all levels of planning and decision-making; and strategies for conservation and development such as protected area management, transfrontier conservation areas, community-based management, wildlife tourism and bioprospecting. Attention is also paid to commercializing South Africa's biodiversity, exploiting traditional knowledge, the current state of funding, and the status of knowledge, research and information about biodiversity in the country. The past ten years have witnessed profound paradigm shifts in conservation in South Africa: from a strictly protectionist approach, towards one that recognizes the need to use biodiversity sustainably and to involve the community in conservation. Despite remarkable achievements since the Earth Summit — including the development of a widely accepted national policy on biodiversity and an expansion of the country's protected areas — biodiversity loss continues, with South Africa having the highest known concentration of threatened plants in the world. Few of the priorities for implementation listed in the 1997 Biodiversity White Paper have received adequate attention. Serious constraints preclude more effective management of the country's biodiversity: these include insufficient skills, expertise and funding, legal fragmentation, the inadequate integration of biodiversity considerations into sectoral and land-use plans, and weak political commitment. Redress requires us urgently to adopt a uniform and progressive legislative framework for biodiversity conservation and use; develop a national strategy and action plan for biodiversity; and 'mainstream' biodiversity into existing development and environmental planning. Also needed are clear, unambiguous criteria and principles for quantifying biodiversity loss in the long term against socio-economic gains in the short to medium term. Success requires political commitment and leadership.

Introduction

South Africa stands proud as the third most biologically diverse country in the world, containing between 250 000 and 1 000 000 species, many of which occur nowhere else.¹ It has a rich and spectacular array of ecosystems and landscapes, rang-

ing from desert to subtropical forest, as well as a great diversity of marine and coastal systems. These resources underpin the livelihoods of millions of South Africans and contribute significantly to the country's economy. Yet South Africa's biodiversity is one of the most threatened on the planet.

Substantial post-Rio changes to the conservation and management of biodiversity in South Africa have come about predominantly through democratization, but also by the international paradigm shifts about ways in which our natural heritage can and should be conserved and used. No longer is biodiversity an issue confined to a handful of die-hard conservationists and wildlife enthusiasts. Its critical importance to farming methods and communities, to indigenous peoples and their livelihoods, and to human rights, political dispensations and global trade issues, are now well recognized. Biodiversity has moved from the realms of 'saving the rhino' to affect us all by encompassing politics, culture and economy.

This review describes trends in the conservation and use of biodiversity in South Africa over the past decade, as a contribution towards a global review of these activities for the forthcoming World Summit on Sustainable Development in Johannesburg in August/September 2002. The paper does not cover comprehensively all issues that relate to, influence, or are affected by biodiversity. Instead, it analyses key achievements, gaps, constraints and opportunities within the biodiversity sector since 1992, as well as some of the difficult trade-offs continually faced in attempting to marry the country's development needs with those of conservation.

Focus areas have been identified through a comprehensive review of the literature over the past ten years, through submissions from concerned parties within various policy and discussion forums, and through analysis of the present policy imperatives of the South African government. A suite of issues has been identified, ranging from threats posed to biodiversity from alien invasive species, habitat transformation, climate change, and the overexploitation of resources, to strategies for conservation and development, including the management of protected areas, community-based conservation and co-management, wildlife tourism and bioprospecting.

The context and history of biodiversity conservation and use in South Africa are described, together with analysis of the sector in 1992 (the year in which Agenda 21 and the Convention on Biological Diversity (CBD) were adopted), and an overview of the current legislative, policy, and institutional framework for biodiversity management in the country. Key issues for biodiversity management in South Africa are identified and discussed, and recommendations are made to guide decision-makers.

Where have we come from?

'The environment [also] suffers from a perception that it is a white, middle-class issue focused on nature conservation, that is

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not relevant to the urgent needs of the country for development and social justice²

In the last ten years, conservation in South Africa has moved squarely into a socio-political arena concerned with human rights, access to natural resources, equity and environmental sustainability. This has not always been so. Biodiversity conservation is deeply embedded in the country's turbulent past of colonialism and apartheid, and, historically, followed a protectionist approach, regarding people as separate from nature, and to be kept away from it.

Conservation was also associated with protected areas that served a privileged elite, and restricted access to natural resources often involving the forced relocation of black communities. Far from being seen as a national asset and heritage by the majority of South Africans, conservation in 1992 was viewed with suspicion, a situation exacerbated by perceptions that the apartheid government was more concerned about preserving wildlife than about the poverty and oppression faced by most of its people.³

This history has largely obscured South Africa's substantial achievements in conserving biodiversity. Twentieth-century government policies were extremely supportive of biodiversity conservation and of developing the scientific capacity to manage biological resources. Efforts to save threatened species and develop a system of protected areas were especially remarkable,⁴ earning global recognition for the country's nature conservation practices. Also noteworthy was the expansion of nature conservation functions to private lands through natural heritage sites, conservancies and biosphere reserves.

Support for conservation had limited focus, however, and was often conditional upon matching the political objectives of the colonial and apartheid governments. Sustainable use, for example, although long touted as a national policy,⁵ focused in practice largely on recreational hunting and fishing, and took place outside the pressing development needs of the majority of the populace. Similarly, protected areas were established on land considered marginal for agriculture or undesirable for rural settlement, rather than following any plan to represent biodiversity patterns and processes. Despite growing support for conserving ecosystems and landscapes outside protected areas,^{6,7} conservation was not integrated into an national land-use strategy for the country, nor was biodiversity brought into sectoral plans and programmes. Biodiversity conservation was equated with nature conservation, which, in turn was equated with the management of protected areas.

Apartheid created a fragmented, uncoordinated and polarized set of institutions. Before the 1994 election, no fewer than 17 government departments had a primary responsibility for nature conservation, and many of these had divergent and sometimes conflicting laws.⁶ Commentators have suggested that South Africa's excellent record of conserving biodiversity occurred more by default than by design,⁸ driven by the committed efforts of many individuals and non-governmental organizations. Fragmentation also undoubtedly hindered attempts to construct a coherent approach for conserving biodiversity, and to integrate biodiversity considerations into national decision-making.

In the early 1990s, a compelling suite of new biodiversity issues emerged internationally concerning equity, social justice and power relations. These, in addition to the ones traditionally focused on conservation and use, framed the development of the CBD and the text of Agenda 21. Important questions arose about the commercial use of biodiversity, and the need to share its benefits with the countries and communities of origin. Increasingly, the vital role of traditional knowledge in

biodiversity conservation was acknowledged. Concern was growing about the patenting of life and the risks associated with genetic engineering, and the contribution of local communities in managing protected areas was receiving prominence. South Africa's political exclusion at the time largely isolated the country from such debates and their relevance to the conservation and sustainable use of biodiversity.⁹ Furthermore, the country lacked the capacity to deal with these complex issues. Its biodiversity managers were almost exclusively natural scientists who had little understanding or interest in the wider social and political issues.

A coherent and integrated policy on biodiversity in South Africa had long been recognized, but political changes in 1994, combined with South Africa's ratification of the CBD in 1995, brought new urgency: a new direction was soon to emerge.

The legislative, policy and institutional framework for biodiversity management in South Africa

Laws and policies

The democratic election of 1994 was the catalyst for a series of fundamental changes to South Africa's legislative, policy and institutional framework for biodiversity management. In the environmental field alone, some seven policy processes were initiated, including those relating to environmental management, biodiversity, forestry, water, fisheries, sustainable coastal development, and integrated pollution control, as well as a range of relevant policies concerning land, energy, trade and industry, tourism, education and science and technology.

The 1997 Biodiversity White Paper establishes South Africa's central policy. Before democracy, civil society had enjoyed little influence on decisions about biodiversity, and was not represented on any of the formal structures set up to consider its conservation and use. In 1995, the South African government initiated a national consultative process to develop a policy and strategies for biodiversity and to ensure that it reflected the interests and aspirations of all South Africans. Various draft policy documents^{10,11} were drawn up and discussed under the guidance of a national reference group, and a national conference¹² and workshops involving concerned parties were held. Breaking markedly from past approaches to biodiversity conservation in South Africa,^{13,14} the end result, adopted by Cabinet in 1997, is a comprehensive policy, with six main goals and supporting objectives that follow the themes of the CBD (Table 1).

In addition to the CBD, South Africa has signed many other international agreements on biodiversity conservation and use, including regional agreements and initiatives, and conventions relating to wetlands, migratory species, trade in endangered species, desertification and world heritage. Although the government participated actively in developing the Cartagena Protocol on Biosafety, it has not yet signed this agreement. Significant, however, is the strong emphasis on biodiversity conservation by the New Partnership for Africa's Development (NEPAD), and the use of biodiversity as an economic strategy for the continent.¹⁵

Institutional arrangements for biodiversity management

The Department of Environmental Affairs and Tourism (DEAT) is the lead institution charged with administering the CBD and formulating national norms and standards for biodiversity management. Implementation of the White Paper is, however, undertaken by different government institutions at central, provincial and local levels. Such institutions are also responsible for implementing other relevant policies and laws. Nationally, these include: the departments of Water Affairs and

Table 1. Goals and priorities of the 1997 Biodiversity White Paper.**Goals**

1. Conserve the diversity of landscapes, ecosystems, habitats, communities, populations, species and genes in South Africa.
2. Use biological resources sustainably and minimize adverse impacts on biological diversity.
3. Ensure that benefits derived from the use and development of South Africa's genetic resources serve national interests.
4. Expand the human capacity to conserve biodiversity, to manage its use, and to address factors threatening it.
5. Create conditions and incentives that support the conservation and sustainable use of biodiversity.
6. Promote the conservation and sustainable use of biodiversity at the international level.

Priorities

1. Develop an action plan through which detailed implementation strategies can be developed.
2. Obtain a political commitment from all relevant ministers and senior provincial representatives towards achieving the objectives of the policy (such as through approved sectoral plans and budgets for relevant central and provincial departments and institutions).
3. Address concerns relating to the fragmentation amongst nature conservation agencies.
4. Secure necessary funding for implementation.
5. Strengthen and rationalize South Africa's protected-area system.
6. Establish legal and administrative mechanisms to control access to South Africa's genetic resources.
7. Institute a national biodiversity education and awareness plan.
8. Participate in the development of an international Biosafety Protocol and instituting appropriate measures for biosafety.

Forestry (DWAF); Agriculture; Arts, Culture, Science and Technology (DACST); Health; Trade and Industry; South African National Parks (SANP); and the National Botanical Institute (NBI). At the provincial level, environmental and conservation departments as well as provincial departments of agriculture and regional offices of DWAF are responsible for implementing an array of policies and laws aiming to conserve biodiversity. The South African Constitution gives concurrent legislative competence to national and provincial governments for most functions relevant to biodiversity conservation.¹⁶ National parks, botanical gardens and marine resources are, however, an exclusively national competence.

At a broad political and strategic level, Cabinet and directors general remain responsible for making decisions across national departments, in addition to the Committee for Environmental Coordination (CEC), established in terms of Chapter 2 of the 1998 National Environmental Management Act (NEMA), and comprising the directors general of ten national departments and the heads of provincial environmental departments, as well as a representative from local government. Issues relating to biodiversity and heritage are considered by a working group established under MINTEC, a technical committee set up to support the work of MINMEC, which, in turn, is a ministerial forum that addresses coordination between national and provincial governments. Focused committees are also constituted under the Biodiversity and Heritage Working Group. Within the Branch: Marine and Coastal Management Coordination of DEAT, a technical working group on marine biodiversity comprises mainly government officials, with representatives from academe.

No national forum exists for involving non-governmental stakeholders in biodiversity management, although NEMA provides for the establishment of a National Environmental Advisory Forum, a body that has yet to be constituted. Government tends to canvas participation of interest groups on an informal and issue-to-issue basis (for instance, the ratification of the Biosafety Protocol), or for specific projects (such as the Cape Action Plan for the Environment project). To enable dialogue among interested parties, formal institutions have been created in certain sectors (for example, the National Forests Advisory Council of the National Forest Act) and at provincial and local levels (such as the local conservation boards in KwaZulu-Natal, which aim to promote local involvement in managing protected areas).

Key issues

The administrative and legal changes described above have profound implications for the use and conservation of biodiversity in South Africa. By chance, they coincided with the post-Rio implementation of Agenda 21 and the CBD, which makes it difficult to attribute specific trends to the Rio agreements. This section analyses the key achievements, gaps, constraints and opportunities within the biodiversity sector over the past decade, including a critique of our success in reconciling the country's conservation and development needs.

Habitat transformation and biodiversity planning*Habitat transformation*

The single greatest threat to terrestrial biodiversity in South Africa is the transformation of ecosystems and habitats by cultivation, grazing, urban developments, afforestation, mining, dams and alien plant invasions (discussed in more detail below). It is estimated that about 16.5% of South Africa's land cover is transformed, and a further 10.1% degraded¹⁷ (Table 2). These figures include some 30% of the fynbos biome, 26% of grasslands, and 10% of the savanna biome.¹⁸ The impact on biodiversity has been substantial and significant proportions of our flora and fauna are threatened.

Some general trends are discernible with respect to habitat transformation over the past decade.

- Cultivated areas appear to have declined in most parts of the country, largely due to increased settlement and other forms of land use, grass conversion schemes, invasive alien species, higher input costs and market-related forces.^{19,20} Cultivation is considered to be the single largest factor responsible for habitat transformation in the country, and current estimates put 12.2% (14.9 million hectares) of the country under arable use.¹⁸ Although not directly comparable, 12.3% of South Africa in 1987 (excluding the former homelands) was estimated to be under cultivation.²¹
- Grazing areas have also declined in all provinces except the Free State, mainly resulting from rapid urbanization or settlement expansion.²⁰ Other factors include an increase in alternative land-use practices — such as mining, crop cultivation, conservation and forestry — and land degradation through soil erosion or alien plant invasions.
- Commercial forest plantations have increased dramatically. In 1985, 1.2 million hectares was afforested with introduced species. In 1994, a 50% increase was recorded, up to 1.79

Table 2. The status of biodiversity: a snapshot during the 1990s.^{13,17–19,22,30,69}**Transformed**

- 16.5% of terrestrial habitats has been transformed for crop forestry, industry and human settlements.
- 50% of wetlands has been transformed for crop cultivation, forestry, industry and human settlements.
- 10% of terrestrial habitats has been degraded through over-use and poor management.
- 8% of terrestrial and riparian habitats is heavily infested by alien vegetation.

Threatened

- 15% of plant species.
- 14% of bird species.
- 24% of reptile species.
- 18% of amphibian species.
- 37% of mammal species.
- 22% of butterfly species.

Top priority vegetation types

- West Coast Renosterveld
- Sandplain Fynbos
- Dry Clay Highveld Grassland
- South and South West Coast Renosterveld
- Short Mistbelt Grassland
- Coastal Bushveld-Grassland
- Moist Cold Highveld Grassland
- Sour Lowveld Bushveld
- Afro Mountain Grassland
- Coast-Hinterland Bushveld

million hectares (1.5% coverage of South Africa).¹⁸ In recent years, however, such expansion has slowed down.

- Rural and urban settlements have grown substantially since 1992, although the spatial extent of transformation is relatively small. There are particular concerns about the effect on vegetation of expanding settlements in the Western Cape, Limpopo Province, and the Port Elizabeth district of the Eastern Cape.²⁰

Whereas these trends seem to indicate an overall decline in the rate and extent of habitat transformation, they take into account neither the impact of fragmentation on biodiversity, nor the extent to which habitats are degraded. The ability of habitats to harbour biodiversity or to perform valuable ecosystem functions is also crucial when we assess trends.¹⁸ Statistics show an overall *increase* in the numbers of threatened plants in southern Africa, in fact, with comparisons between the numbers of threatened plants in 1980 (1915 threatened taxa), 1984 (2373) and 1995 (3435), indicating an 80% and 45% increase, respectively.²² South Africa now has the dubious reputation of having the highest known concentration of threatened plants, and the highest extinction estimates for any area in the world.^{22,23} Climate change is likely to exacerbate these trends,²⁴ with climate models predicting that, within 50 to 100 years, existing biomes will have been reduced to 35–55% of their present area. Places now supporting Succulent Karoo vegetation will become so arid as to support only the hardiest plants, and the northern part of the fynbos biome may disappear altogether.²⁵

Mainstreaming the planning of biodiversity

Current trends reaffirm the need for a 'landscape approach' to biodiversity conservation, and for biodiversity to be considered at all levels of planning and decision-making. This approach has been absent, despite its strong endorsement in the Biodiversity White Paper, constraining effective conservation of biodiversity in South Africa.

The management of biodiversity needs planning at three levels: (a) at the strategic level, where biodiversity is integrated into sectoral policies and programmes; (b) at the physical planning level, which is more spatial in approach; and (c) at the

species- or habitat-specific level.

At the strategic level, NEMA requires national departments and provinces to prepare environmental implementation plans (EIPs) and environmental management plans (EMPs), whose primary purpose is to promote cooperative governance in environmental management through the alignment of government policies, plans, programmes. Although the intention is to include biodiversity in such plans, and so enable their 'mainstreaming' into decision-making, this has not yet occurred in practice. As a result, biodiversity considerations at the strategic planning level remain marginalized and narrow, and sorely neglected within existing plans (for example, the Environmental Implementation and Management Plans of the Department of Land Affairs, and Department of Water Affairs and Forestry).^{26,27} Strategic environmental assessment allows issues of biodiversity to be more strongly integrated into the formulation of policies, plans and programmes.

Some successes have been achieved at the physical planning level, most notably those adopting a bioregional approach, such as the Cape Action Plan for the Environment (CAPE).²⁸ Overall, however, environmental assessment in South Africa is hampered by the lack of plans containing clear biodiversity priorities that are mapped and accessible.²⁹ The spatial development initiatives (SDIs) and the integrated development plans (IDPs) required of municipalities offer important opportunities to rectify this situation. Incorporating a conservation plan within IDPs and SDIs would provide a valuable tool for planning and setting priorities at the local level — essential in the South African context of inevitable trade-offs between environmental and developmental imperatives.

Planning at the species- or habitat-specific level is the most advanced, with several notable achievements on record (for instance, in the cases of specific threatened species). Such plans are essential, but they need to be developed more proactively and holistically, and complemented by the broader plans described above. Biodiversity studies in EIAs, for example, commonly focus on Red Data Book species, charismatic, or commercially important species. The functional component of biodiversity is largely neglected, and effects at the genetic level are seldom if ever addressed.²⁹

One of South Africa's most pressing needs is for a national biodiversity strategy and action plan. The Biodiversity White Paper's comprehensive policy for biodiversity conservation and use needs urgently to translate into actions with time frames. Although this activity was identified in the white paper as a priority, progress has been slow because of insufficient capacity and funding, and lack of political support. The intention, however, is to develop a national biodiversity action plan in the immediate future.

Alien invasive species

Alien invasive species pose one of the gravest threats to South Africa's biodiversity. An estimated 8%, or 10 million hectares, of South Africa has been invaded by about 161 different alien species,³⁰ and all seven of South Africa's terrestrial biomes suffer alien plant invasions to varying extents.³¹ In some biomes, such as the species-rich fynbos, infestations of up to 14% of the total area³⁰ have caused extensive transformation. Almost 1900 of South Africa's 3435 'Red Data' species are threatened wholly or in part by alien invading plants,³⁰ which have also been shown to alter the diversity of insect species.³² Invading alien plants use about 3.3 billion m³ of water annually, accounting for 6.7% of the water that would otherwise flow in South Africa's rivers, and reducing water availability.

Likewise, introduced animals have reduced South Africa's biodiversity, with some of the most dramatic effects being recorded on islands and in rivers. Up to 60% of threatened endemic freshwater fish may be endangered by introduced fish species such as trout, carp and bass.³³ In the marine environment, accidental introductions from the discharge of ships' ballast water have caused alien species to occupy South Africa's shores and sometimes displace local species.

At current rates of expansion (5% per annum), the impact of alien invasive species could double in fifteen years, so their removal is a priority well recognized by government. Through the Working for Water Programme (an inter-departmental initiative of DWAF, DEAT and Agriculture), it supports an innovative and internationally acclaimed process to control invading alien plants and rehabilitate ecosystems, involving economic empowerment and transformation. The programme is undoubtedly one of South Africa's main achievements in conserving biodiversity since Rio.

Accompanying these successes have come conflicts and resistance. Two side-effects of biodiversity conservation in particular are worth highlighting: the effect on commercial forestry, and the effect on subsistence users of products from invasive alien plants. Forestry has been one of the country's greatest sources of alien infestation and 38% of the area invaded in South Africa is occupied by species used in commercial forestry. Seed pollution is a major concern, as is the siting of plantations. Yet plantation forestry is an important part of the economy, contributing R1.8 billion, or 2%, to the GDP and employing over 100 000 people. Downstream industries based on forestry are worth a further R9–10 billion, and earn valuable foreign exchange.³⁴ Creative and mutually beneficial trade-offs are required to balance such ventures with the need to control the spread of alien plants and minimize threats to biodiversity and watersheds. The slowed expansions of plantation forestry and its adjustments to meet environmental standards reveal the industry's new, more responsible approach to forestry in South Africa. Certification through the Forestry Stewardship Council has also considerably improved environmental performance and management systems, although social issues remain poorly addressed.³⁵

In many parts of the country invasive species are invaluable sources of fuelwood for communities reliant on natural resources for energy and income. In the southwestern Cape, for example, invasive Australian species form the basis of a charcoal industry valued at US\$1.2 million and fuelwood sales of \$7.6 million a year.³⁶ Indiscriminate clearing programmes can severely damage livelihoods. One solution is to allow for well-managed woodlots where fuelwood is scarce, using non-invasive species. Educational programmes can encourage people to use alternative species, but eliminating invasive plants could well increase the pressure on indigenous biodiversity.

Such conflicts, combined with difficulties in managing the programme, its location within a broader strategy for rural development, poor awareness of its purpose, and the short-term nature of many of the jobs it has created, have led to criticisms,³⁷ but there is no doubt about the substantial long-term environmental — and, in turn, developmental — potential benefits. For these to be realized, ongoing maintenance and continued political and financial support are vital.

Protected areas and Transfrontier Conservation Areas

Protected areas

Considerable headway has been made in expanding and consolidating South Africa's protected areas. Since 1994, over 155 000 hectares of land has been added to the terrestrial pro-

TECTED-AREA system — the greatest expansion in any comparable period in the country's conservation history.^{38,39} Notable efforts have also been made to expand conservation efforts outside protected areas by establishing biosphere reserves, and several World Heritage Sites have been declared. Apart from private reserves, the existing system of protected areas constitutes some 6% of our land surface, and there are plans to increase this proportion to 8% within ten years.³⁸ New marine protected areas are also being developed, with the intention of increasing the proportion under conservation from 5% to 20%.³⁹ Crucial to these achievements has been political will, and the recognition of links between conservation and the economic opportunities of tourism.

The existing protected-area system, however, inadequately represents biodiversity patterns and processes. As many as 50 of South Africa's 68 vegetation types are less than 10% conserved, and identification of important bird areas shows the vast majority of them falling outside reserves and on private land.⁴⁰ Recent expansions of protected areas have been largely *ad hoc*, in places that are either well conserved already, or remote, rugged and uncontentious. Little attention has been given to land types that are more difficult and controversial, such as the highveld grasslands, Cape lowlands, or those occurring in communal lands (R. Cowling, University of Port Elizabeth, pers. comm.). Notable exceptions to these trends include the systematic conservation planning undertaken for the Succulent Karoo and Cape ecoregions, such as that done in the CAPE project.²⁸

Major constraints hamper management of protected areas in South Africa. Resources allocated for nature conservation have declined in all provinces, and frustration and disillusionment have caused a mass exodus of highly trained managers and scientists from conservation departments. Nature conservation agencies lack the capacity to deliver on official policy statements, and national performance is reduced thanks to extreme fragmentation: 13 different agencies control some 403 protected areas, which fall under 11 national and 9 provincial laws.³⁸ The so-called Kumleben Investigation,⁴¹ commissioned in 1998 to investigate institutional arrangements for nature conservation in South Africa, yielded few results. The formulation of a national Biodiversity Bill or, as is currently proposed, a Protected Areas Bill, will help towards harmonizing legislation and providing for a uniform national classification system for protected areas, but many challenges remain.

Continued financing of protected areas is a key issue, given steadily declining state funding for conservation, and subsequent pressures to commercialize protected areas so conservation can 'pay its way'. SANP, for example, has embarked on a strategy in which the private sector will help to deliver certain commercial functions, thus ensuring sustainable income for national parks, resulting in job creation and capital investment.⁴² Provincial conservation agencies are following a similar route, and many are establishing parastatal boards for greater autonomy and fundraising capacity. Declining provincial subsidies are leading many municipalities to deproclaim their nature reserves or to re-use them for more lucrative developments.⁴³ Commercialization undoubtedly brings benefits, but the overwhelming concern is that the state will abdicate responsibility for managing its natural heritage in favour of profit. South Africa, as a developing nation, can ill-afford to place the burden for protected areas on its taxpayers, but protected areas must be recognized for their vital ecosystem services to the current and future development of the nation.

Further dilemmas arise with the lodging of land claims in conservation areas. By 1999 some 25 had been lodged.⁴⁴ There is

no question that land rights must be restored to people who were forcibly removed, yet maintaining protected areas is essential for conserving the country's natural environment for future generations. These conflicts, and mistrust between the historically disparate land and conservation sectors, have provided major challenges. Creative solutions and opportunities for community co-management and empowerment have emerged in some instances. The Makuleke community in Limpopo Province, for example, now run a tourist facility through a successful land claim in the Kruger National Park, and at the Dwesa-Cwebe nature reserve in the Eastern Cape, government and the community have agreed to manage the area jointly in a manner that both conserves biodiversity and benefits the community.

Private landowners have become increasingly important in managing South Africa's biodiversity. Some 16 million hectares are under private conservation management in the country, an almost threefold increase over the amount of state land designated for protection.⁴³ In the Cape Floral Kingdom alone, it is estimated that at least 85% of the remaining biodiversity is privately owned. These resources need to be secured and their sustainable use ensured, yet few incentives encourage conservation on private land. Biosphere reserves can draw private landowners into partnerships for conservation, and they require support and strengthening. New legislation for municipal systems and rural taxation also creates opportunities, but care is needed so as not to undermine livelihoods.

Transfrontier Conservation Areas

Transfrontier Conservation Areas (TFCAs), or 'Peace Parks', are huge areas spanning country borders and comprising a range of different conservation locations, from communal lands to wildlife management areas. Conceptually, they move away from strict wildlife conservation towards greater emphasis on multiple resource use, especially by local communities. Their overall aim is to conserve biodiversity whilst promoting tourism, local economic opportunities and regional collaboration. Seven TFCAs have been proposed along the borders of South Africa, and the first, the Kgalagadi Transfrontier Park, was launched in April 2000 by the presidents of Botswana and South Africa. Southern Africa's next 'super-park' is likely to be the Gaza-Kruger-Gonorezhu, involving South Africa, Mozambique and Zimbabwe and jointly making up an area of just under 10 million hectares. Other TFCAs under development include those of Lumombo, Limpopo/Shashi, the Richtersveld/Ais-Ais and Maluti/Drakensberg.

While TFCAs have enjoyed acclaim, they have been criticized for their effects on community development and economic empowerment, and seen as an 'ecological crusade' that could marginalize and displace communities even further.⁴⁵ Weak communal property rights and the difficulties of implementing community-based natural resource management are key constraints to realizing TFCA development objectives.⁴⁶ It is vital, therefore, to integrate TFCAs in regional economic development, as has been achieved in some areas through the SDIs. Lessons learned from these experiences will need judiciously to be applied.

The sustainable use of biological resources

South Africa's biological resources provide a vast array of goods and services, varying from the direct use of species — including the gathering, harvesting or hunting of animals and plants for food, medicine, shelter, fuel and fibre — to the direct use of ecosystems and specific habitats for grazing, croplands,

mining, recreation and tourism. Sustainable use is supported by government policy, but has proved difficult to put into practice.

Millions of rural South Africans depend upon biological resources for day-to-day survival. Access to this 'natural capital' provides a crucial contribution to livelihoods, a buffer against poverty and an opportunity for self-employment.⁴⁷ As a 'hidden economy', it also generates substantial income. For example, The informal medicinal plant trade is estimated to total R21 million per annum in the Witwatersrand area alone, for example,⁴⁸ and R60 million in KwaZulu-Natal.⁴⁹ About 19 500 tons of medicinal plants is traded each year in the country as a whole, with a trade value of R270 million.⁴⁹

The sustainable use of biological resources has been affected by two key issues over the past decade. First is the extent to which government *undervalues* wild resources and their role as 'free goods' in cross-subsidising basic services such as healthcare.⁴⁷ Second is the *decline in availability* of resources and concerns about overharvesting. Both highlight the need to increase investment and institutional support for the sustainable use of wild resources, for enhanced efforts to cultivate and manage harvested resources, and for greater recognition of the value of wild resources in land reform and rural development.

Animal welfare is one of the most contentious issues in debates about sustainable use, spurred by controversies surrounding the treatment of the Tuli elephants by an animal breeder, the proposed culling of elephants in the Kruger National Park, and the use of primates for medical experiments. Underpinning these debates are different value systems rather than clinical scientific facts. Nonetheless, they point to an important gap in animal welfare policies and laws in South Africa, and the need to engage constructively with different interest groups. Policy is currently being drafted, but both the Department of Agriculture and DEAT are reluctant to assume responsibility. Also needed is frank dialogue as to the explicit meaning of 'sustainable use' in the South African context, and under what — if any — circumstances a protectionist approach (such as prohibitions on resource use in protected areas) is valid. These concepts are muddled by the range of agendas among the country's conservation and development fraternities.⁵⁰

The wildlife trade, with its benefits and risks, exemplifies the difficulties of practising sustainable use. South Africa is at the hub of illegal and legal wildlife trade in the region, yet it lacks the capacity, budget and muscle for effective management, and is constrained by its plethora of inefficient laws, which are considered 'inconsistent, incomplete, outdated and overly complex'.⁵¹ Provincial restructuring in 1994 is considered to have exacerbated the fragmented legal environment. South Africa did, however, play a prominent role in negotiating proposals of the Convention on International Trade in Endangered Species (CITES) to allow limited trade in products from the African elephant, and a major project has been undertaken to ensure compliance with the treaty's requirements, including setting up an electronically linked administrative system. Legislation drafted to implement CITES will form part of the Biodiversity Act to be promulgated in the near future.

Community-based conservation and tourism

Community-based conservation remains one of the greatest challenges facing conservation in South Africa. Intensely debated over the past decade, it was catalysed to some extent by the rush of land claims on conservation areas following the 1994 elections. The Makuleke land claim in the north of the Kruger National Park is a notable example of progress, but there have been few achievements overall with respect to co-manage-

ment.⁵² Models that have been adopted include contractual national parks, where communities are landowners and primary decision-makers (such as the Makuleke); committee-based management, which is less formally structured around stakeholder interests (for example, the Cape Peninsula National Park); and conservancies, a concept being promoted in the Richtersveld.

Nature-based tourism, as a key economic growth sector in South Africa, is an important component of community-based conservation but there is little sign so far that small-scale, local enterprises are being seriously promoted.⁵² Perhaps the most important constraint is the lack of institutional capacity at both state and community levels. Community-public-private partnerships are an important strategy being heralded as a potential solution,⁵³ but there is a need to train people for the higher-skilled and well-paid jobs in tourism and conservation. Lack of clarity about land and resource tenure presents a further stumbling block, especially in communal areas.

Community-based conservation has thus far been viewed largely in the context of protected areas. Extending co-management initiatives throughout rural areas is urgently needed, however, for broader benefits to be derived from the nation's biodiversity. For this, land rights must be secure and meaningful. If rural people cannot control access to an area, they cannot conserve its biodiversity, raise money from entry fees, or prevent external tour operators from bringing in visitors. Critical in such ventures is the role of women, which has generally been overlooked.⁵²

Indiscriminate tourism can affect biodiversity and local cultures considerably. South Africa's policy of 'responsible tourism' places community involvement at the heart of tourism growth and aims to minimize environmental impacts. Commitment has yet to be demonstrated, however. The SDIs, for example, have focused on large-scale external investment, with only superficial public consultation and involvement. Long-term environmental and cultural impacts that may arise from developments in tourism are often neglected in the face of the short-term benefits of instant job creation and foreign exchange. A careful balance must be struck between regulating the industry, promoting appropriate investment, and ensuring that benefits accrue to local economies, communities and conservation. This seems a tall order to meet.

Bioprospecting, benefit-sharing and commercializing South Africa's biodiversity

Important commercial opportunities come from South Africa's plants and animals. Not only is the country exceptionally rich in biodiversity, but its levels of endemism are also extremely high. In the plant kingdom alone, at least 80% of the 18 000–20 000 species are known to be endemic.⁵⁴ A high number of endemics is also likely among the more than 43 500 insect species found in the country.⁵⁵ Unusually high intraspecific genetic diversity adds to the potential for developing new medicines, crops, cosmetics, ornamental plants, and other useful products. Combined with well-developed institutions and research capacities in the country, these attributes favour bioprospecting (that is, the exploration of biodiversity for commercially valuable genetic and biochemical resources),⁵⁶ and are also ideal for developing locally-driven industries, based on less technologically sophisticated approaches to natural product development.

Post-Rio, South Africa has engaged in a flurry of activities in bioprospecting and natural product development (Table 3), involving many international and national companies and research institutions in research and development. These initia-

Table 3. Examples of bioprospecting in South Africa.

Two bioprospecting initiatives have recently placed South Africa under the spotlight: an agreement between South Africa's National Botanical Institute (NBI) and the Chicago-based company, Ball Horticulture; and another between the CSIR and the British-based Phytopharm, which specializes in phytomedicines. Both initiatives have raised considerable public comment.

Not playing ball?

The NBI-Ball agreement, which is the first North–South bioprospecting venture in the horti- and floriculture sector, will see the institute using its expertise to select South African plants of horticultural interest to Ball, both from its living collections and from the wild. Ball will patent any chosen or hybridized varieties of these plants, and the NBI will receive a share of the profits for 20 years following the plant's introduction to the market. Profits generated by the agreement will be placed in a special account administered by the NBI Board, to be used for capacity building in botany and horticulture. Other benefits include staff training and the building of greenhouse facilities, where plants will be propagated before being sent to America.

Much controversy has surrounded the agreement, largely because of the public role of the NBI, and the use of public funds to develop collections and expertise that are now commercially attractive. Considerable criticism has been levelled at the benefit-sharing provisions of the agreement, which are perceived to undervalue South Africa's national heritage, to undermine the local horticultural industry, and to neglect national imperatives towards job creation and development.^{58,70} A key reason for these deficiencies is the under-development of the South African horticultural industry — and thus the weak bargaining power of the NBI. The institute has justified the agreement as a long-overdue opportunity for South Africa to obtain benefits from indigenous genetic resources, and a world first to 'set new precedents for ethical bioprospecting in the field of ornamental horticulture'.⁷¹ Many of these issues reach far beyond the NBI and Ball, and point to the legislative and institutional vacuums with regard to bioprospecting in South Africa.

Slimming drugs from the San

The second case concerns the development of an appetite suppressant (dubbed 'P57') derived from a species of *Hoodia*, a succulent plant indigenous to southern Africa and long used by the San to stave off hunger and thirst whilst hunting in the desert. The appetite suppressant is considered to have the potential to become the first blockbuster drug to be derived from an African plant and is to be commercialized as a prescription medicine with an estimated market value of more than US\$6 billion. The United States is the largest market for obesity drugs, with up to 65 million obese citizens.

The active components of the plant have been patented by the CSIR and a licensing agreement for the further development and commercialization of the product has been signed with Phytopharm. The company in turn has sold the rights to license the drug for \$32 million to Pfizer, the U.S.-based pharmaceutical giant, which hopes to have a pill available within three years. Projected annual royalties to the CSIR are expected to amount to hundreds of millions of rands for the lifetime of the patent. It is anticipated that any money made by the CSIR will be invested back into the organization, or into providing scientific services; no part of the projected royalties has been earmarked for conservation, nor for benefit-sharing with holders of traditional knowledge about the plant. Indeed, only recently have the San heard of the commercialization of their knowledge. Importantly, through a recently concluded Memorandum of Understanding with the South African San Council, the CSIR has formally recognized the San as the originators of traditional knowledge associated with human use of *Hoodia*. The San have also implicitly agreed not to challenge the patent, but rather to recognize the 'context' in which the patent was registered by the CSIR, including the lack of consultation with them. Discussions are under way to reach a mutually acceptable agreement with the San, although the conclusion of these negotiations is some way off.

tives have helped to strengthen local scientific institutions and build the capacity of researchers, in a climate of diminishing public funds for scientific research. Limited benefits are derived by South Africa from its bioprospecting, however. Although bioprospecting gives valuable opportunities for conservation, poverty alleviation and job creation, these national imperatives have featured inadequately in existing bioprospecting agreements.⁵⁷

More meaningful benefit-sharing has been thwarted by the

absence of legal and administrative mechanisms to control access to South Africa's genetic resources and set conditions for the sharing of benefits. The Biodiversity White Paper's broad policy on bioprospecting, has proved insufficient. Political leadership is lacking, and the problem is aggravated by poor coordination between government departments, lack of capacity on the part of both government and those engaging in agreements to negotiate a 'good deal', and poor understanding of the issues.⁵⁸ Recent controversies surrounding the commercial development of South African species have added momentum to the need to rectify the situation. New bioprospecting legislation, currently being drafted as part of the Biodiversity Bill, will help to guide collaboration with foreigners, strengthen the bargaining arm of local institutions, and lay down conditions for benefit-sharing that serves national interests.

Recognition has grown over the past decade of the economic importance of adding value to natural resources, in contrast to previous approaches that disregarded the importance of indigenous genetic resources. The Innovation Fund, for example, an initiative of DACST, identifies value addition with respect to biodiversity as a key focal area warranting the allocation of scarce government funds. The Biodiversity Sector of the National Research and Technology Foresight Project identified 'the development of techniques to add economic value at local level to harvested or cultivated products' as critical to South Africa in respect of biodiversity, wealth creation and quality of life.⁵⁹ Such initiatives mark an important turning of the tide: historically, most research and development on South African species has been conducted outside the country.

Compared with the sophistication of bioprospecting, there are fewer risks and delays associated with the option of developing industries based on phytomedicines (herbal medicines), personal care products and food supplements. It offers the use of technologies more appropriate to South Africa, and also a far greater chance of benefits reaching the ground. The commercialization of South Africa's biodiversity has succeeded most at this level, with such products as rooibos and honeybush tea, *Aloe*-based products, marula beverages and buchu oil. Long-term biodiversity commercialization in South Africa clearly needs to learn from these successes, and understand the mix of approaches required to optimize the potential of the country's biological wealth.

Intellectual property rights, traditional knowledge, and community rights

The diverse peoples of South Africa have a rich and varied traditional knowledge of biodiversity. The programme on Indigenous Knowledge Systems being undertaken by DACST, as well as legislative proposals acknowledge the need to recognize and protect this knowledge, but serious concerns exist about the suitability of the existing intellectual property system for protecting traditional knowledge. A strong case can be made for introducing *sui generis* ('of its own kind') legislation, and among several examples proposed is a model law developed by the Organisation for African Unity.⁶⁰

Of particular concern is the lack of recognition of holders of traditional knowledge in the development of medicines, crops, cosmetics and other natural products. In South Africa, the issue was catapulted into the spotlight when the CSIR patented an appetite-suppressant compound from *Hoodia*, an indigenous plant, for potential use in an anti-obesity drug. *Hoodia* has long been used by the San people to assuage thirst and hunger but they received no compensation for the use of their knowledge in a commercial product.⁵⁸ Examples abound in South Africa of the

trend to discount traditional knowledge about a product because of the difficulties in determining appropriate arrangements to share benefits.⁵⁸ Protocols need urgently to be developed, as well as mechanisms for obtaining prior informed consent from traditional holders of knowledge before such knowledge is used, and for setting minimum standards for benefit-sharing.

Vexed questions also arise in agriculture. South Africa has strong intellectual property legislation in place, complying with the 1978 Agreement of the Union for the Protection of New Varieties of Plants (UPOV) and the Trade-Related Aspects of Intellectual Property Rights Agreement (TRIPs) of the World Trade Organisation. Similar policies do not exist for farmers' rights, although there is growing support for and recognition of traditional breeders in the country. Tension exists between the commercial seed industry, which supports strict intellectual property regimes and prohibitions on seed-saving, and small farmers, who base their farming on farm-saved seeds and on-farm crop selection. These, in turn, underpin the conflicts that face government in weighing the options between an agricultural strategy that is internationally competitive and highly industrialized, and one that pursues agriculture as a means towards community development and poverty alleviation.

Biotechnology

Modern biotechnology, or genetic engineering, is a further cause of conflict. South Africa is the only African country in which genetically engineered crops are commercially grown, and it has adopted the technology more quickly than any other country in the world. In 1999, over 250 000 hectares were planted with genetically engineered crops. In 2000, this figure increased by 100 000 hectares.⁶¹ Approximately 200 field trials are under way, and five commercial releases have been approved. The geographical extent of plantings is wide, involving eight of South Africa's nine provinces (Fig. 1). Already, 28% of the cotton and 6% of the maize planted in South Africa is genetically engineered.⁶²

These figures represent drastic changes from the situation in 1992, when the technology was still in the early stages of commercialization. Related changes include an increasing dominance of international seed companies, who now control some 60% of the hybrid maize market in South Africa and 90% of South Africa's wheat. These same companies are applying for and growing transgenic crops in South Africa: over 90% of the applications for transgenic crop testing in the country have been for herbicide- and insect-resistant strains, with 70% of applications being received from transnational 'gene giants' including Monsanto, Pioneer Hi-Bred, AgrEvo, Delta and Pine, Syngenta and Du Pont.⁶³ Developments that could make a real impact on African food production, such as improvements in nitrogen fixation, or drought resistance, remain sorely neglected. Such issues raise the importance of publicly funded research that has no industrial strings attached. Budget cuts within research institutions such as the CSIR, the Agricultural Research Council and most universities, often result in research being directed by industry contracts, rather than by national priorities.

Of major concern is the lack of environmental assessments conducted on any of the field trials or commercial releases of genetically engineered organisms approved in South Africa. Although legislation exists to regulate genetic engineering, it is widely considered to be out of line with the internationally agreed Biosafety Protocol, and with NEMA and the South African Constitution.⁶⁴ The problem is compounded by the large number of government departments involved in regulating genetic engineering (including the departments of Environ-

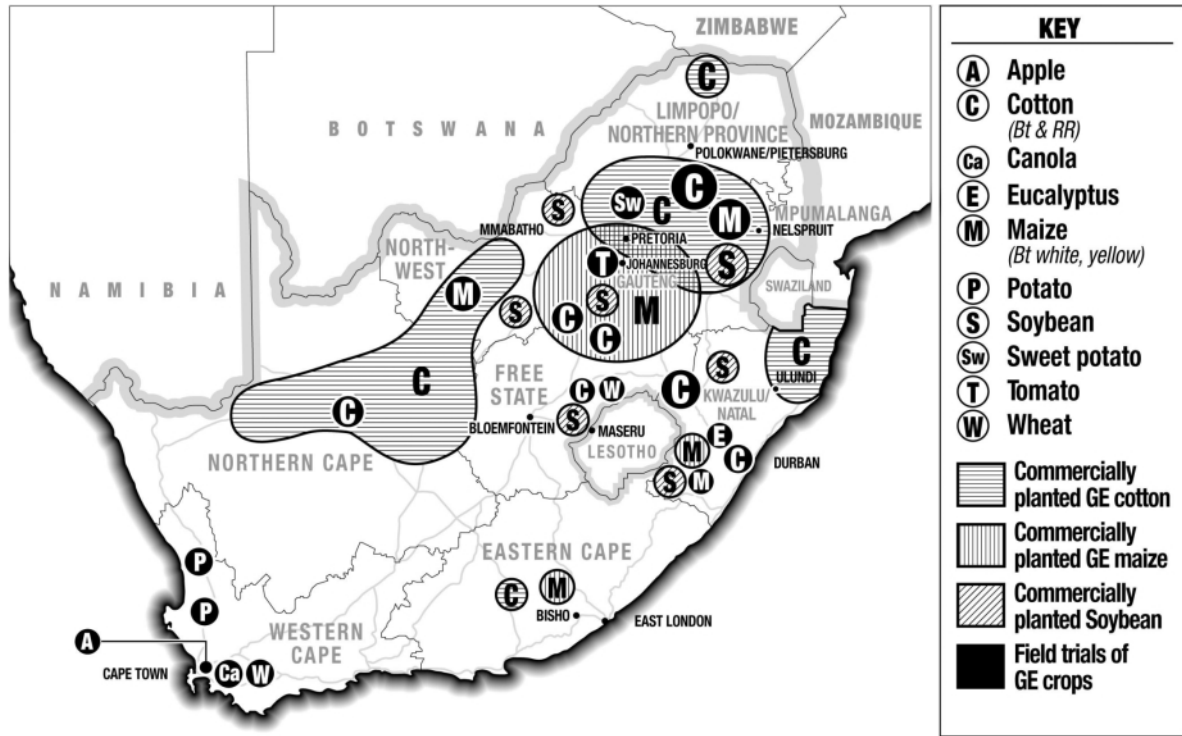


Fig. 1. Plantings of genetically engineered crops in South Africa in 2002 (courtesy of Biowatch South Africa).

mental Affairs and Tourism, Agriculture, Health, Trade and Industry, and Arts, Culture, Science and Technology), and by difficulties in achieving coherent policy positions on the matter. Restricted access to information about field trials, commercial releases, and risk assessments, combined with the lack of civil society involvement in decision-making, and other concerns, led some 127 South African organizations and more than 1300 individuals to call for a five-year moratorium on genetic engineering.⁶⁵

The hasty introduction of genetically engineered crops into South Africa in the absence of any public policy process has caused considerable public concern and controversy, enormous rifts and two clear ‘camps’: those supporting and those opposing the technology, with government commonly perceived as aligning itself with a pro-industry lobby. Debate is thus at a stalemate, precluding rational discussion about the role of modern biotechnology in South Africa and its associated benefits and risks. A National Biotechnology Strategy has recently been published to promote biotechnology in South Africa,⁶² but this too has taken place in a policy vacuum. Objective political leadership is urgently needed to create the space for public involvement in the development of biotechnology policies and laws that meet South Africa’s needs.

Funding

Government funding for biodiversity management has dwindled over the past ten years, evidenced by the rapid privatization of many protected area agencies and, in some instances, the deproclamation of protected areas. Diminishing public funds for scientific research have also hampered biodiversity management, and inadequate funding has greatly inhibited the effective implementation of the Biodiversity White Paper.

Since 1994, there has been a surge of donor interest in assisting with South Africa’s environmental problems. For example, between 1994 and 1999 some R128 million, or 43% of foreign funds allocated for environmental issues in South Africa, was received from the Global Environment Facility of the World

Bank, the United Nations Development Programme and the United Nations Environment Programme.⁶⁶ Invaluable in the face of declining resources from the state, such funding is unlikely to be sustained as donors turn their attention elsewhere. A noteworthy fact is that funding from both government and donors is still strongly focused on conservation. In the five years from 1994 to 1999, for example, 56% of funding to DEAT from Britain’s Department of International Development was allocated to the South African National Parks and the National Botanical Institute.⁶⁶ Funding allocations for biodiversity management need to be increased, and such allocations must be balanced with demands from other environmental sectors.

Knowledge, research and information

Major institutional reforms since 1994 involving museums, universities and science councils have emphasized applied research and capacity building, especially within historically black institutions, thereby involving a greater diversity of people in the biodiversity sector. In the years since Rio, South Africa has also recognized the crucial need for improved knowledge and understanding about biodiversity and for research to support this. The Biodiversity White Paper, for example, specifies stronger inventory work and improved understanding of biodiversity.¹³ Results from the Foresight project similarly emphasize research to determine sustainable use, to understand the effects of disturbance on biodiversity, and to develop techniques that support conservation and sustainable use.⁵⁹ Despite these policy pronouncements, research capacity has continued to diminish, especially in the area of taxonomy. The so-called ‘taxonomic impediment’ is critical in South Africa, and the country’s museums and herbaria in particular face severe financial difficulties and the continued deterioration of resources and skills. During the last decade the number of taxonomists employed in South Africa’s museums has declined by 35%, matched by a concurrent fall in research grants to museums.⁶⁷

There is urgent need for redress, through a national initiative to coordinate biodiversity information and research.⁶⁸ Although

institutional arrangements have not yet been finalized, it is anticipated that a National Biodiversity Institute will be established, amongst other things to organize and integrate information about South Africa's biodiversity, coordinate biodiversity inventory work, and generate and update lists for threatened components of biodiversity. The establishment of such a body will be a major achievement for biodiversity conservation in South Africa, and will have implications for the strategic role of parastatals such as the SANP and the NBI and numerous other parties.

Conclusions and recommendations

The years after Rio have witnessed mixed trends in South Africa's conservation and sustainable use of biodiversity. Remarkable achievements include the development and adoption of a national consultative policy on biodiversity, an expansion of South Africa's protected areas, the development of TFCAs, the Working for Water programme, some noteworthy examples of bioregional planning, and commercial initiatives to develop the country's magnificent natural heritage. Decisions made regarding biodiversity have recognized the need to involve people in conservation, and the centrality of equity and social justice. Loss of biodiversity continues, however, with an alarming number of constraints precluding its more effective management.

It is instructive to compare progress against the priorities listed in the 1997 Biodiversity White Paper (Table 1). Few, if any, have received adequate attention. Some improvements have been achieved, but overall progress is extremely slow.

Trade-offs between achieving biodiversity conservation and achieving economic development have been highlighted in this paper, and specific proposals have been made, but five overarching recommendations require highlighting.

- First, the speedy proclamation of an effective and progressive Biodiversity Bill is a high priority. Stakeholder support for this legislation is imperative to its success.
- Second, a national biodiversity strategy and action plan is needed, that includes specific actions, budgets and timeframes for achieving priority objectives.
- Third, biodiversity should be 'mainstreamed' into existing development and environmental planning initiatives.
- Fourth, clear, unambiguous criteria and principles should be developed to balance biodiversity loss in the long term against socio-economic gains in the short to medium term, including a system whereby 'limits of acceptable change' are adopted and rigidly implemented. Targets for representation of biodiversity need to be set and applied, on both state and privately-held property.
- Finally, stated political commitment and demonstrated political leadership is the key for achieving the objectives of biodiversity conservation and sustainable use, and for overcoming the numerous obstacles that currently thwart effective management of biodiversity in South Africa.

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Science policy

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Here, representatives of 10 of the main institutions and organizations in South Africa's 'science system' summarize what these bodies do, or, in some cases, would like to be doing. The organizations represented are the Associated Scientific and Technical Societies of South Africa (A. Pater-son), the National Science and Technology Forum (M. Hlongwane), the Foundation for Education, Science and Technology (A. Pouris), the Academy of Science of South Africa (W. Gevers), the Suid-Afrikaanse Akademie vir Wetenskap en Kuns (Van Zyl de Villiers), the Royal Society of South Africa (J. Skinner), the South African Universities

Vice-Chancellors' Association (E. Preston-Whyte), the National Advisory Council on Innovation (A. Webb), the Committee of Heads of Organizations of Research and Technology (G. Garrett), and the National Research Foundation (K. Mokhele, G. von Gruenewaldt & A. Botha).

These submissions are based on presentations made at a symposium in September 2000. As with all evolving systems, especially those subject to the rapidly changing environmental conditions that are such a feature of today's South Africa, some of these accounts, at least in part, have already been overtaken by events. Nevertheless, here are declarations of good intent to make science and technology play a very much greater role in the strongest economy in Africa.

Copies of the booklet are available from Hannekie Botha, National Research Foundation, P.O. Box 2600, Pretoria 0001 (e-mail: hannekie@nrf.ac.za).