ADAPTING TO climate change IN THE CAPE FLORISTIC REGION

Building Resilience of People and Plants in Protected Areas

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The World Conservation Union

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World Commission on Protected Areas (WCPN)
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1. *Securing Protected Areas in the Face of Global Change: Lessons Learned from the South African Cape Floristic Region*, and
2. *Climate Change and Conservation: Tipping points for action in the Cape Floristic Region*.

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Contents

Introduction

Twenty percent of the Cape Floristic Region (CFR) is currently formally protected, and. 259 protected areas act as custodians of one of the richest and most threatened areas for plants in the world. Not only is the CFR one of 34 terrestrial Global Biodiversity Hotspots, but eight of its protected areas are on UNESCO's World Heritage List. The CFR is home to about 1 400 threatened plant species, one of the highest known concentrations in the world.

Fynbos, the predominant ecosystem type in the CFR, is already threatened by a growing water crisis in the region, aggressively invasive alien vegetation, property development and other land transformation pressures. To this brew of pressures, climate change is projected to bring rising temperatures, changes to regional rainfall patterns (with a drying trend in the west of the region) as well as more intense and more frequent fires. An increase in CO_2 in the atmosphere could also stimulate the spread of woody alien invasive species. Under these conditions, competition for fresh water will increase sharply.

These changes imply two options for Fynbos species: they will either adapt as they have done for millennia, or follow a path to extinction. The outcome will depend on species resilience, and the rate and extent of climate change. Rate and extent of climate change is crucial, because adaptation to a changing climate can occur through genetic transformation *in situ* (see glossary), or by migrating to suitable sites as the ones in which they are currently located become less hospitable. With climatic changes that occur too rapidly, or are too extreme, these options become increasingly less viable.

Our knowledge of adaptation responses that can be implemented through management is rudimentary, but growing. In recent years, ecological corridors have been established to connect fragmented hotspots in the region. Five corridor initiatives in the CFR are turning the traditional concept of nature conservation on its head by reaching mutually beneficial protection agreements with private land-owners whose lands border on formally protected areas. Most importantly, for Fynbos to adapt to a changing climate, the corridors connecting different landscapes offer natural species an opportunity to migrate. What other responses might be available to us in this effort to adapt, that we have not yet exploited?

Climate change is now rapidly moving from the periphery to becoming a mainstream concern for the people of the Western Cape, its economy and its potential for a sustainable future. Research shows that ecosystems and their biodiversity are at a real risk from this new threat The purpose of protecting Fynbos biodiversity from such threats, is not simply for the aesthetic and genetic value of the plants, but also to sustain the essential goods and services that the people of the Western Cape derive from natural ecosystems.

Will climate change catastrophes make biodiversity conservation redundant? We don't think so. In fact, we suggest that conservation, and the policies which set conservation priorities, should take their cue from Fynbos ecosystems and adapt to climate change as well. Focusing positively on enhancing adaptation to climate change creates new opportunities to manage the complexity of inter-connected threats and pressures in a more integrated way.

Why read on?

By reading this booklet, you will gain more information about the science of climate change and about the application of sound ecological and organisational principles in order to strengthen the resilience of the natural biodiversity *as well as* the resilience of the human systems that manage this biodiversity in and around protected areas in the CFR.

fact file

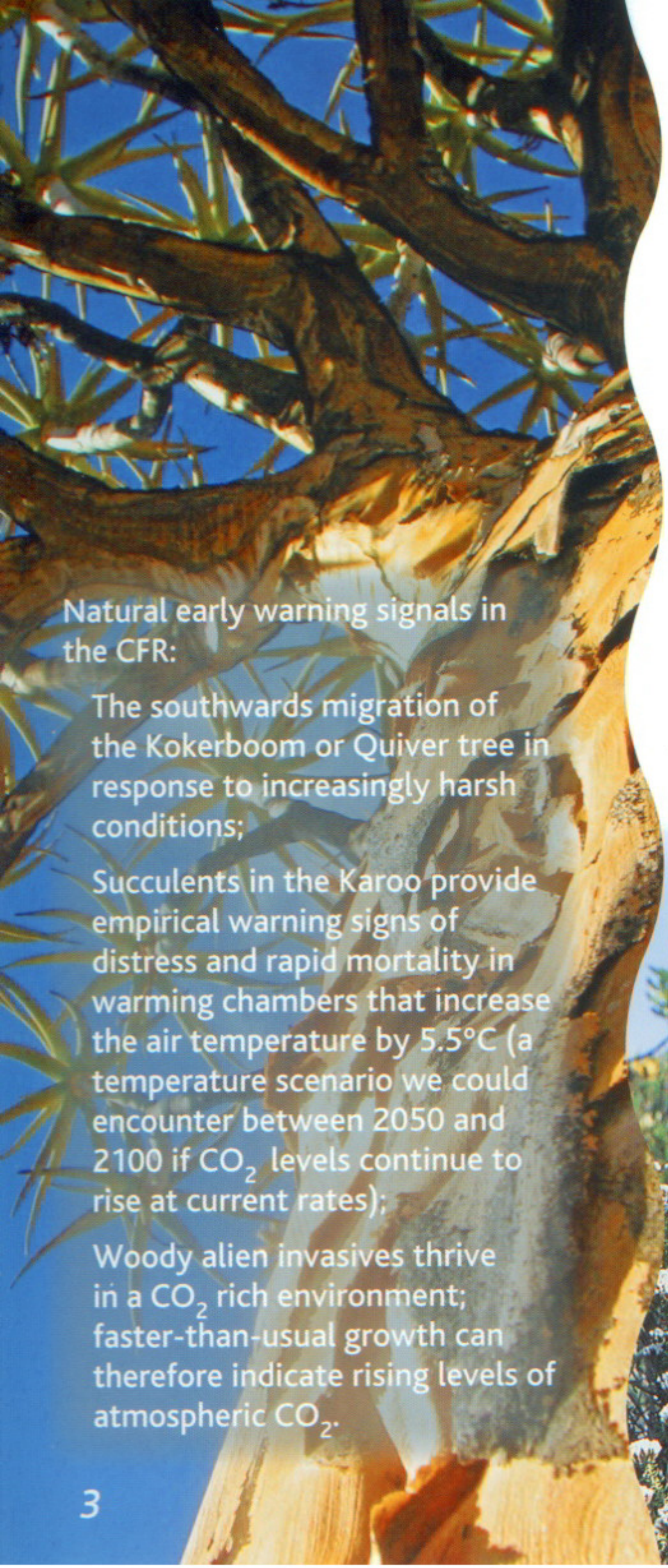
Examples of Fynbos goods and services

- Well-managed Fynbos areas produce high volumes and high quality water run-off after rainfall, with 63 – 85% of the water reaching streams
- Fresh and dried Fynbos cut-flowers are a popular commodity
- Rooibos tea and honey bush tea come from plants endemic to the Fynbos
- The renowned beauty and variety of Fynbos attracts local and international tourists to the CFR
- Essential oils extracted from Fynbos species (e.g. Buchu or *Agathosma* spp.) are used for cosmetic and medicinal purposes

The Cape Floristic Region

The unique climate of the CFR supports some of the most dramatic biodiversity in the world. The CFR covers a total land area of 87 892 km^2 in the Western and Eastern Cape provinces of South Africa at the southern tip of Africa and is home to some 9 030 species of vascular plants, nearly 70% of which are endemic (see glossary). The Fynbos biome and Succulent Karoo biome have been recognised as Global Biodiversity Hotspots (see glossary) due to the threat of human impacts. For example, 26% of the CFR has been transformed by agriculture, including forestry plantations.

Fynbos is the dominant vegetation type in the CFR, and occurs only in South Africa. This fire-prone shrubland vegetation type is mainly characterised by three plant families: shrubby Proteaceae and Ericaceae, and reed-like Restionaceae. The Fynbos biome, named for this vegetation type and the ecosystem it supports, takes centre stage in this study on managing climate change impacts.



Natural early warning signals in the CFR:

- The southwards migration of the Kokerboom or Quiver tree in response to increasingly harsh conditions;
- Succulents in the Karoo provide empirical warning signs of distress and rapid mortality in warming chambers that increase the air temperature by 5.5°C (a temperature scenario we could encounter between 2050 and 2100 if CO_2 levels continue to rise at current rates);
- Woody alien invasives thrive in a CO_2 rich environment; faster-than-usual growth can therefore indicate rising levels of atmospheric CO_2.

The Protected Area System

National protected area legislation in South Africa has recently been reformed. A new Protected Areas Act was passed in 2003. It proposes a new system of protected areas comprising special nature reserves, national parks, nature reserves (including wilderness areas) and protected environments (DEAT 2003). Eventually this will result in an interlocking system of conservation areas that explicitly encourages the cooperation of private landowners through conservation stewardships.

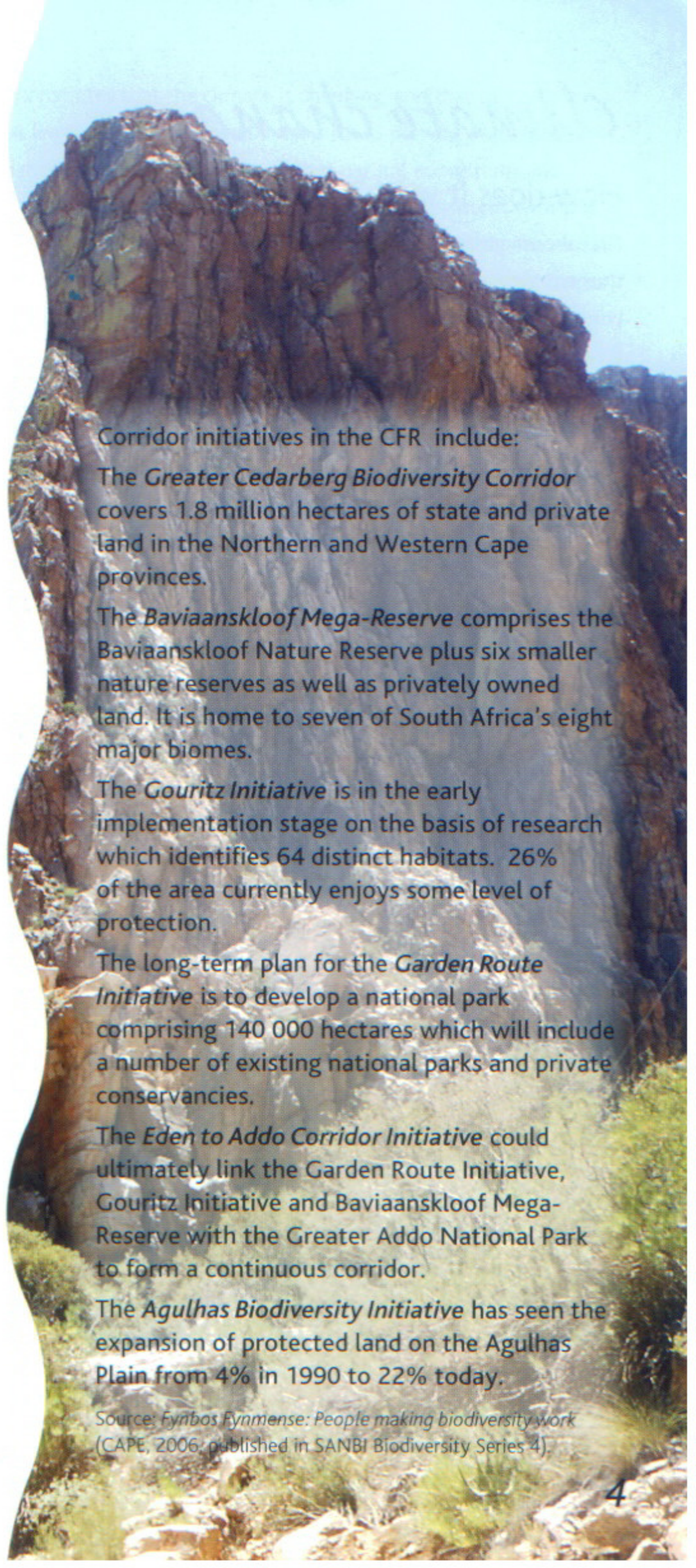
The corridor initiatives hold hope for shifting old patterns of competing land use interests on the basis of shared longer-term futures.

Currently, more than 75% of the total area of the CFR is privately owned. Private landowners interested in negotiating agreements with protected areas can choose between Conservancies, which are not legally binding; Biodiversity Agreements which are longer-term but don't involve re-zoning of land and are less formal; and Contractual Park Agreements, according to which the landowner agrees to re-zoning. In the latter case, the land is proclaimed a nature reserve in perpetuity and the owner qualifies for incentives such as alien clearing and tax rebates.

Innovative systematic conservation planning exercises such as the Cape Action Plan for the Environment (CAPE) and the Succulent Karoo Ecosystem Programme (SKEP) are managing the participatory processes to consolidate and expand South Africa's protected area system. The National Spatial Biodiversity Assessment identifies priority areas to inform action plans for each identified area through a five-year cycle of reviews and revisions.

"The loose, goodwill land agreements are fantastic and may build up to something more. They're very useful in areas that are not high priority biodiversity [but] we have to distinguish between formally declared protected areas and those which could change if the land was sold to someone with less goodwill."

Biodiversity mapping expert



Corridor initiatives in the CFR include:

The *Greater Cedarberg Biodiversity Corridor* covers 1.8 million hectares of state and private land in the Northern and Western Cape provinces.

The *Baviaanskloof Mega-Reserve* comprises the Baviaanskloof Nature Reserve plus six smaller nature reserves as well as privately owned land. It is home to seven of South Africa's eight major biomes.

The *Gouritz Initiative* is in the early implementation stage on the basis of research which identifies 64 distinct habitats. 26% of the area currently enjoys some level of protection.

The long-term plan for the *Garden Route Initiative* is to develop a national park comprising 140 000 hectares which will include a number of existing national parks and private conservancies.

The *Eden to Addo Corridor Initiative* could ultimately link the Garden Route Initiative, Gouritz Initiative and Baviaanskloof Mega-Reserve with the Greater Addo National Park to form a continuous corridor.

The *Agulhas Biodiversity Initiative* has seen the expansion of protected land on the Agulhas Plain from 4% in 1990 to 22% today.

Source: *Fynbos Fynmense: People making biodiversity work* (CAPE, 2006, published in SANBI Biodiversity Series 4).

Climate change:

How does it work?

Greenhouse gases (especially CO_2 and methane) trap heat in the atmosphere, thus ensuring a moderate temperature on our planet. However, as we burn fuels made from fossil deposits of carbon, we release additional greenhouse gases, causing greater heat absorption, and resulting in changes to temperature, precipitation and atmospheric circulation patterns. Projected climate change trends in the CFR indicate later arrival of winter rainfall, and drying especially towards the southwest. In eastern regions, some increases in intense rainfall events, and more summer rainfall from January onwards have been projected. Temperatures are expected to rise everywhere, with the sharpest increases inland. We can expect changes in averages (such as temperature) and changes in extremes (such as extreme rainfall events). The uncertainties in rainfall projections in the east are high, but there is greater certainty of rainfall reductions in the west, and greatest certainty in increased temperatures across the entire region.

Where's the evidence?

Scientists have tracked changes to the climate by measuring variations in global temperatures, in the air, the oceans and by monitoring glaciers and other key indicators. There is now overwhelming evidence from around the

Global warming indicators

Temperatures: The ten hottest years on record from 1880 have all been since 1990 (*State of the World*, 2006:44)

Glaciers: The Arctic sea ice has thinned by 40% since the 1950s. In the Antarctic, the five most northerly ice shelves retreated dramatically between 1945 and 1995. Glaciers in the European Alps have lost half their volume since the 1850s (*The Heat is On,* 2001:1)

Oceans: Global sea levels rose 10-25 cm in the last century

It is worth noting that global trends may manifest differently at the regional level.

Mitigation and adaptation

Mitigation: Interventions to reduce sources or enhance sinks of greenhouse gases

Adaptation: Adjustments in human or natural systems in response to change.

In other words, mitigation actions seek to prevent change while adaptation aims to cope with change that has already occurred.

Resilience and vulnerability:

key concepts for understanding threats

The same threat can have different impacts, depending on the vulnerability or resilience of the human or natural system under threat.

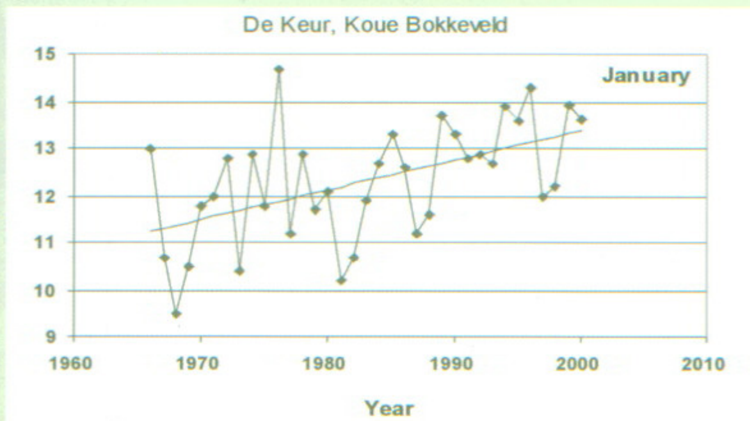
Vulnerability: The likelihood of suffering harm from external stresses and changes. Vulnerability is related to sensitivity and adaptability.

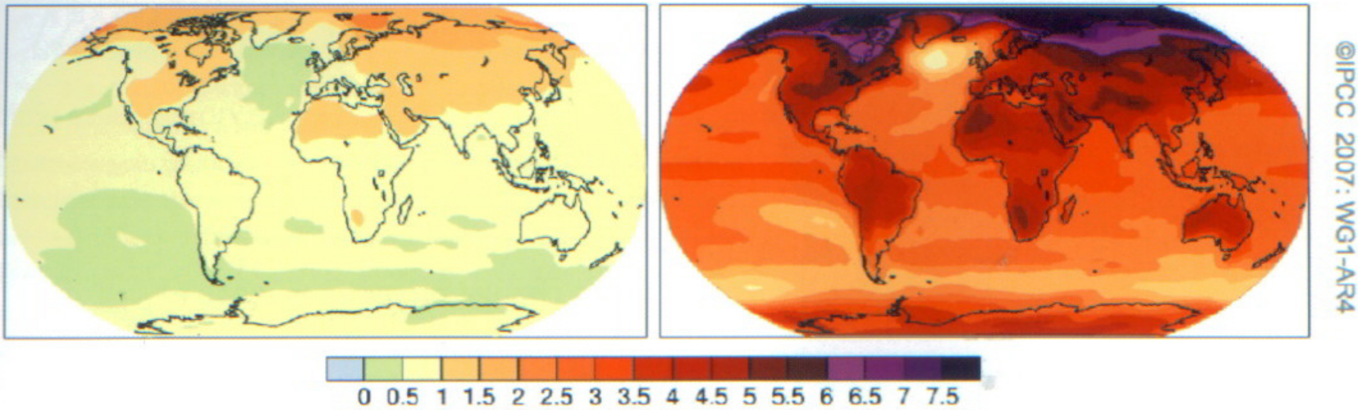
Resilience: The flip side of vulnerability. Resilience provides the capacity to absorb shocks while maintaining function. When change occurs, resilience provides the components for renewal and reorganisation. (Folke *et al*, 2002: 4)

world that demonstrates that the climate is changing, and that this is to a large degree, at least, due to human activities such as burning of fossil fuels. There is also a massive amount of evidence that natural ecosystems and species are responding to these changes in a way that is consistent with our understanding of what should be happening under a warming climate. In the Cape, there is clear evidence that temperatures have risen by about 1°C since the 1970's (see figure for de Keur in the Koue Bokkeveld).

Are climate change projections reliable?

Projections of climate change are very different from weather forecasts. Weather forecasts can be made accurately only days into the future using sophisticated climate models, because the weather is affected by so many interacting factors. Small inaccuracies in measurement of pressure, humidity, windspeed or ocean temperatures, for example, add up over days to large effects. Therefore weather forecasters are continuously dependent on updated measurements to keep their predictions on track. Climate, on the other hand, represents an aggregate of weather conditions over seasons and years. Climate change projections are not concerned with details of the weather in, say 2050, but rather the overall state of the atmosphere, such as the change in position of high and low pressure systems due to changes in the energy and water content of the atmosphere, caused by rising levels of greenhouse gases. Climate models have now been shown to do a reliable job of simulating these changes. Nonetheless, there are still several uncertainties inherent in climate change projections, but these are rapidly being narrowed as the science progresses.



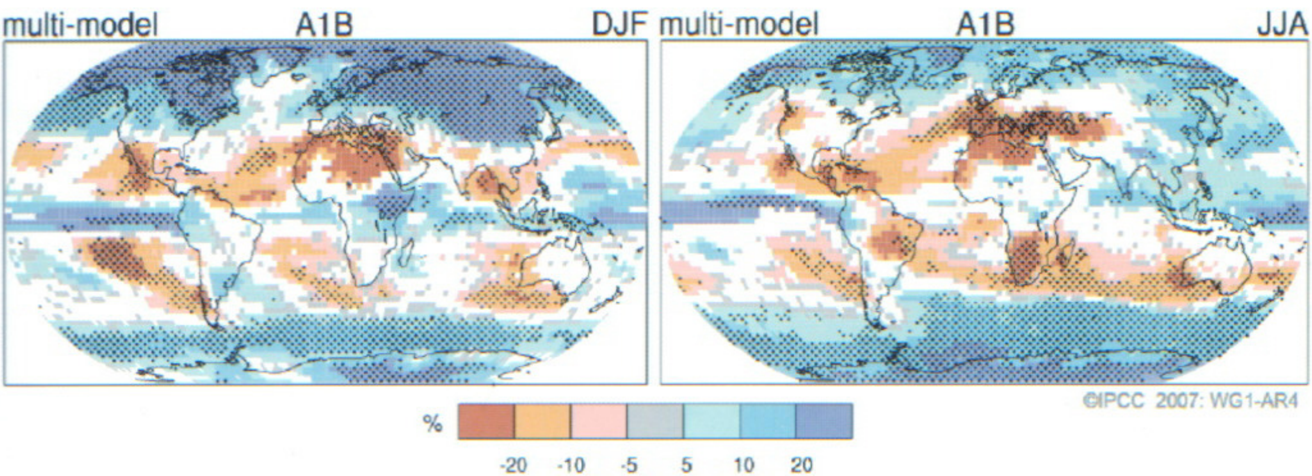


Changes in mean annual global temperature (°C; top) by 2020-2029 (left) and 2080-2099 (right) and rainfall by 2080-2099 (in %; bottom) in the austral summer (left) and austral winter (right) with fairly conservative assumptions of global fossil fuel use, as projected by the IPCC in 2007.

Stippled regions in the bottom figures refer to regions where more than 66% of the models agree on the sign of the projected change.

What are the latest climate projections?

Climate projections are made at a global level using mathematical models of climate that are encoded into computer programs called General Circulation Models (GCM's). These have been developed by several groups around the world (e.g. in the USA, UK, Germany, Japan, and Australia). This work has been drawn together and reviewed by the Intergovernmental Panel on Climate Change (IPCC), which produces reports on climate change roughly every six years (see http://www.ipcc.ch/). The latest report suggests significant increases in temperature for southern Africa by as early as the 2020's, but especially towards the end of this century, and very likely reductions in winter rainfall (see figures). Together, these trends are very likely to put considerable stress on the ecosystems of the CFR.



Ecosystem services:

Ecosystems provide a plethora of goods and services that support the functioning of the biosphere as a life-support system, and deliver tangible benefits to society.

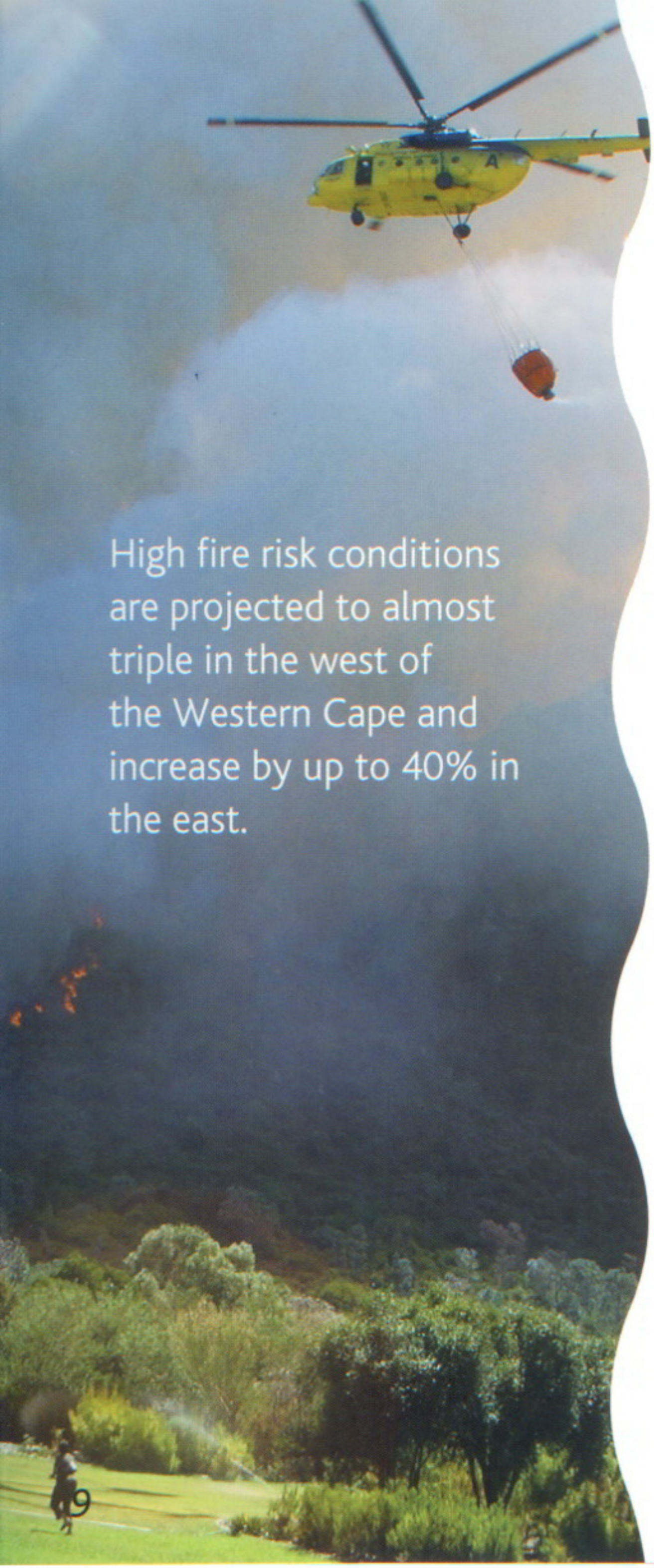
Some of these, such as water purification and pollination, are well known. Others, such as the storage of carbon, are not as obvious, yet vital for climate regulation and human welfare. Some ecosystems services are not of direct use to people, but underpin goods and services of more direct use to people.

These "supporting services" include the processes of soil formation, local climate regulation, and nutrient cycling, all of which are needed for a healthy and resilient ecosystem.

Ecosystems also maintain biodiversity, an increasingly valuable resource that is the basis for many goods and services we enjoy.

Over 95% of the main river ecosystems of the Berg, Breede and Gouritz are critically threatened.

(Nel *et al*, 2004, in Midgley *et al*, 2005:39).



High fire risk conditions are projected to almost triple in the west of the Western Cape and increase by up to 40% in the east.

Impacts on biodiversity

People and plants in the CFR

Impacts are inter-connected, which makes projecting their results complicated. Changes in natural and social systems affect each other, often in unpredictable ways. Nonetheless, one result is already clear: the first to suffer the consequences of climate change are likely to be poor people, whose livelihoods are most vulnerable to stresses and shocks and who are usually constrained to living in high-risk areas.

The impacts of a warmer and possibly drier climate on the CFR will depend on the rate and extent of future changes, especially in terms of seasonality, frequency and intensity of rainfall. At present, the CFR is a winter rainfall region. Apart from the direct effects of heat and drought on Fynbos species, complex interactions between indigenous and invasive alien plants, fuel loads, the seasonality, frequency and intensity of fires, local wind and weather patterns and water balance will all play a key role in changing biodiversity patterns and processes. Some of these dynamic natural processes are discussed in more detail below.

Physical impacts: Aquatic and terrestrial

Available **water**, both surface and groundwater, is already fully committed in most parts of the province, with irrigation being the thirstiest consumer. The rate of exploitation is unsustainable in some places, pushing beyond recharge rates or into the ecological reserve. Demand continues to grow, particularly from agriculture, the Cape Metropolitan Area and the coastal resort towns. A drier scenario has severe implications for the competing interests of environmental integrity and socio-economic development. It is fair to speak of a looming water crisis in the Western Cape. The ecological integrity of wetlands, rivers and estuaries will be significantly affected, with resulting impacts on the livelihoods and natural ecosystems they support. Some water-related biodiversity will be lost, possibly irretrievably.

Rivers, wetlands and estuaries are highly productive sites in both an economic and ecological context. They provide habitat and breeding grounds for a wide range of fauna and flora, including fish and birds, and play a vital stabilising role by providing fresh water, cycling nutrients, diluting pollution, reducing floods or sea water intrusions, storing water and recharging ground water. The dessication effect of climate change will compromise these services significantly. The majority of Western Cape estuaries - those parts of river systems which have contact with the sea from time to time - are already in a poor state. Climate change presents estuaries with increased competition from agricultural and urban demands for water.

Even if fossil fuel emissions were to cease today, we face a **sea level rise** of up to 0.3m, the impacts of which will only become evident roughly 30 years from now. In terms of **coastline** impact, we can expect to see increased salt water intrusion and raised groundwater levels, an increase in the frequency and extent of flooding associated with extreme storm events, and coastal erosion. The sandy nature of much of the Western Cape's coastline makes it particularly vulnerable to erosion.

Worst case climate change scenarios paint a picture of 30% species loss in the Western Cape's **biodiversity** hotspots. This can be understood through the interplay of climate change dynamics - hotter and drier conditions, changing fire regimes and shifting patterns of invasion by alien plants. Tolerance limits, the key determining factor in the presence of these influences, are not yet fully understood – which makes it difficult to accurately anticipate what events will lead to mortality among which plant and animal species. The way in which patterns of alien invasion will shift in response to climate change is a factor of competing processes. Overall, woody **alien invasion** is set to expand, at a rate determined by the interaction between hotter and drier conditions, wildfire regimes and alien clearing projects, as well as the level of atmospheric CO_2 which feeds the growth of woody aliens. As hotter and drier conditions become more prevalent, **fires** will burn more often, over more extensive areas, with the concomitant possibility of the fire cycles over larger areas becoming synchronised. This means more Fynbos populations would be present only as immature plants, burned before they can set their seeds.

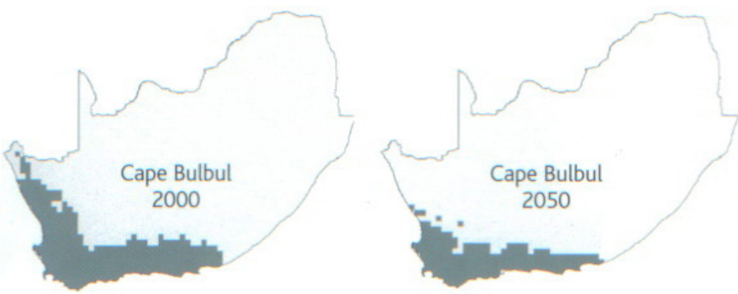
What does this mean for Fynbos?

It is known that organisms and species have preferences for certain climates, such as combinations of temperatures and rainfall. This is often controlled by the physiological tolerances of species (e.g. high temperature stress limits for growth, flowering or seed production, in the case of plants).

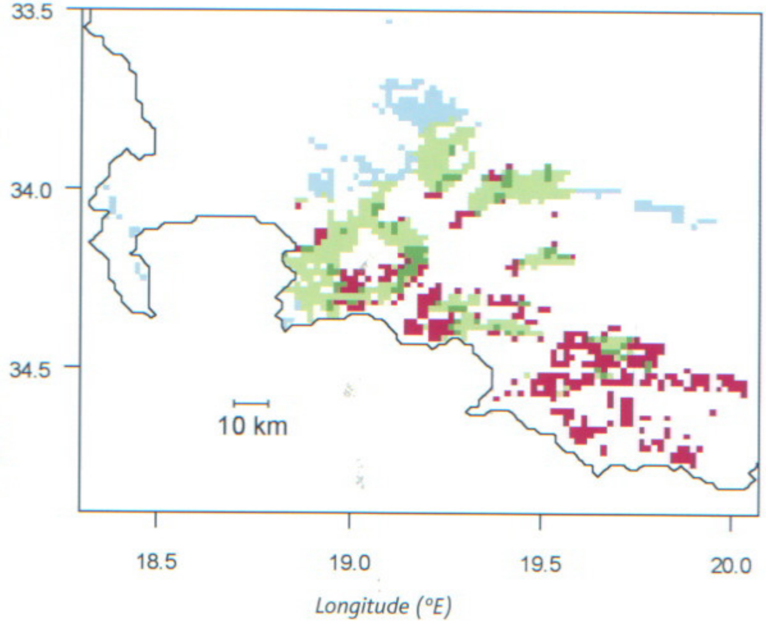
As the climate changes, so the climate zones that are suitable for individual species will shift, and the species will either adapt over time through selection, or the species will shift its geographic range, or will go locally extinct. Thus in general, climate change is likely to lead to impacts on species distributions (i.e. the ranges in which species can occur), and community composition (the mix of species at any point).

But climate change also changes the rates at which water evaporates from plants and soils, and can affect the conditions for the occurrence of fire. In this way, ecosystem functioning is affected (including water yield and nutrient cycling), disturbance regimes (such as fire), and ecosystem services (see previous page). At worst, this combination of stresses might result in extinctions of species that are not able to adapt to rapidly changing climates.

Modelling the geographic ranges of species shows that they tend to shrink for endemic CFR species, mainly because the CFR is already at the southern tip of the African continent, and with warming climates, geographic ranges of species contract up mountain slopes or are forced southwards, out into the ocean (see Figure for endemic Cape birds).



The range of the Cape bulbul at present, and projected by 2050 with climate change (after Simmons et al *(2005),* Ostrich *75(4):95–308).*



Protea longifolia – *showing regions where by 2050 the species' geographic range contracts (purple); stays in place (dark green); expands within range of its dispersal potential (light green) and where it could grow, but it is unable to reach by natural dispersal (light blue). From Schurr* et al. *(in press,* Global Ecology and Biogeography*).*

Such a shifting of range threatens current conservation efforts that rely on static protected areas. For example, Rutherford *et al* (1999) project that four out of five protected areas in South Africa will lose roughly 10 – 40% of their plant species by 2050. On the other hand, climate change might benefit species and ecosystems in protected areas by increasing the degree of protection they are afforded against other human pressures.

However, we need to understand more about vulnerability and resilience of species and ecosystems in order to forecast and assess more credibly the likely impacts on plants and people. It is crucial that we continue developing an ever keener understanding of how species distributions are controlled in order to model their likely responses. We also need to reduce uncertainties in our projections of the future climate by modelling regional climate change with greater confidence. Advances in all these areas would allow us to present decision-makers with much clearer future scenarios.

Vulnerabilities to climate change

Vulnerability to climate change is a measure of both sensitivity to change and the ability to adapt. Climate change does not impose blanket risks, as the level of risk depends both on specific existing conditions (such as exposure to climate stresses) and the resilience of species and ecosystems being affected (a measure of both sensitivity and ability to adapt).

Research indicates, for instance, that certain members of the Proteaceae will be among the most vulnerable of Fynbos plants to climate change, even in the near future. This is because they appear to show both a high sensitivity to climate change, and are exposed by being located on flat coastal plains. Their ability to adapt by migration is therefore limited as they are unable to migrate to cooler, higher altitudes. On the other hand, Proteaceae in mountainous regions within the CFR would seem much better able to adapt through migration. This indicates a need to better understand species-specific abilities to disperse seeds and establish new viable populations in the case of mountain-bound species, and possibilities for active translocation of populations from species on plains.

What makes a protected area more vulnerable to change?

The protected areas system in the CFR is faced with many challenges even without climate change. For example, it is insufficiently representative of biodiversity patterns and processes, and it needs to be managed more efficiently and effectively for both biodiversity and people. Climate change will exacerbate these challenges, especially if species are likely to shift geographically as their optimum climate zones shift, shrink or even disappear. Coping with fire and alien invasive species may become even more difficult. Therefore, a good understanding of the basic principles of ecosystem functioning will be essential in sustainable management approaches. Greater knowledge will allow assessment of growing new risks, and will allow us to answer questions such as: Will additional measures taken now to limit the spread of alien invasive species pay off in the long run?

Potential climate change impacts on biodiversity

1 **Species distributions**

- Individualistic species responses in latitudinal and altitudinal directions
- Individualistic species responses to warmer/cooler and drier/moister conditions
- Geographic variation in the magnitude of species responses to the changing conditions
- Species range shifts/losses due to range expansions, contractions and eliminations
- Species range shifts relative to reserve boundaries: net loss/gain of species in reserves
- Local, regional and global extinctions of species due to the changing conditions
- Spread of invasive alien species and/or pathogens and parasites

2 **Community composition and configuration**

- Changes in presence/absence and relative/absolute abundance (evenness/richness)
- Formation of non-analogue communities (new species assemblages)

3 **Ecosystem functioning, services and states**

- Changes in phenology (the timing of events such as flowering)
- Changes in nutrient cycling and natural resource supply (e.g. water)
- Changes in predator-prey, parasite-host, plant-pollinator and plant-disperser relationships
- Changes in ecosystem services such as pest control, pollination and soil stabilization
- Ecosystem switches following changes in ecosystem functioning and disturbance regimes

4 **Disturbance regimes**

- Changes in the intensity, frequency and seasonality of periodic and extreme events such as fires, floods, droughts and other extreme weather events
- Changes in human land use pressures (global change synergies)

Source: *Securing Protected Areas in the Face of Global Change*. Bomhard and Midgley (2005)

Spatial limitations of protected areas increase vulnerability to change

Examples of "reserves at risk" in the CFR:

Small reserves

Bontebok National Park, Robberg Nature and Marine Reserve

Reserves with rare or threatened species with restricted habitats or home ranges

Table Mountain National Park, Cape Flats Nature Reserves, Kogelberg Nature Reserve

Reserves with high-altitude environments

Cape Fold Mountain Catchment Areas, Swartberg Nature Reserve

Reserves with low-altitude environments

West Coast National Park, Cape Flats Nature Reserves

Reserves with species at the limits of their latitudinal or altitudinal range

Table Mountain National Park, Tsitsikamma National Park, Swartberg Nature Reserve

Reserves with abrupt land use transitions outside their boundaries

Table Mountain National Park, Cape Flats Nature Reserves

Reserves without usable connecting migration corridors

Table Mountain National Park, De Hoop Nature Reserve, De Mond Nature Reserve

Reserves with rare or threatened species near the coast

Knysna National Lake Area, Langebaan Ramsar Site, Wilderness Lakes Ramsar Site

Reserves with interior wetlands

Wilderness National Park, Goukamma Nature Reserve

Sources: Shafer (1999), Bomhard and Midgley (2005)

What makes the biodiversity sector vulnerable to climate change?

Factors which render the sector more vulnerable to climate change impacts include:

- Ongoing institutional transformation and restructuring processes in the biodiversity sector;
- Loss of expertise from the sector and loss of institutional memory as a result;
- Fragmented monitoring, planning and implementation between organisations and sub-regions of the CFR;
- Off-reserve management: lack of coherent policy, insufficient capacity and a dearth of climate change education materials for private landowners;
- Failures to consistently convert monitoring data into relevant local information for reserve managers;
- Fear and paralysis in the face of alarmist messages about climate change;
- Land market and competing demands for land, which can cause tensions within the sector;
- The role of climate change denialists;
- Information for reserve managers.

Surveys show that while the majority of people in the CFR's biodiversity sector perceive that climate change is a real phenomenon, most feel overwhelmed by the implications. This is a key vulnerability, but a temporary one if role-players receive information and support to respond to climate change challenges appropriately.

What makes the biodiversity sector more resilient to change?

- Research collaborations, such as that which produced a *Status Quo* Report on climate change impacts in the Western Cape, commissioned by the provincial government in 2005;
- Ongoing documentation of lessons learned by ecological corridor initiatives;
- Active interest and support of key funders;
- Goodwill across the local biodiversity sector, evidenced by the annual Fynbos Forum (now in its 30th year)
- The strategic co-ordinating role played by Cape Action for People and the Environment (CAPE) and its counterparts in other biomes;
- The frequency with which the sector meets, shares information and engages with common challenges. Both the quality of networking relationships and the quality of information are high; and
- An orientation that embraces learning.

Resilience to climate change

Natural resilience of Fynbos

Fynbos is naturally resilient, and has adapted and persisted with historical climate changes for millennia. Under changing climates of the past, its component species either migrated to landscapes to which they were better suited, or underwent genetic adaptation *in situ*. However, with the accelerated rates of change and unprecedented levels of temperature and drought, the natural resilience afforded by these adaptive responses may be exceeded. How might we best enhance this natural resilience? A strong argument for ecological corridors in enhancing resilience is that they facilitate natural migration patterns in response to changes in temperature and precipitation.

We now suspect that most Fynbos species do not migrate far or fast and there is still much research to be done to establish what kinds of corridors different species may require. What constitutes a corridor for a pollinating bee, for example?

Ultimately, it is also important to establish to some level of certainty what a safe level and rate of climate change might be. This knowledge will be critical in guiding our contribution to the global debate on how rapidly to reduce reliance on fossil energy sources.

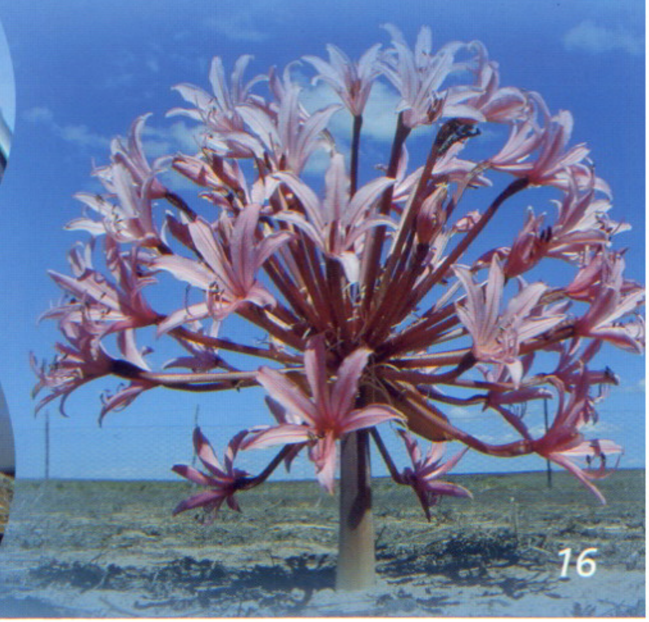
Opportunities

Climate change presents opportunities for new research and for interesting collaborations between researchers. Change has attracted the attention of funders, resulting in more money being available to the biodiversity sector. Most importantly, it has raised awareness about crucial issues that otherwise were in danger of being overlooked. The public is more attuned to the natural environment and the biodiversity sector is more attuned to what happens beyond protected area boundaries. Old patterns of perceiving the natural and social systems as isolated and separate are challenged. Climate change presents us with the opportunity to understand the symbiotic relationship between the two.

What can we do?

Lessons and recommendations

Climate change demands three elements of response: ***Strong political leadership*** (substantial policy development at global, national and local level, and fine-scale planning), ***good science***, and significant human ***behaviour change*** in the way that we consume natural resources.



Conservation responses

The conservation challenges brought into play by climate change require integrated conservation strategies to bolster biodiversity's adaptation to climate change. Important insights into climate change-integrated strategies have been gained in the CFR.

Alien plant management and associated fire management are key strategies which make sense both for the current health of indigenous terrestrial ecosystems and for their future persistence. Monitoring of flagship indicator species and populations will be critical in improving our understanding of species responses to climate change and in identifying early warning signs of impacts.

Careful assessment of the protected area system and its expansion where possible, combined with sensible reductions in other human-induced stresses on ecosystems, and involvement of commercial land managers in reducing impacts, will increase the adaptive capacity of natural landscapes and ecosystems. Possible *ex situ* conservation or transfer of key threatened species to new sites in the wild may be necessary in extreme cases.

Some of these options are considered in more detail below.

Regional modelling and monitoring of climate change and biodiversity responses to climate change.

There is recognition that species, rather than communities, are the unit of biotic response to climate change, providing a much richer and more realistic picture of projected changes. Even so, it is also critical to acknowledge that disturbance regimes such as fire create a set of ecological rules that govern the persistence of whole groups of species. If fire frequencies increase, for example, slow maturing species are increasingly likely to suffer the consequences as a group. Ultimately though, species may be more useful in establishing early warning systems in the CFR, with a monitoring effort focussed by regional modelling projections.

This combined approach will serve as a test of modelling projections, and to support proactive rather than reactive management approaches. There is still much to be learned about simultaneous assessment of multiple threats. Regional modelling of climate change impacts on invasive alien species and disturbance regimes is a critical component given their important influence on many ecosystems.

Systematic conservation planning, including reserve site selection, with climate change as an integral factor.

The geographic range of a significant species is a key indicator when seeking reserve sites. Climate change prompts planners to identify sites where current and future species ranges - due to migration in response to climate change – overlap. This creates opportunities for working creatively with the existing reserve network under changing climate scenarios.

Management across regional landscapes, including reserves and their surrounds, with climate change as an integral factor.

There is potential for the climate change principles that shaped landscape planning to be lost at management level. The challenge is to keep longer-term and less visible climate change threats in view while managing the more immediate challenges in the CFR.

Regional co-ordination across national and provincial borders and local implementation of land use planning, decision-making and management.

Co-ordination across political boundaries (municipal, provincial, national and international) is vital for anticipating climate change impacts and making decisions on a matching scale. However, even the most ambitious national and regional conservation plans will eventually be implemented locally. The CFR has already learned important lessons about coarse scale co-ordination through regional participatory planning processes that establish overarching frameworks for biodiversity conservation, led by CAPE (Cape Action Plan for People and the Environment) and SKEP (Succulent Karoo Environmental Plan). The Cape Lowlands Renosterveld Project is a good example of a pioneering model of fine-scale implementation and planning process.

In summary, conservation can apply a range of more or less interventionist practices to protect biodiversity from climate change threats. Increasingly, there is an emphasis on facilitating natural responses, although more extreme measures such as gene and seed banking have not been ruled out.

Organisational responses

The principles that guide the facilitation of natural responses to climate change can be applied to the organisations responsible for protecting biodiversity from threats. Four key principles that translate from conservation actions to organisational behaviour are:

Principle 1: Develop mega-reserves of protected and private land / **Think big**

- Act decisively;
- Build strong leadership on climate change in the biodiversity sector;
- Provide public leadership by bringing information about impacts on ecological goods and services to the attention of broader society; and
- Lobby for policy change on the basis of well-researched climate change scenarios.

Principle 2: Establish corridors to connect fragmented landscapes / **Connect**

- Link monitoring to analysis and provide an information feedback loop to management teams in protected areas;
- Link monitoring and modelling to policy change;
- Link scientists with non-scientists in the sector;
- Involve planners in implementation advisory roles;
- Connect with the purpose of the work;
- Keep action-learning cycles intact; and
- Network.

Principle 3: Integrate off-reserve land / **Integrate**

- Bring a transdisciplinary approach to the work;
- Develop ideas co-operatively – draw on the "wisdom of crowds";
- Apply joined-up thinking;
- Integrate climate change adaptation into planning processes;
- Integrate climate change planning logic into the implementation and ongoing management of biodiversity projects; and
- Work towards win-win scenarios with different interest groups.

Principle 4: Protect and enhance *in situ* transformation / **Work with what you have**

- Build capacity;
- Value local adaptation initiatives; and
- Encourage creativity.

The key learning is that adapting to climate change does not mean letting go of what has been learned so far. Climate change presents the biodiversity sector with opportunities to get back to basics and to commit to fundamental, resilience-based principles.

Adaptive organisational strategies: Lessons learned

- Adaptation to climate change means preparing for future change, even where some uncertainty exists;
- Good preparation means putting shock absorbers in place, to increase resilience in the face of risk;
- Resilience can be enhanced by positive attitudes; resilience can be woven into organisational culture but it can also be implemented by ensuring a core of consistent staff who sustain the institutional memory, and a core budget. Resilience means creating structures that are better able to cope with the unexpected;
- Decisive action is possible, even while some knowledge gaps remain open;
- The active engagement of decision-makers is vital. It is possible for the scientists to paint scenarios in enough detail to give decision-makers clear choices, based on a range of likelihoods;
- Policy-makers have a range of options available to them, from rewarding behaviour change to regulating it;
- Public attitudes are changing. People are more interested in climate change now than they were a few years ago; are more receptive to useful information, and more able to articulate what information they need;
- People respond to information that is relevant to them. Information about climate change that answers the question, "What will this mean for me" is more likely to galvanise action by policy-makers, conservationists and members of communities;

- Making economic linkages can be very powerful. Drawing connections between climate change and related issues that have more immediate urgency and relevance (such as water shortages) can attract attention;
- We are challenged to keep climate change messages clear and not create the kind of alarm that freezes people into inaction;
- Action includes two main threads: treading more lightly on resource use (which means some re-prioritising and changing of consumption patterns in private and professional life) and finding more effective ways to protect and preserve (naturally adapting) biodiversity. This second area of work will be informed by monitoring species assumed to be climate change 'winners' and 'losers' - if scientists can identify what is most worth saving, this will facilitate major investment in protection strategies. Ecosystem functions and services that benefit human well-being should stay at the forefront of this work;
- There is no one climate change adaptation goal. Instead, there are tiers of goals. It is important to have achievable goals that offer rewards as well as longer-term more complex goals. Working towards a shared set of goals, and ensuring that there are incentives along the way requires co-ordination;

- There is no one solution, but many ways of addressing local challenges at a local level;
- Different organisations in the biodiversity sector offer different kinds of resilience. Some are more able to take risks. Others have established strong relationships with vulnerable communities. Still others successfully connect local biodiversity initiatives with international expertise. There is no one-size-fits-all. If organisations recognise what makes them resilient and can contribute these strengths to the overall resilience of the sector, the bigger picture starts to emerge. This needs both co-ordination and leadership at a birds-eye view level of the whole system; and
- Climate change needs leaders who can manage and communicate the complexity of inter-connected threats and pressures, and who can articulate the ways in which climate change links to existing challenges, but also creates new opportunities. Leaders who understand that valuable learning happens through making mistakes and reflecting on what 'went wrong', and who can create the space for this kind of learning. Good leaders can reach people across the diversity of the CFR.

Communication strategies

Communicating about climate change is a complex task. Most audiences struggle with the lack of certainty about precise impacts in climate change messages. However, the majority of people surveyed in the biodiversity sector state that consistent, reliable and relevant information would enable them to take action in response to climate change. Those responsible for keeping the sector informed may find that their messages are most effective if they:

- cater for the different information needs of different role-players. For example, corridor initiatives channel information to private land-owners and therefore seek information that meets their own knowledge needs, as well as information packaged for time-strapped farmers;
- assume that the basics of climate change are not clearly understood by most audiences, even those that have been exposed to climate change information in the past, and that revisiting the basics in most presentations will benefit engagement with more complex messages; and
- give people working in protected areas regular and constructive feedback about the adaptation or mitigation strategies they have adopted.

Glossary

Anthropogenic: human-made. Used in this context to refer to greenhouse gas emissions that are produced as the result of human activities, or climate change that results from these.

Biome: A grouping of similar plant and animal communities into broad landscape units that occur under similar environmental conditions.

Biodiversity: The numbers and relative abundances of different genes (genetic diversity), species, communities and ecosystems in a particular area. More generally, biodiversity refers to the variety of life on earth at all these levels.

Endemic species: Restricted or peculiar to a locality or region. With regard to human health, endemic can refer to a disease or agent present or usually prevalent in a population or geographical area at all times.

Greenhouse gases: gases such as water vapour, carbon dioxide, methane and nitrogen oxides that absorb and trap the energy of sunlight within the Earth's atmosphere, causing it to warm up.

Hotspot (biodiversity): a region with exceptionally large numbers of species, but also threatened by human activities.

Further information

PALNet, the Protected Areas Learning Network, facilitates interaction and sharing of experience between people responsible for protected area policy and management:

www.parksnet.org

SANBI, the South African National Biodiversity Institute:

www.sanbi.org.

IPCC, the International Panel for Climate Change:

www.ipcc.ch/

You might also want to read...

Midgley, G. *et al.* 2005. ***A Status Quo, Vulnerability and Adaptation Assessment of the Physical and Socio-Economic Effects of Climate Change in the Western Cape.*** Commissioned by the Western Cape Department of Environmental Affairs and Development Planning.

Midgely, G., Rutherford, M. & Bond, W. 2001. ***The Heat is On: Impacts of climate change on plant diversity in South Africa.*** Published by SANBI: Cape Town

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