CLIMATE CHANGE

Protecting South Africa's national parks against the threat of climate change

An assessment of the vulnerability of South Africa's national parks to climate change is informing the development of adaptation strategies. Article by Sue Matthews.

Sue Matthews

We like to think of our national parks as refuges where plants and animals are largely safe from human interference, apart from the minor disturbance caused by park visitors and staff, and all the infrastructure required to support them. The reality, of course, is that national parks are subject to many of the same pressures facing natural environments beyond their borders, such as the spread of invasive alien species, reduced water quantity and quality in rivers flowing through the park and – far more insidious and difficult to remedy – the threat of climate change.

In 2016 South African National Parks (SANParks) published *Taking Stock of Parks in a Changing World*, an assessment of six drivers of environmental change – climate change, land-use change, disease, alien species, change in freshwater systems and resource use – in the 19 parks. The report emphasised that these drivers influence and interact with one another, so climate change should not be seen in isolation, but it was recognised that a climate change adaptation strategy was needed for the parks.

SANParks' Landscape Ecologist, Dr Mmoto Masubelele, based at the Cape Research Centre, was given overall responsibility for developing this strategy.

"Initially it was planned to be a broad document that identified priority actions around species and ecosystems, such as establishing migration corridors and restoring ecosystem services," he explains. "Subsequently it was realised that an implementation plan for each of the parks was more appropriate."

The process was informed by collaboration with Prof Wendy Foden of the University of Stellenbosch, who chairs the Climate Change Specialist Group of the IUCN Species Survival

Commission (SSC). She also led the development of the IUCN SSC Guidelines for Assessing Species' Vulnerability to Climate Change, published in 2016, and currently coordinates the African component of the Spatial Planning for Protected Areas in Response to Climate Change (SPARC) project, which is funded by the Global Environment Facility (GEF) and implemented by Conservation International.

"The globally accepted approach for developing adaptation strategies has essentially four steps: identify conservation targets, assess vulnerability to climate change, identify management options and then implement them. Ongoing monitoring, review and revision of each step is essential for ensuring that strategies are effective, particularly as understanding of climate change impacts and the adaptation approaches grows. Assessing vulnerability to climate change is extremely important, because if you don't know what's likely to go wrong, how can you know what to do about it?" she says.

"Vulnerability is a combination of how exposed you are – what change is coming your way – how sensitive you are – your ability to stick it out where you are – and your adaptive capacity – whether you can escape, either by moving or by changing yourself or your behaviour. From a species perspective, the approach that many conservation organisations internationally have taken is to examine how much climate change each species is exposed to, and then to look at its traits, such as those relating to dispersal and physiology, to figure out how sensitive and adaptive that's going to make it."

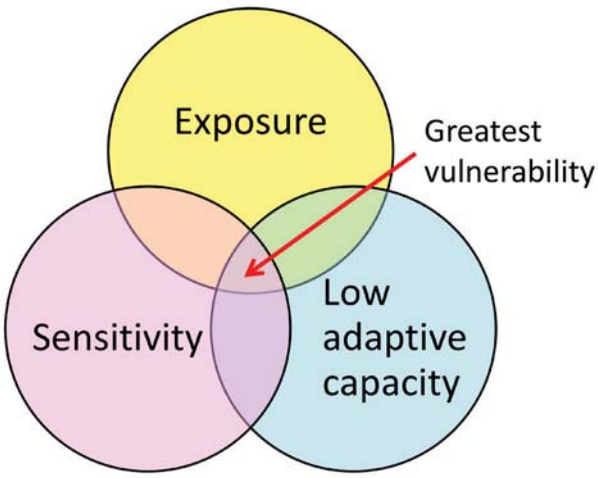
A presentation by Prof Foden to the 2017 Masters students at the University of Cape Town's African Climate and Development Initiative (ACDI) piqued the interest of Kevin Coldrey, who approached her about applying the SSC Guidelines for a vulnerability assessment of protected areas for his MPhil research project. Rather than just focusing on species, though, he decided to expand the scope of the vulnerability assessment to include the socio-economic impacts of climate change that affect the conservation mandate of protected areas. This would entail developing a new methodology, which he would apply to the 19 national parks as a test case.

Ultimately, he selected five categories of impact to investigate – species, ecosystems, infrastructure, tourism and neighbouring communities. The approach recognises that climate change is likely to cause shifts in the distribution of species and biomes, and further threaten vulnerable species, potentially resulting in the disappearance of some species from particular national parks and a change in dominance from, for example, grassland to savanna. Apart from these direct biodiversity impacts, the three socio-economic categories may indirectly impact biodiversity by negatively affecting the finance and governance of a protected area, which makes conservation more challenging.

Park infrastructure will in future be at increased risk of being damaged by extreme weather events, sea level rise and fire, which will have a knock-on effect for tourism when road networks and accommodation are affected. Tourism is predicted to be negatively impacted by climate change in several other possible ways too, such as higher temperatures, raising discomfort levels to the point that tourists avoid visiting a park during the summer months, the loss of charismatic species from particular parks and/or increased bush encroachment – both of which impede the game-viewing experience – as well as altered malaria risk, even at parks that were previously malaria-free. Lastly, the 'neighbouring communities' category refers to poor communities in the vicinity who might demand access to a park's natural resources for food, firewood, traditional medicines and craft materials – or simply resort to poaching or illegal harvesting – as they become increasingly stressed by climate change.

Coldrey's methodology relied on a number of different indicators, models and datasets to assess these impacts, but one of the first tasks was to consider how different each park's temperature and rainfall regimes might be in the future, compared to the present day. The 2016 SANParks report included a retrospective analysis of available weather station data up to 2009 to identify temperature and rainfall trends, which had produced some startling results. It was found, for example, that the average maximum temperature at Twee Rivieren in the Kalahari Gemsbok National Park had risen by 1.95°C between 1960 and 2009. There was a corresponding increase of 36 additional days per year when the temperature had exceeded 35°C, while minimum temperatures no longer fell below 0°C as often as they used to. No changes in total rainfall were detected in the rest camp's 90-year historical rainfall record, but some of the southern parks had experienced a reduction in rainfall, and rainfall intensity had increased in several parks. In many cases, however, trend analysis was compromised by the availability or accuracy of data, with data gaps, short time-series, and monthly rather than daily rainfall data all presenting problems.

"Based on the information we had, our report looked at how climate had actually changed, with some speculation as to what that might mean," says lead author, Dr Nicola van Wilgen. "Kevin's study takes it a step further, and asks how vulnerable that makes us."



According to the IUCN SSC Guidelines for Assessing Species' Vulnerability to Climate Change, the greatest vulnerability occurs when species are exposed to large and/or rapid climate change-driven alterations in their physical environment, are sensitive to those changes, and have low adaptive capacity.

Wikipedia

South Africa's national parks

"It is important for park managers to analyse the results of the individual assessments for their parks so as not to overlook or misinterpret the aggregated scores," he notes. "They also need to bear in mind that each potential impact category has its own level of uncertainty."

Coldrey first developed a dataset of projected temperature and rainfall for each park in the year 2050, based on outputs of the CSIR's simulations of future climate over southern Africa at 50-km resolution using the conformed-cubic atmospheric model (CCAM). He used the 'worst case scenario' – the RCP 8.5 scenario of very high greenhouse gas emissions adopted by the Intergovernmental Panel on Climate Change (IPCC) in 2014 – which predicts that by the period 2046–2065 global mean surface temperature will rise by an average 2°C, with a likely range of 1.4-2.6°C. By comparing his projected data with current climate variables, Coldrey could determine the expected change in mean annual temperature, mean annual minimum temperature, mean annual maximum temperature, days hotter than 35°C and high fire danger days, as well as mean annual rainfall, heavy rainfall days (>10 mm within 24 hours) and extreme rainfall days (>20 mm within 24 hours).

Notable findings were that the Golden Gate National Park had the largest percentage increase in all five temperature variables, while the Kruger National Park had the most marked increase in mean annual rainfall (8.8% change), and was only surpassed by Mapungubwe National Park in having more days with heavy or extreme rainfall in future. The Namaqua, Richtersveld and Tankwa Karoo National Parks were all projected to experience a 14-18% reduction in mean annual rainfall by 2050.

But what are the implications of these changes for species, ecosystems, infrastructure, tourism and neighbouring communities? The impact assessment required that various assumptions and choices be made in the modelling exercises and the weighting of aggregated indicators, so the results should be interpreted with caution. Nevertheless, the Bontebok National Park scored highest in terms of total species impact because the park was projected to contain unsuitable habitat for a number of vulnerable amphibians and the range-restricted Cape sugarbird by 2050. The Camdeboo and West Coast National Parks scored highest for ecosystems impact, with dramatic changes in biome representation.

With regard to infrastructure, the Kruger National Park had the highest value of infrastructure at risk, largely due to the potential flood damage caused to bridges over rivers, given the predicted increase in extreme rainfall. Yet it was the West Coast National Park that had by far the greatest proportion of total infrastructure at risk, because many of the park's assets lie below the 5 m contour line, and would thus be threatened by storm surge events associated with sea level rise.

The tourism impact score for each park was determined by summing four separate scores for lower occupancy rates due to discomfort related to high temperatures, malaria risk, bush encroachment and loss of charismatic species. Mapungubwe and Marakele National Parks had the highest total scores, but for different reasons. While Marakele was projected to experience an increase in malaria risk, with more than 65% of the park area expected to be stable for malaria transmission by 2050, Mapungubwe was expected to become nearly devoid of malaria. However, Mapungubwe shared the top spot with Augrabies Falls National Park in terms of potential loss of charismatic species, neither park being climatically suitable for leopard and zebra under projected conditions. Bush encroachment, partly a result of rising carbon dioxide levels, was predicted to have the most significant impact at the Addo Elephant and Marakele National Parks, while Mapungubwe and the Kruger National Parks scored highest for tourism impact due to discomfort caused by high temperatures.

"Although all parks were predicted to have at least a 25% increase in days over 35°C, this doesn't mean they will all experience an overall decline in tourism demand owing to discomfort," says Coldrey. "In fact, some parks stand to gain tourism demand. This is because the marginal decline in occupancy levels due to extreme hot temperatures in the summer months will be outweighed by the higher occupancy rates associated with increased temperature during the winter months, when the cold historically deterred people from visiting."

Another somewhat counter-intuitive result, given its urban setting, is that Table Mountain National Park scored highest in the neighbouring community impact assessment. This can be attributed to the high number of poor households in the vicinity of the park. Realistically, however, communities in urban areas will be less likely to depend on park resources than those in rural areas, because they have better access to basic services.

All of these impact scores, together with the projected temperature and rainfall, are an indication of the national parks'

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Both the climate envelope model and the dynamic global vegetation model predict that the Camdeboo National Park is likely to experience a significant change from its current biome representation, translating to a high ecosystem impact.

exposure and sensitivity to climate change, but the remaining component of the vulnerability assessment is the adaptive capacity of the parks to respond to these threats. Two measures of management performance for each park, as well as its capacity for expansion into climate-resilient corridors, were combined to give an overall adaptive capacity score. Only the Namaqua, Tankwa Karoo, Karoo and Mountain Zebra National Parks scored reasonably well in terms of their capacity to expand, based on the indicators selected. The overall adaptive capacity scores were quite uniformly spread within the 40-55% range, with Bontebok National Park scoring highest.

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The availability of suitable land to expand the Mountain Zebra National Park means that this park has a high adaptive capacity, and its overall vulnerability to climate change is relatively low.

Finally, the impact assessment scores and adaptive capacity scores were used to compute a vulnerability score. The West Coast National Park scored highest, suggesting that it is the park most vulnerable to climate change, while the Karoo National Park had the lowest ranking. Coldrey highlighted a number of caveats in his thesis discussion, however, given the constraints of the modelling approach and the omission of many other potential impacts of climate change.

"It is important for park managers to analyse the results of the individual assessments for their parks so as not to overlook or misinterpret the aggregated scores," he notes. "They also need to bear in mind that each potential impact category has its own level of uncertainty."

He concludes by noting that the next step would be to identify the adaptation options available to the different park managers, based on the results of the study. Dr Masubelele confirms that a process is under way, as the vulnerability assessment has been incorporated as an initial stage of the comprehensive framework he has drawn up for the SANParks climate change adaptation strategy.

"We sit with the park management teams and ask them what issues around climate change concern them most, working on the ground. Where there is corroboration between their concerns and Coldrey's findings, those are the priority areas we would focus on in terms of our implementation actions for adaptation."

Dr Masubelele notes that park managers have a good understanding of endemic species in their areas and the current threat status – described in the management plans for each park – and existing management actions such as alien-clearing will improve the resilience of ecosystems to climate change. Land expansion and corridor development is also ongoing, even though it is often motivated by the need to meet biodiversity conservation targets, rather than climate change adaptation. Likewise, a park manager who reroutes a coastal hiking trail inland because it is repeatedly damaged by storm seas sometimes has to be reminded that this is effectively an adaptation action against sea level rise. In addition, greening initiatives are being implemented to reduce the environmental footprint of park infrastructure, and visitors are alerted to the need to save water and electricity, which can help alleviate the threat of climate change.

"Kevin's study has helped us identify possible future scenarios to enable us to think about the problem," adds Dr Van Wilgen. "Whether or not these scenarios will be realised, it's about putting measures in place to make sure that they don't happen, or that we are prepared for what's going to happen. We have to think about novel ways of managing a situation that wasn't there a decade ago!"

Since completing his MPhil thesis, Coldrey has been contracted by Conservation International to apply the methodology to 1 500 tropical protected areas across Africa, Latin America and South-East Asia, and by WWF to use it as part of a broader study of threats to Kenya's Masai Mara National Reserve. He will also be applying it to 13 of Ezemvelo KZN Wildlife's largest nature reserves, and will present the results at the Symposium on Contemporary Conservation Practice in November, where he will convene a special session on climate change in protected areas.

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The vulnerability assessment indicated that Addo Elephant National Park may experience a reduction in tourism demand by 2050 because game-viewing would potentially be impeded by bush encroachment, largely due to higher atmospheric carbon dioxide levels that favour the growth of woody plants over grasses.

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The West Coast National Park was found to be the park most vulnerable to climate change, because it scored highly in the ecosystems and infrastructure impact categories, and poorly in the adaptive capacity assessment.