

# SOUTH AFRICA'S CHANGING CLIMATE

**Leonie Joubert**, *B Journ & Media Studies, MPhil (Journ)*

*Freelance science writer, Cape Town*

## ABSTRACT

South Africa's weather records over the past six decades indicate that the region's climate is shifting. This is evident in small but statistically significant temperature increases in the past half-century. Changes in rainfall patterns are less clear. Nevertheless, responses from the natural environment confirm that conditions are changing, and that these reflect trends elsewhere in the world.

Increases in temperature will continue across the country in the next century, but with regional differences: coastal areas may warm by 3-4°C, and the interior by 6-7°C. Rainfall patterns will become less predictable in parts, with overall drying conditions in some areas and wetting in other areas; fire conditions will increase in some areas; natural extreme weather events and cycles such as droughts, floods and heatwaves will be amplified in both severity and frequency.

The pressures associated with climatic shifts are anticipated to exacerbate existing environmental, social, developmental and economic vulnerabilities and may roll back many of the advances made in terms of the United Nations Millennium Development Goals.

This article discusses anticipated climatic shifts across the region over the next half-century, and highlights the likely impacts for South Africa's vegetation, landscape and communities, both urban and rural.

## INTRODUCTION

The presence of a small concentration of greenhouse gases (GHGs) in the atmosphere is responsible for trapping the sun's heat around the earth and keeping conditions moderate for modern life forms. The concentration of these gases – carbon dioxide, methane, nitrous oxide and several others – has fluctuated as a result of

Leonie Joubert's books include *Scorched: South Africa's changing climate*, *Boiling Point: people in a changing climate* and *Invaded: the biological invasion of South Africa*. She specialises in climate change, energy issues, agriculture and, more recently, food security. She has written news, features, narrative style non-fiction, television scripts and general reports. She is associated with the University of Cape Town's Centre of Criminology for her latest project, an exploration of food security in southern African cities. She was the 2007 Ruth First Fellow, was listed in the *Mail & Guardian's 200 Young South Africans You Must Take To Lunch* (2008), and was named the 2009 SAB Environmental Journalist of the Year (print/internet category). Leonie has received two Honorary Sunday Times Alan Paton Non-Fiction Awards.

natural causes for hundreds of billions of years.

Since humans transitioned from hunter-gatherer to early agriculturalists about 10 000 years ago, GHG concentrations have climbed from an estimated 180 parts per million (ppm) to over 380 ppm today (the largest amounts have been added to the atmosphere in the past 50 years, indicating a massive increase in the rate of emissions release). If emissions are allowed to continue accumulating in the atmosphere at the present rate, the United Nations Framework Convention on Climate Change anticipates by the end of this century a hike in global mean temperature of a conservative 1.1-2.9°C, or, as much as 2.4-6.4°C, relative to 1990 temperatures.<sup>1</sup>

As UK economist Sir Nicolas Stern wrote in the *Stern Review* on the economics of climate change in 2006, a 'warming of 5°C... would be far outside the experience of human civilisation and comparable to the difference between temperatures during the last ice age, and today'.<sup>2</sup>

South Africa's temperature records show a small but statistically significant rise in mean averages across the country over the past half-century<sup>3</sup> – a half-degree average increase over 50 years, matched by increases in average maximum and minimum temperatures. The trend shows fewer cooler days, and the occurrence of more warm days.

This climate 'signal' has been most notable in the Western Cape, where increases in both minimum and maximum temperature over a 30-year period were a full degree.<sup>4</sup> Similarly, sea surface temperatures off the West Coast have climbed slightly and wind speeds may be increasing.

The overall consequences of temperature increase include greater water evaporation, plant stress, a decline in quality and availability of surface and ground water, overall drying, increased likelihood of fire conditions, and unpredictability of weather events and seasonal conditions.

## CHANGE IS INEVITABLE, BUT WHERE TO FROM HERE?

Changes to the region's climate are inevitable, because of the amount of GHGs that have accumulated in the atmosphere, and because of the 'lag' in the ocean-climate system (it can take decades for GHGs released this year to heat the air, then the ocean, and much later manifest in altered long-term weather trends), meaning that even if all human-caused emissions stopped immediately, climatic changes would continue for many decades to come.

Projecting how SA's climate will change in the future depends on whether GHG emissions continue as they are, or stabilise and eventually decline.

Modelling based on a 'business as usual' scenario, where global emissions continue unchecked, suggests that the region will see temperatures climb by about 1°C along the coast and up to 3°C in the interior by 2050. By the year 2100, South Africa could be between 3°C and 4°C warmer, on average, along the coast and between 6°C and 7°C in the interior.<sup>3</sup> This is consider-

ably outside of the conditions in which plant and animal species in the country have evolved over the past few million years.

Projecting rainfall trends by means of computer modelling is more difficult. Precipitation patterns in South Africa's summer rainfall regions may remain unchanged, although some areas may see increased flooding events. However, increased inundations during rain events do not produce 'useful' water since they will not necessarily recharge groundwater. Meanwhile longer dry spells between rainfall events could lead to an overall drying trend in some areas, even if it appears that more rain is falling over a season during inundation events.

The Western Cape, with its Mediterranean climate of wet winters and dry summers, could see winter rainfall decline by as much as 25%, and might experience occasional bouts of severe flooding.<sup>4</sup>

The effect on water reserves will be the area where temperature increases will be felt most acutely,<sup>3</sup> impacting on natural landscapes, agriculture, and water availability for human communities in cities and rural environments alike. Warmer conditions will drive increased evaporation from the country's water bodies (by 5-10% by mid-century, and by as much as 25% by 2100), and soils will become increasingly dry.

Stress on water reserves will be felt heavily by the agriculture sector, the country's largest water consumer. Decreased availability of water will impact human, plant,

animal and ecosystem health. Groundwater levels will drop, particularly in the west and interior. Meanwhile '(i)ncreases in physical, chemical and biological pollution from flooding, soil erosion, agricultural and industrial solutes, poor sanitation and increased temperatures will adversely effect (sic) both surface water and groundwater quality in the absence of adaptation responses'.<sup>3</sup> This will have profound implications for human well-being, agriculture and food security.

## CHANGES IN VEGETATION AND LANDSCAPE

Before detailed climate maps were available, scientists would map the vegetation of an area and use this as a proxy climate map.<sup>9</sup> South Africa has nine distinct vegetation types (Desert, Forest, Fynbos, Grassland, Nama-karoo, Savannah and Succulent Karoo), each of which represents a bioclimatic envelope. This is a mathematical summary of the conditions experienced across a region, which produces a common set of climatic conditions across a geographical range that a species in that envelope will experience and will have evolved into.

Scientists theorise that as conditions warm, species will move towards the poles or to higher altitudes to seek out preferred temperatures. To understand how South Africa's bioclimatic envelopes will respond to rising temperatures, scientists here fed these data through a modelling process and produced a map which shows a projection of the South African landscape in coming decades (Fig. 1) – the bioclimatic zones shifted south-east, with a warming and drying effect sweeping in from the north-west.<sup>6</sup>

This initial modelling showed that, within the next hundred years, '... the bioclimate of the country shows warming and aridification trends which are sufficient to shrink the area amenable to the country's biomes to between 38% and 55% of their current combined (regional) coverage. The largest losses occur in the western, central and northern parts of the country. These include the virtual complete loss or displacement of the existing Succulent Karoo biome... an extensive eastward shift of the Nama-karoo biome and contraction of the Savannah biome to the northern borders of the country and its expansion in the Grassland biome. The species rich Fynbos biome... may... lose many species.'<sup>7</sup>

An animal such as a bird may try to track this shifting or shrinking climatic envelope, but its food source must also move for the bird to survive. Plants, meanwhile, cannot uproot themselves and move, so many die out in one part of a range, while the offspring must germinate and survive for it to spread into a new landscape. The quiver tree or tree aloe (*Aloe dichotoma*) (Fig. 2) appears to be dying in the north of its range, in the Brandberg mountains in Namibia, yet is thriving in the south on the provincial border of the Western Cape. This trend is several decades in the making, and suggests that the climatic envelope of this desert is pressing south towards the Cape.

The country's three high-diversity 'hotspots' – the Cape Floristic Region, the Succulent Karoo, and the Maputaland-Pondoland-Albany area in the Eastern Cape – are areas of concern, with species at risk of extinction.

## HUMAN HEALTH AND WELLBEING

The changing footprint and incidence of vector-borne diseases such as malaria, schistosomiasis and Rift Valley fever have, for a long time, been presented as being at the coalface of health concerns in the context of rising temperatures and shifting rainfall patterns. Early modelling suggests an increase in the malaria zone along the country's north-eastern borders, possibly linked to rainfall pattern changes rather than temperature increases,

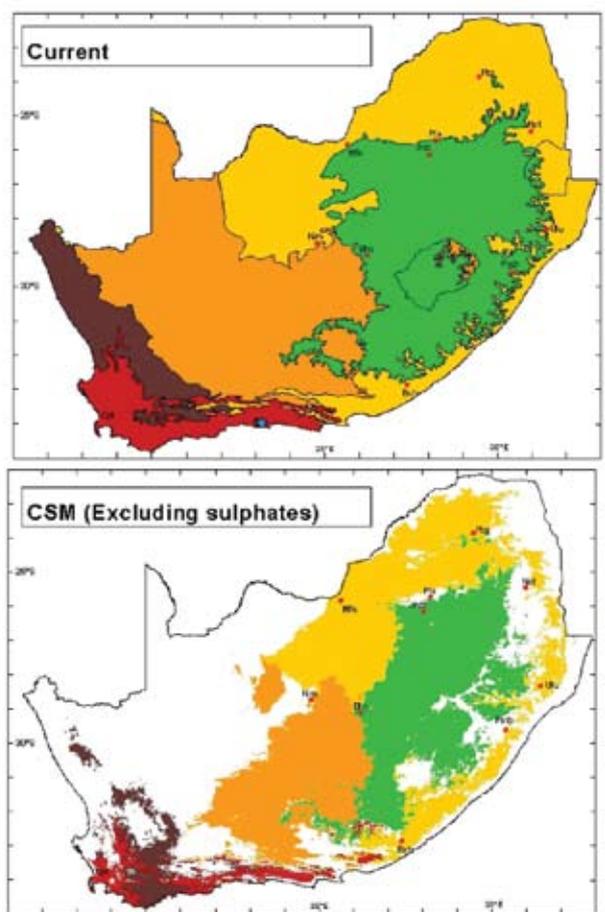


Figure 1. Projected changes in major South African biomes (Succulent Karoo, brown; Fynbos, red; Nama-karoo, orange; Grassland, green; Savanna, yellow) by ~2050 according to the General Circulation Model CSM given the IS92a emission scenario used in the SA Country Study on Climate Change (SACSCC).

Reprinted with permission from Midgeley G et al. *Impacts, vulnerability and adaptation in key South African sectors. Report for Department of Environment Affairs and Tourism. UCT Energy Centre, 2007.*



Fig. 2. Tree aloe (*Aloe dichotoma*).

although the suggestion is that mechanical control offset the range shift.<sup>3</sup>

But the true health impacts are much more diverse and, as with many of the impacts associated with climate change, amplify existing vulnerabilities.

For instance, the converging crises of HIV/AIDS, tuberculosis and a shortage of protein in the diet (manifesting in protein energy malnutrition or PEM), which already work in concert to undermine mostly poor communities, will be exacerbated as food insecurity mounts with climatic impacts on agriculture.

The frontline of climate impacts on health are the immediate effects of extreme weather events: heatwaves, flooding, fires, storms, air pollution events. Following the 2003 heatwave which struck Europe, nearly 15 000 deaths in France alone were caused by heatstroke, hyperthermia and dehydration.<sup>8</sup> This was one of the first weather events where scientists showed how rising global temperatures due to human-linked GHG emissions had increased the likelihood of the heatwave.<sup>9,10</sup>

In a slum environment, where many already economically vulnerable people live in uninsulated, makeshift shelters, the associated health risks are exacerbated. Similarly, in the case of flooding or fires, shack dwellers are more vulnerable than communities living in brick-and-mortar houses, as is often witnessed in informal settlements in Cape Town where the hot, dry, southeasterly wind often brings devastating fires in summer, while the north-westerly storm fronts bring severe flooding in winter.

The incidence of *Salmonella*, *Campylobacter* and other food-borne infectious diseases leading to gastroenteritis – common-or-garden food poisoning – is expected to keep in step with rising temperatures.<sup>11,12</sup> Similarly, flooding and drought events are linked with cholera – should these become more frequent or intense, so could cholera outbreaks. Declining water quality as a result of pollution and over-extraction of water will be exacerbated by amplified drought and flood events, increasing the risk of water-borne diseases.

Another emerging area of concern is the psychological and emotional impact of discomfort, stress and social dislocation associated with rising temperatures and weather extremes, and how they threaten homes, communities, security and livelihoods.

When communities respond to local environmental shocks (flooding, drought or environmental degradation) by migrating, they become dislocated, fractured and more vulnerable.

## REFERENCES

1. Intergovernmental Panel on Climate Change. IPCC, 2007: Summary for Policymakers. In: Solomon S, Qin D, Manning M, *et al.*, eds. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press, 2007.
2. Stern NH. *The Economics of Climate Change: The Stern Review*. London: HM Treasury, 2006.
3. *South Africa's Second National Communication under the United Nations Framework Convention on Climate Change*. Pretoria: Department of Environmental Affairs, 2010.
4. Midgley GF, Chapman RA, Hewitson B, *et al.* *A Status Quo, Vulnerability and Adaptation Assessment of the Physical and Socio-economic Effects of Climate Change in the Western Cape*. Report to the Western Cape Government, Cape Town, South Africa. CSIR Report No. ENV-S-C 2005-073. Stellenbosch: CSIR, 2005.
5. Colinvaux P. Coping with interesting times. *Nature* 2005; 437: 479.
6. Rutherford MC, Midgley GF, Bond WJ, Powrie LW, Roberts R, Allsopp J. Plant biodiversity. In Kiker G, ed. *Climate Change Impacts on Southern Africa*. Report to the National Climate Change Committee. Pretoria: Department of Environmental Affairs and Tourism, 2000.
7. Kiker G. Terrestrial Plants, Biodiversity Sector Executive Summary. In: Kiker G, ed. *Climate Change Impacts on Southern Africa*. Report to the National Climate Change Committee. Pretoria: Department of Environmental Affairs and Tourism, 2000.
8. Pomadere M, Mays C, Le Mer S, Blong R. The 2003 heat wave in France: dangerous climate change here and now. *Risk Analysis* 2005; 25: 6.
9. Allen MR, Lord R. The blame game. *Nature* 2004 [Published online: 01 December 2004]. Available: [doi:10.1038/432551a].
10. Patz JA, Campbell-Lendrum D, Holloway T, Foley JA. Impact of regional climate change on human health. *Nature* 2005; 438: 310-317.
11. Confalonieri U, Menne B, Akhtar R, *et al.* Human health. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. In: Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE, eds. Cambridge: Cambridge University Press, 2007: 391-431.
12. Bambrick H, Dear K, Woodruff R, Hanigan I, McMichael AJ. The impact of climate change on three health outcomes: Temperature-related mortality and hospitalisations, salmonellosis and other bacterial gastroenteritis, and population at risk from dengue. Commissioned report for the Garnaut Climate Change Review, 2007. Canberra: The Australian National University, 2007.