Climate change projections for South Africa up to 2050 and beyond project warming as high as 5–8°C over the South African interior, and somewhat less over coastal regions, under an unmitigated global emissions scenario. A general pattern of a risk of drier conditions to the west and south of the country and a risk of wetter conditions to the east of the country has been projected, but many of the projected changes are within the range of historical natural variability. These rainfall projections are associated with a high degree of uncertainty.

Global climate model ensembles summarised for South Africa suggest a significant benefit from effective mitigation responses (global CO₂ stabilisation at between 450 and 500 ppm) relative to unconstrained emission pathways by as early as mid-century. Effective global mitigation efforts would halve median warming at the regional level from just under 2°C to about 1°C by as early as 2050, and would reduce the risk of high regional warming and extreme changes in rainfall.

Even under effective international mitigation responses, significant socio-economic implications are expected for vulnerable groups and communities in South Africa under both wetter and drier climate futures. These implications would largely be felt through impacts on water availability in many (but not all) regions.

FACTSHEET SERIES PRODUCED BY SANBI, DEA and GIZ in consultations with relevant sector stakeholders

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1. Introduction

The climate and scenarios work done in LTAS Phase 1 is the most significant step thus far in consolidating relevant data for South African climate change modelling (see Box 1). The process engaged with local and international climate modellers to develop a consensus set of climate scenarios for South Africa representing different future global emissions pathways. This included downsampling global climate models from the fourth and fifth assessment reports (AR4 and AR5) of the Intergovernmental Panel on Climate Change (IPCC), and exploring short-term scenarios for the time period 2015 to 2035 (centred on ~2020), in addition to the medium and long-term scenarios previously explored (centred on ~2050 and ~2090 respectively). The process also compared observed climate trends for South Africa from 1960 to 2010 to modelled trends for the same period to begin identifying possible strengths and weaknesses in the current modelling approaches. Due to the variety of emissions scenarios employed by climate modellers in the projections, the LTAS process has attempted to gather those into two main groups, namely unmitigated (unconstrained) and mitigated (constrained) future energy pathways (see Box 1, final bullet).

**Box 1. Progress of Work on Climate Change Scenarios for South Africa**

- 2003, South Africa’s Initial National Communication: The overall view was that South Africa faced a considerably drier and warmer future by mid-century, with some indication of an increased risk of intense rainfall events.
- 2003–2007: Modelling approaches developed extensively internationally, including improved representation of oceanic influences on global and regional climates. In South Africa and the broader region, downsampling methods were applied far more extensively than before.
- 2007, Fourth Assessment Report (AR4) of the IPCC: High levels of uncertainty relating to rainfall projections in the summer rainfall regions of South Africa, while the winter rainfall region continued to show a higher likelihood of drying than wetting by mid- to end-century.
- 2011, South Africa’s Second National Communication: Statistical downsampling of AR4 results showed a far higher likelihood of increased rainfall over the summer rainfall regions of South Africa, however, the impacts of rising temperature would lead to a net decrease in water availability in many (but not all) regions.

The project is part of the International Climate Initiative (ICI), which is supported by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.
The LTAS presents climate trends and projections at national scale, and for the six hydrological zones of South Africa developed for the National Water Adaptation Strategy process, namely zone 1: the Limpopo, Olifants and Inkomati water management areas (WMAs) in the northern interior (Limpopo/Olifants/Inkomati); zone 2: the Pongola-Umzimkulu WMA in KwaZulu-Natal in the east (Pongola-Umzimkulu); zone 3: the Vaal WMA in the central interior (Vaal); zone 4: the Orange WMA in the north-west (Orange); zone 5: the Olifants/Inkomati; zone 2: the Pongola-Umzimkulu WMA in KwaZulu-Natal in the east (Pongola-Umzimkulu); zone 3: the Vaal WMA in the central interior (Vaal); zone 4: the Orange WMA in the north-west (Orange); zone 5: the Olifants/Inkomati; zone 6: the Breed-Gouritz and Berg Olifants WMA in the south-west (Breed-Gouritz/Berg) (see Box 2).

**BOX 2. HYDROLOGICAL ZONES IN SOUTH AFRICA**

Climate change impacts across South Africa will be mediated through primary impacts on the water sector. Six hydrological zones have been developed as part of the National Water Adaptation Strategy process, reflecting boundaries defined by water management areas (WMAs) in South Africa, and grouped according to their climatic and hydrological characteristics. These zones can be appropriately modelled and analysed for direct impacts on the water sector, and related indirect effects on other sectors.


Over the last five decades the following climate trends have been observed in South Africa.

- Mean annual temperatures have increased by more than 1.5 times the observed global average of 0.6°C reported by the 4th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) for the period from 1950.
- Maximum and minimum temperatures have been increasing annually, and in almost all seasons. A notable exception is the central interior (zone 3; Vaal), where minimum temperatures have been increasing less strongly, and some decreases have been observed.
- Hot and cold extremes have increased and decreased respectively in frequency, in most seasons across the country, particularly in the western and northern interior.
- In almost all hydrological zones there has been a marginal reduction in rainfall for the autumn months. Annual rainfall has not changed significantly, but an overall reduction in the number of rain days implies a tendency towards an increase in the intensity of rainfall events and increased dry spell duration.
- Extreme rainfall events show a tendency towards increasing in frequency annually, and especially in spring and summer, with a reduction in extremes in autumn.


Some key climatic processes relevant for South Africa may not yet be adequately represented by the General Circulation Models (GCMs) used to model global climate or the downsampling methods being used. Key findings are:

- Modelled simulations more closely match observed temperature trends than rainfall trends.
- Observed trends since 2000 have not increased as steeply as modelled projections, a tendency noted in the IPCC 5th Assessment Report.
- Observed temperature has not changed significantly in the central interior (zone 3, Vaal), but modelled trends are significantly positive, matching all the other zones.
- The models do not reproduce observed reductions in autumn rainfall and tend to show opposite trends.

**4. Projected rainfall and temperature changes for South Africa (to 2050 and beyond)**

Climate change projections for South Africa up to 2050 and beyond under the Special Report on Emissions Scenarios (SRES) A2 and the RCP8.5 unmitigated emissions scenarios (see Box 3) based on statistical and dynamical downscaling of the scenarios, include:

- Significant warming, as high as 5–8°C, over the South African interior (under RCP8.5). This warming would be somewhat reduced over coastal zones.
- A general pattern of a risk of drier conditions to the west and south of the country and a risk of wetter conditions over the east of the country.
- Many of the projected changes are within the range of historical natural variability, and uncertainty in the projections is high (see Figure 1).

**BOX 3. UNCONSTRAINED/MITIGATED EMISSIONS SCENARIO**

<table>
<thead>
<tr>
<th>Emissions Scenario</th>
<th>Projected Change</th>
<th>Mean DJF</th>
<th>10th DJF</th>
<th>Mean MAM</th>
<th>10th MAM</th>
<th>Mean JJA</th>
<th>10th JJA</th>
<th>Mean SON</th>
<th>10th SON</th>
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<tr>
<td>Constrained</td>
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</table>

The risk of extreme rainfall changes, both increases and decreases, would be reduced by 2050 by an effective global emissions reduction pathway (for example under the SRES B1 and RCP4.5 mitigated emission scenarios). High resolution regional modelling supports this finding for 2055, and suggests even larger benefits from effective global mitigation by the end of this century, when regional warming of 5–8°C (projected under RCP8.5) could be more than halved to 2.5–3°C (under RCP4.5). Although the mitigated emissions scenarios reduce the extreme outcomes projected under higher emission scenarios, the spatial pattern of change remains similar. All modelling approaches project warming trends until the end of this century, but most approaches project the possibility of both drying and wetting trends in almost all parts of South Africa.