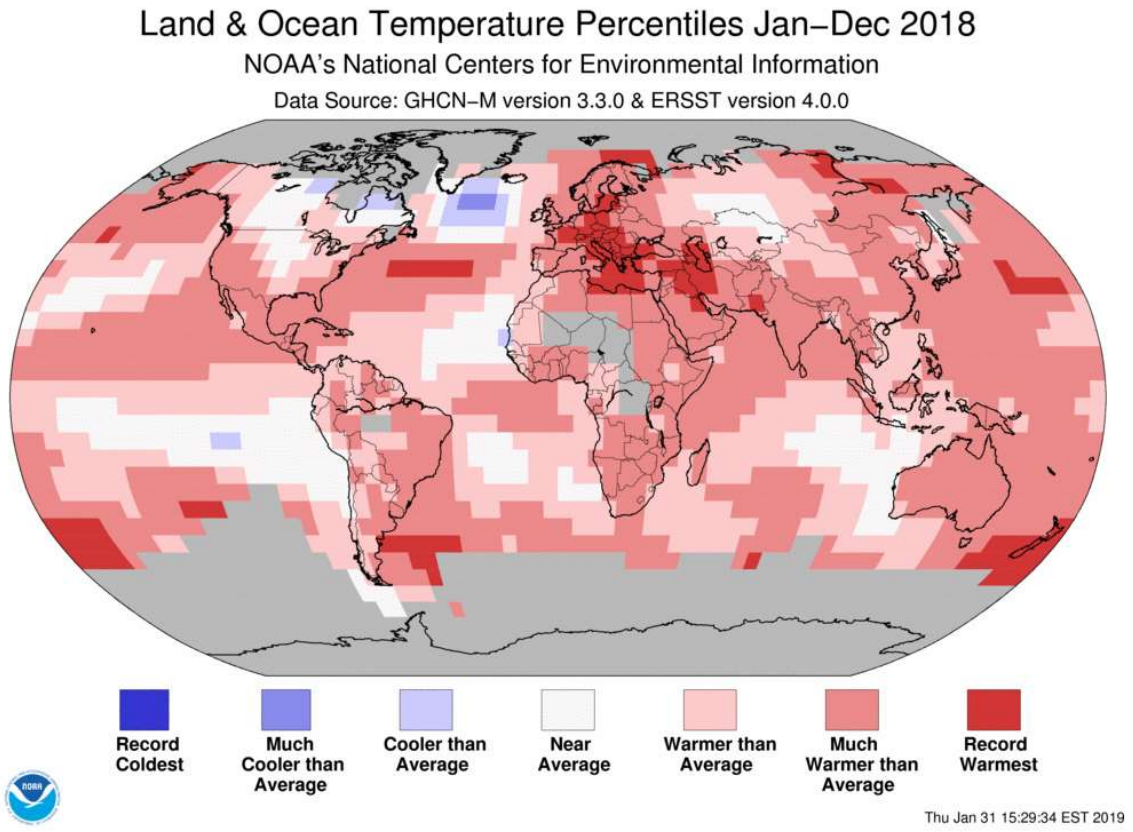
Integrated Decision Support Tools by SAEON

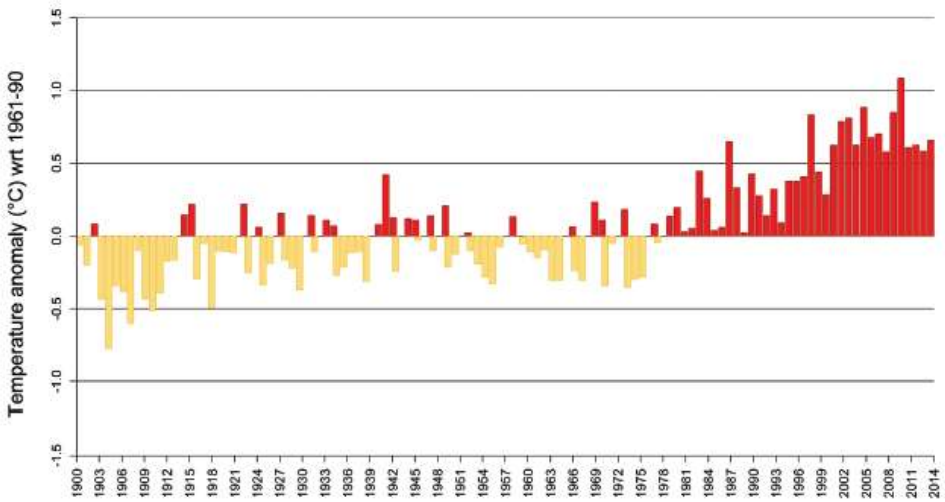
The presentation provides background on SAEON's uLwazi Node and presents some of the online tools and decision-support systems for climate change planning being developed by the team

Nine of the 10 warmest years have occurred since 2005, with the last five years (2014–2018) ranking as the five warmest years on record.

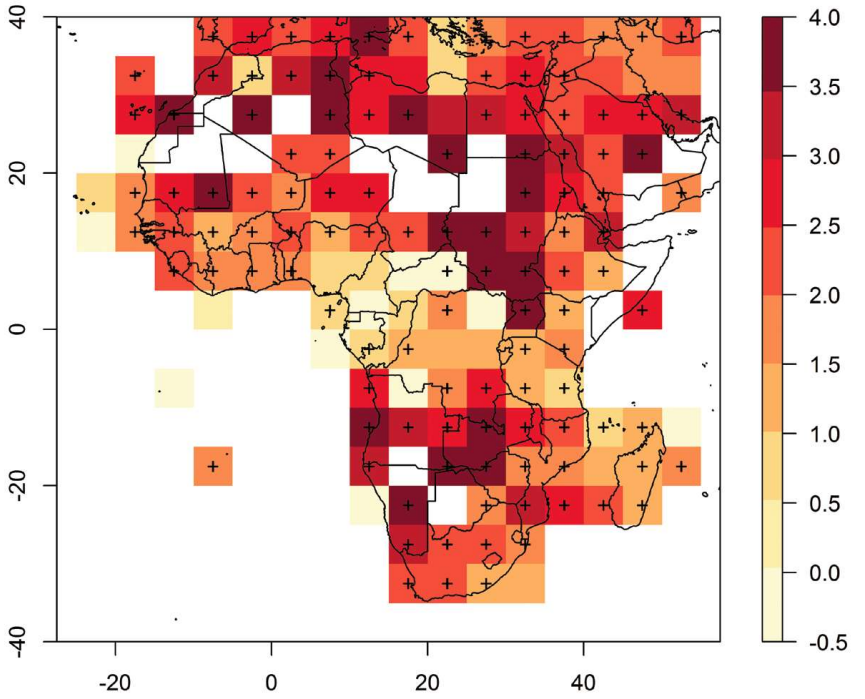


(Source: NOAA)

OBSERVED TEMPERATURE TRENDS



Mean annual temperature anomaly (°C) from 1901 to 2014 with respect to the long-term average climatology 1961-1990. Red represents a positive temperature anomaly and yellow a negative temperature anomaly.



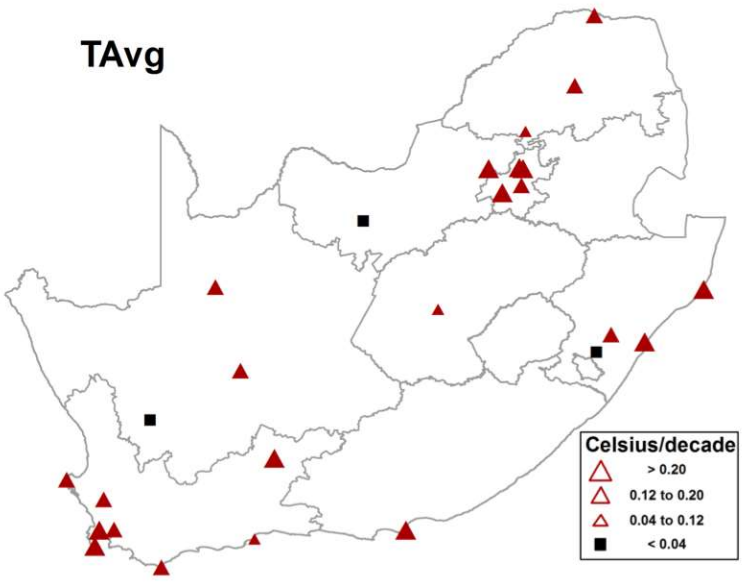
Observed trends in mean annual temperature (°C per decade) over Africa for the period 1961 to 2014. Crosses indicate grid boxes where the trend is statistically significant. White areas indicate incomplete or missing data.

SOURCE: Davis-Reddy and Vincent 2018. Climate Risk and Vulnerability Handbook for Southern Africa (2nd Edition)

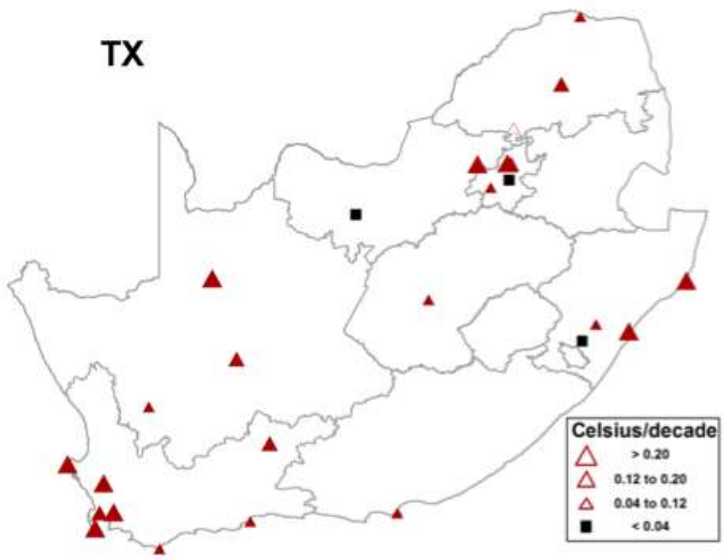
OBSERVED TEMPERATURE TRENDS

South African Weather Service

AVERAGE DAILY TEMP



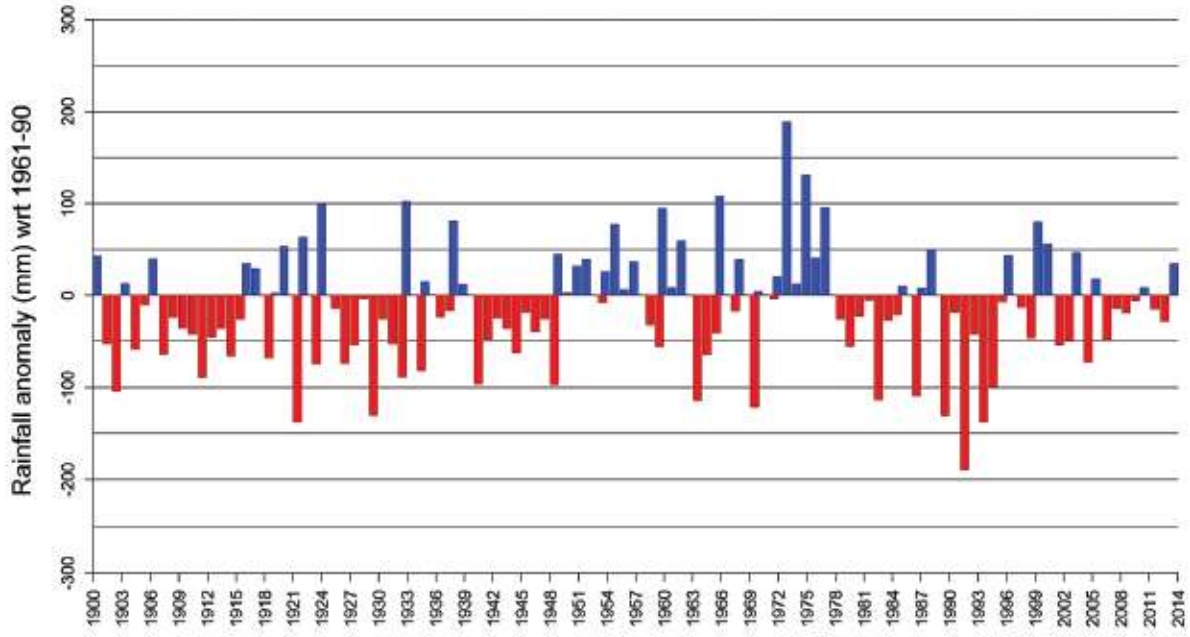
MAXIMUM DAILY TEMP



A total of 27 weather stations was used for temperature trends analysis spanning the period 1931-2015.

OBSERVED RAINFALL TRENDS

Alternating patterns of above-normal/below normal rainfall periods clearly illustrate the rainfall cycles prevalent in southern Africa where extreme wet and dry years have resulted in floods and droughts.



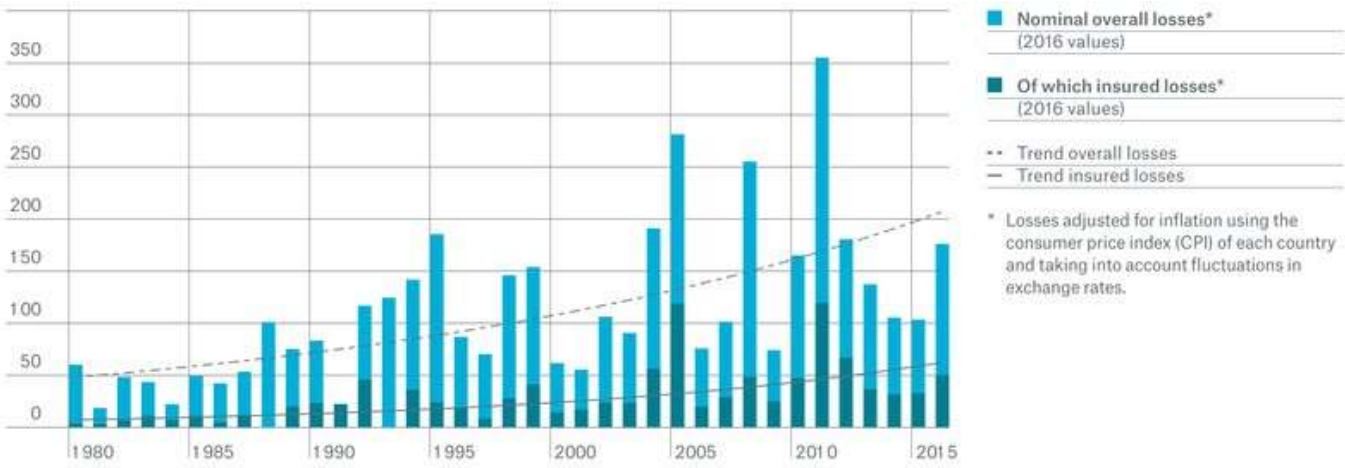
Mean annual rainfall anomaly (mm) over southern Africa from 1901 to 2014 with respect to the long-term average climatology 1961-1990. Blue represents a positive anomaly and red a negative anomaly in rainfall.

SOURCE: Davis-Reddy and Vincent 2018. Climate Risk and Vulnerability Handbook for Southern Africa (2nd Edition)

EXTREME WEATHER EVENTS

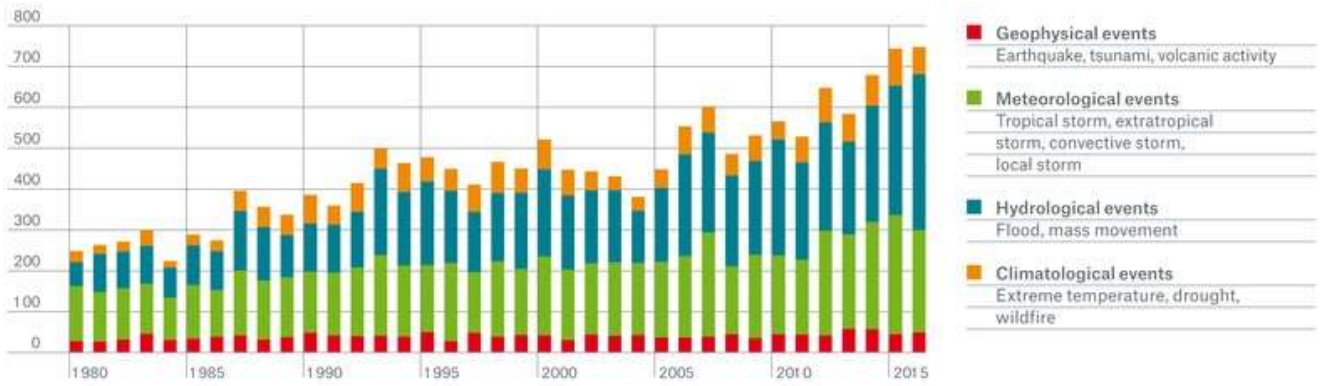
At the global scale, the frequency, extent and severity of natural disasters have increased notably over the last several years and economic losses from weather- and climate-related disasters have also increased

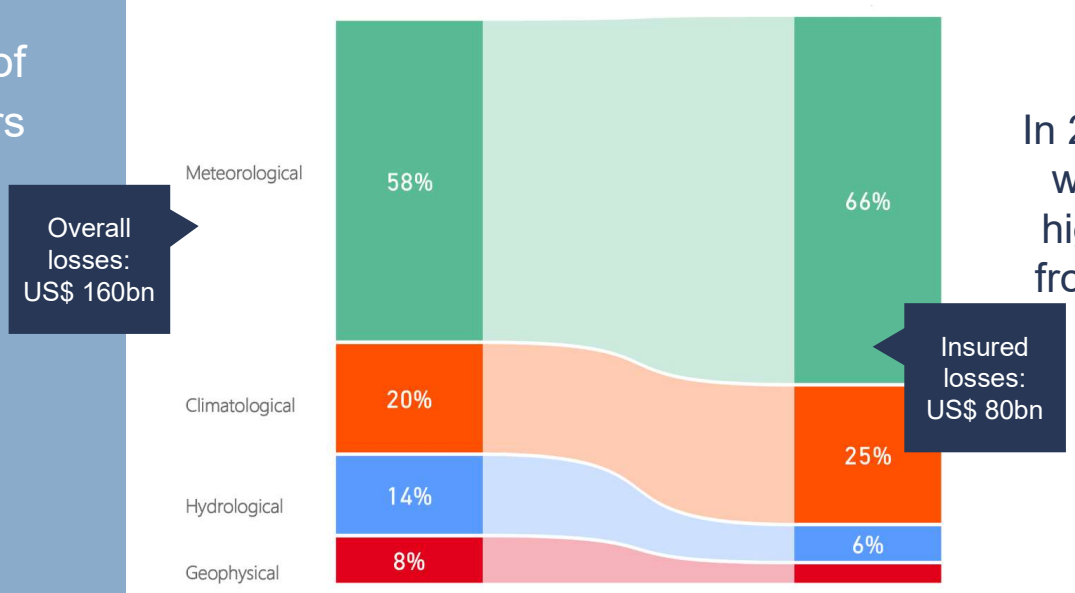
MUNICH RE



Climate-related disasters have come to dominate the disaster risk landscape accounting for upwards of 80% of reported disasters worldwide

MUNICH RE





In 2018 hurricanes and wildfires caused the highest global losses from natural disasters

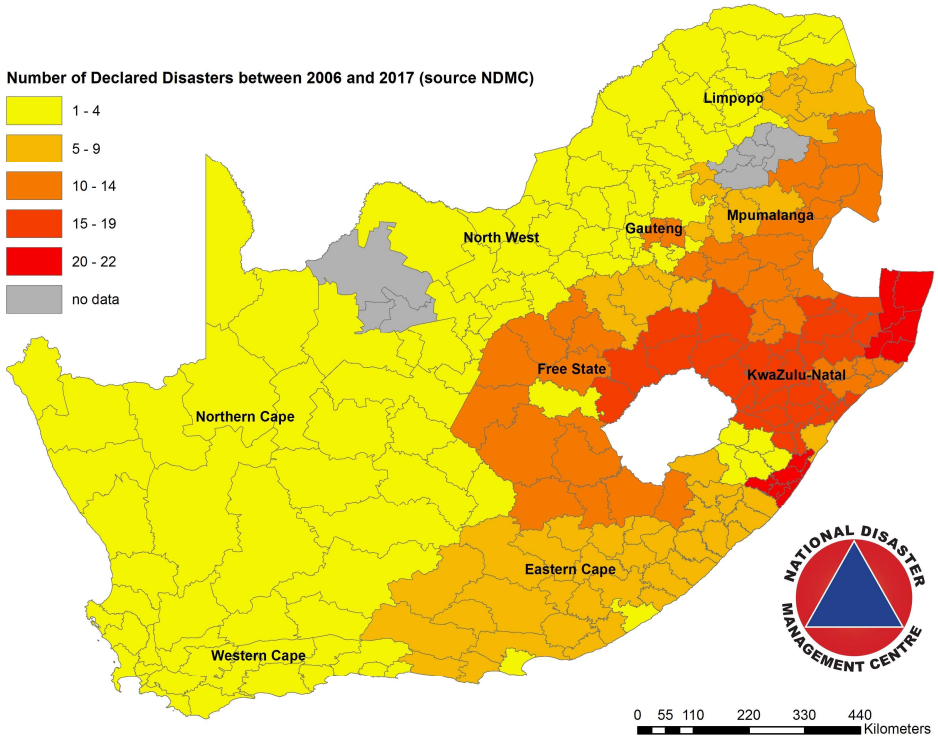
EXTREME WEATHER

- In South Africa, climate-related disasters over the last four decades have resulted in approximately US$5 billion in economic damages (Davis-Reddy et al., 2019 GreenBook)
- Data from the National Disaster Management Centre shows that since 2006 there have been 411 declared disasters in South Africa of which 97% were climate-related disasters.

SOUTH AFRICA

Kwa-Zulu Natal experiences the highest number of disasters; 200 declared between 2006 and 2019. This is a result of a high exposure to recurrent flood events and persistent drought conditions between 2014 and 2017.

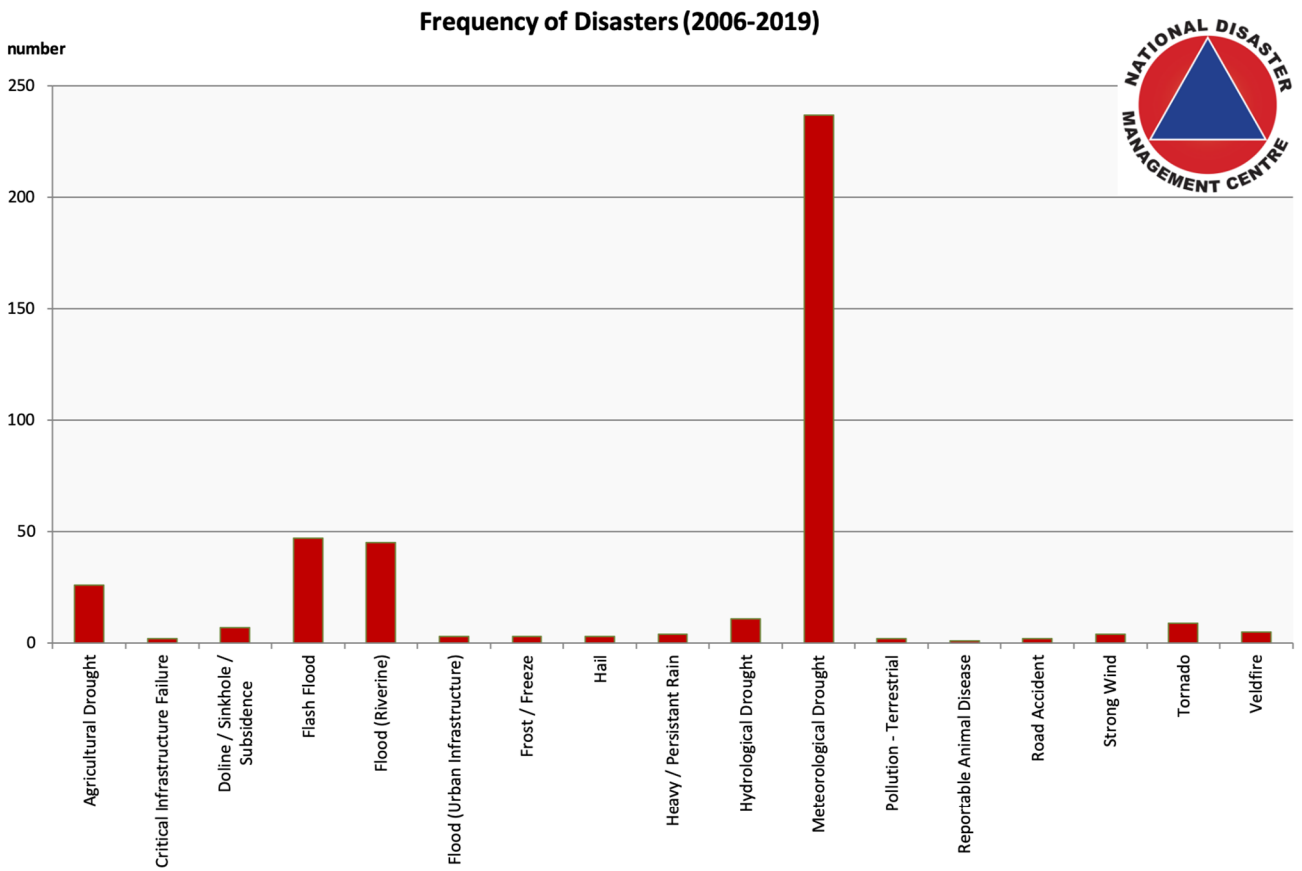
DECLARED DISASTERS BETWEEN 2006 and 2019



SOUTH AFRICA

Meteorological droughts (below average precipitation) are the most frequent disasters with 237 events being declared between 2006 and 2019. The second and third most frequent disasters are flash floods and riverine floods and the fourth agricultural drought events (low soil moisture).

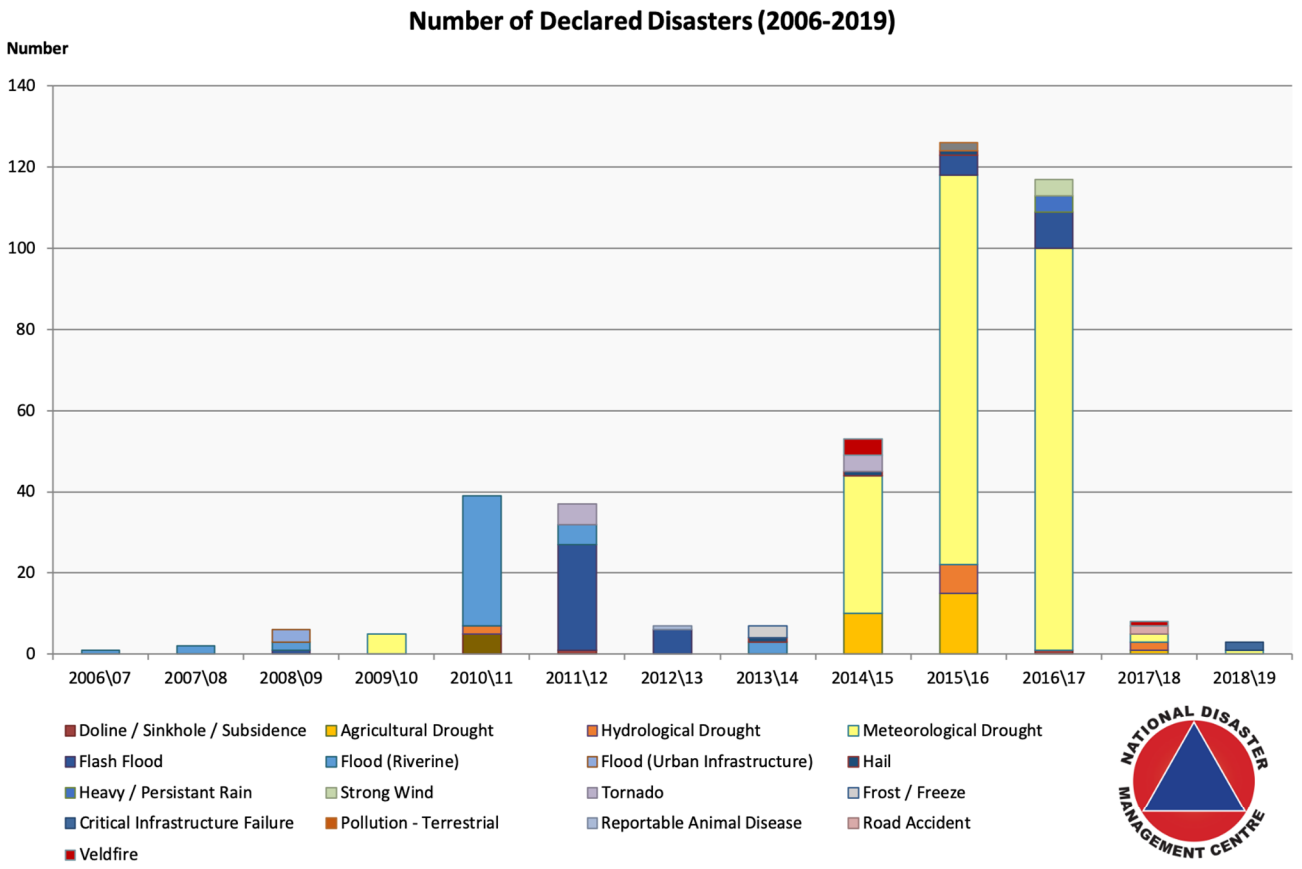
TYPES OF DISASTERS



SOUTH AFRICA

The highest number declared events occurred between 2014 and 2017 as a result of drought events that extended across the country as a result of El Nino event combined with high temperatures.

TYPE OF DISASTERS PER YEAR

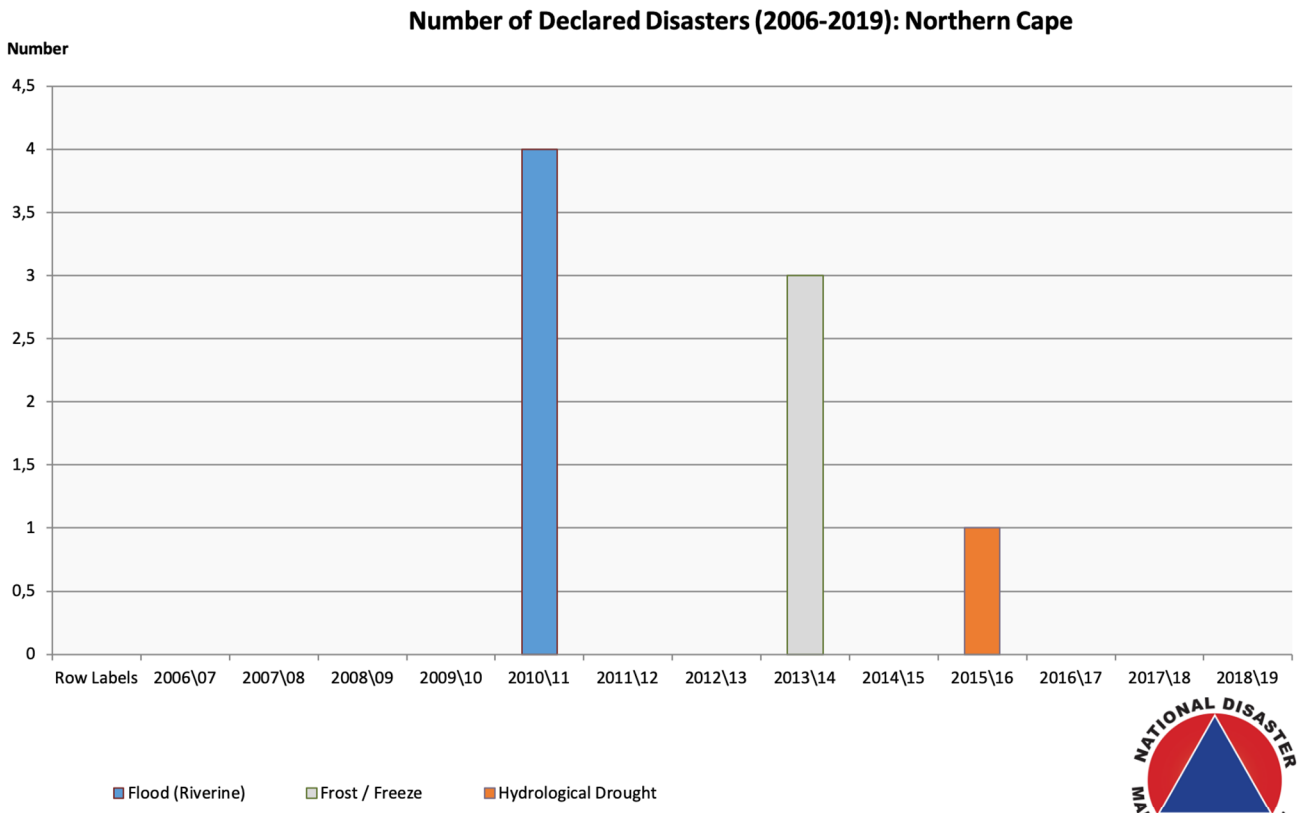


NORTHERN CAPE

The most common disasters faced by people in the northern cape are floods, frost freeze events, and droughts.

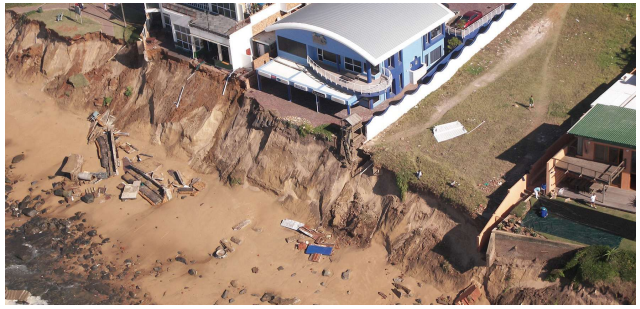
8 declared disasters between 2006 and 2019

TYPES OF DISASTERS



NATIONAL DISASTER MANAGEMENT CENTRE

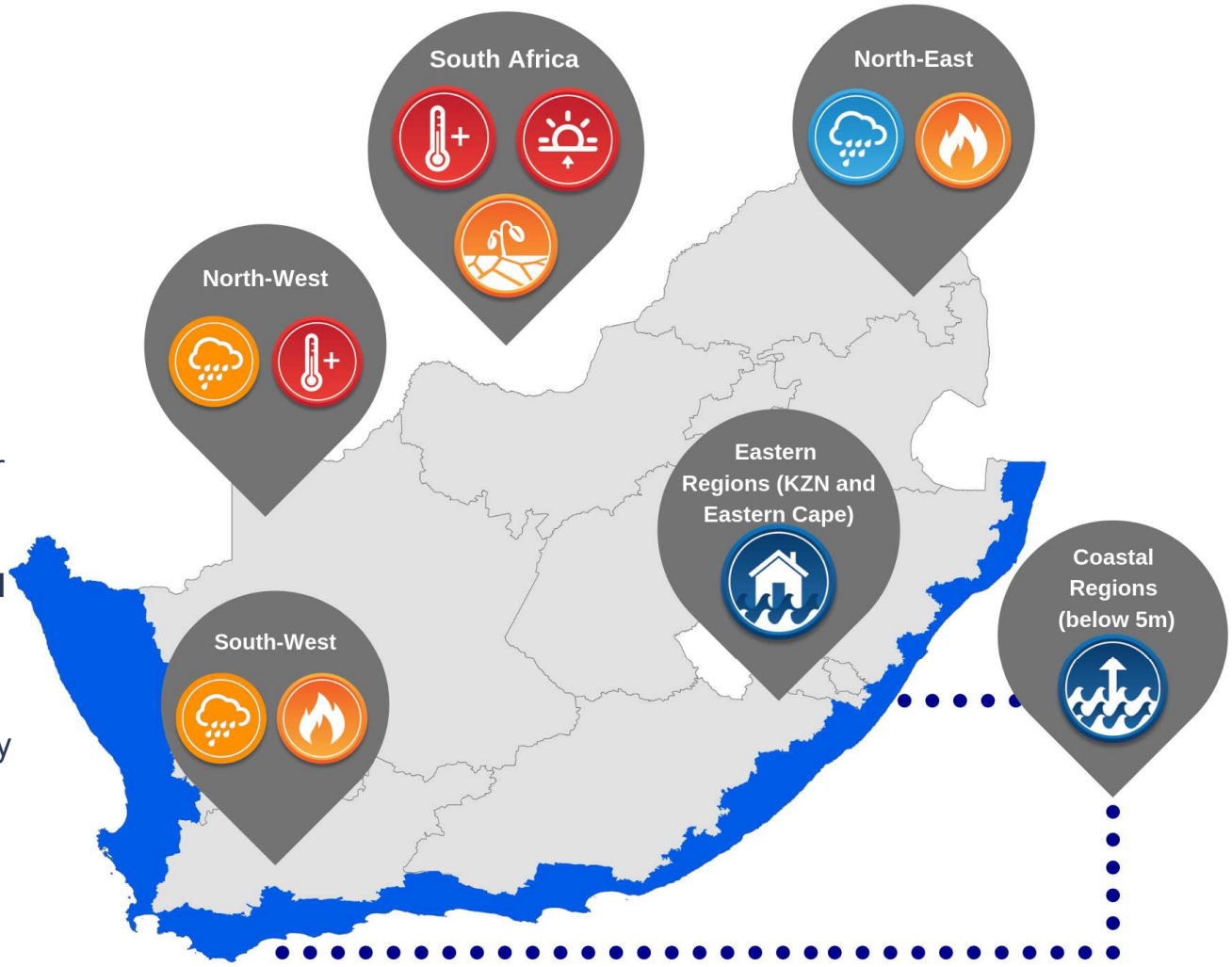
EXTREME WEATHER



- Climate change is expected to increase the frequency, intensity, spatial extent, duration, and timing of many extreme weather-related events
- More frequent and intense events combined with a growing and urbanising population and increasing value in urban and built infrastructure imply greater exposure to such events.
- The expected increase in weather-related disasters as a result of climate change are expected to negatively impact food production and water supply, infrastructure, settlements, and human well-being.


CLIMATE CHANGE FUTURES

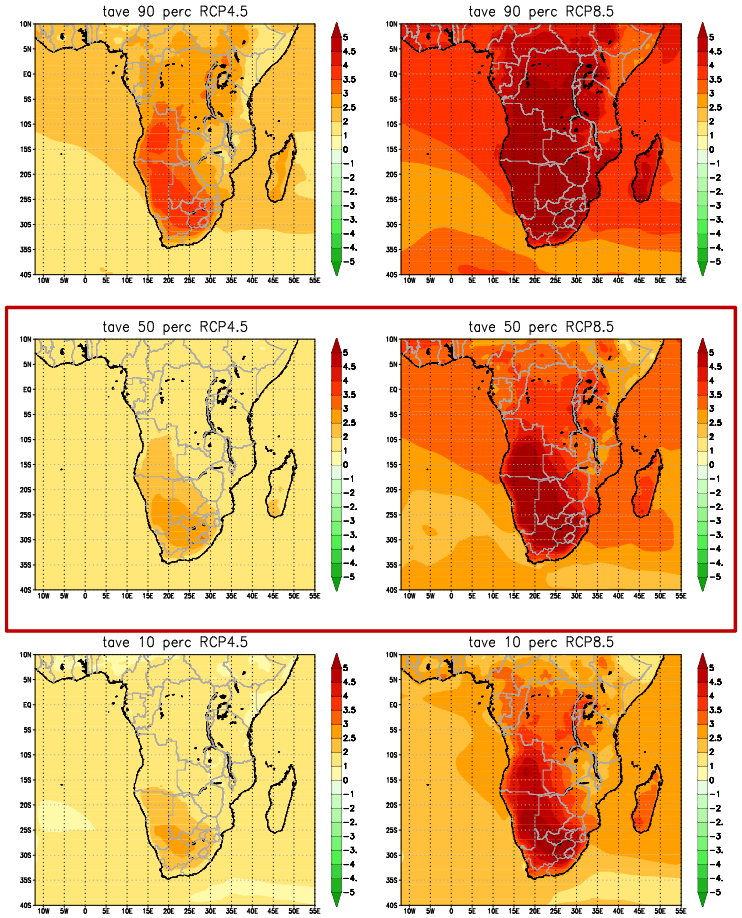
- Increase in mean, maximum and minimum temperatures.
- **Increase in very hot days** – above 35 °C and the frequency of heat wave events.
- **Drier conditions** in the future, with regional variation.
  - Slight increases in rainfall towards the north-eastern region.
  - A **strong drying signal over the southwestern region**, which could result in reductions in rainfall of more than 40 mm per year.
- **Increase in the frequency of extreme rainfall events** (20 mm of rain falling within 24 hours) over eastern parts during the summer months.
- **Sea level rise** and an increase in the frequency and **intensity of sea storms**, accompanied by increases in wave heights
- Increase in the number of **high fire danger** days over north-eastern region and along the Cape south coast and the south-western Cape.



CLIMATE CHANGE PROJECTIONS

The temperature signal is regarded as actionable (IPCC AR5; Engelbrecht et al., 2015)

PROJECTIONS OF RISING SURFACE TEMPERATURES



Regional Climate Model: CCAM

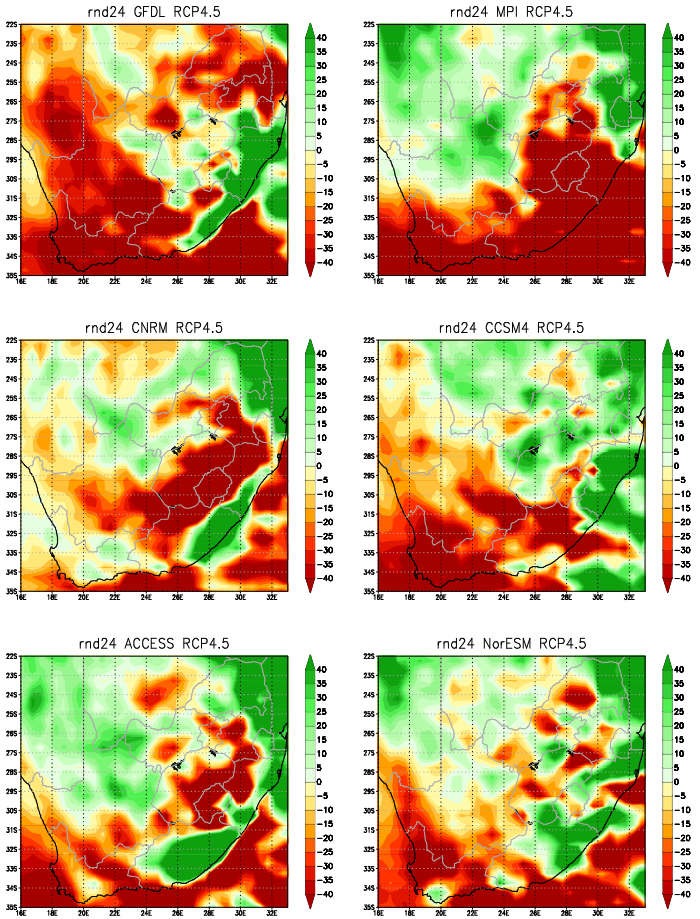
Figure shows the **projected changes in average temperatures** (degrees C) over southern Africa for 2080-2100 relative to 1971-2000 for RCP4.5 (left) and RCP8.5 (right)

CSIR-CSIRO-CHPC-SASSCAL-ACCESS

CLIMATE CHANGE PROJECTIONS

More uncertainty surrounds the projected rainfall futures of South Africa under climate change

PROJECTIONS OF CHANGES IN LONG-TERM RAINFALL: RCP 4.5



Regional Climate Model: CCAM

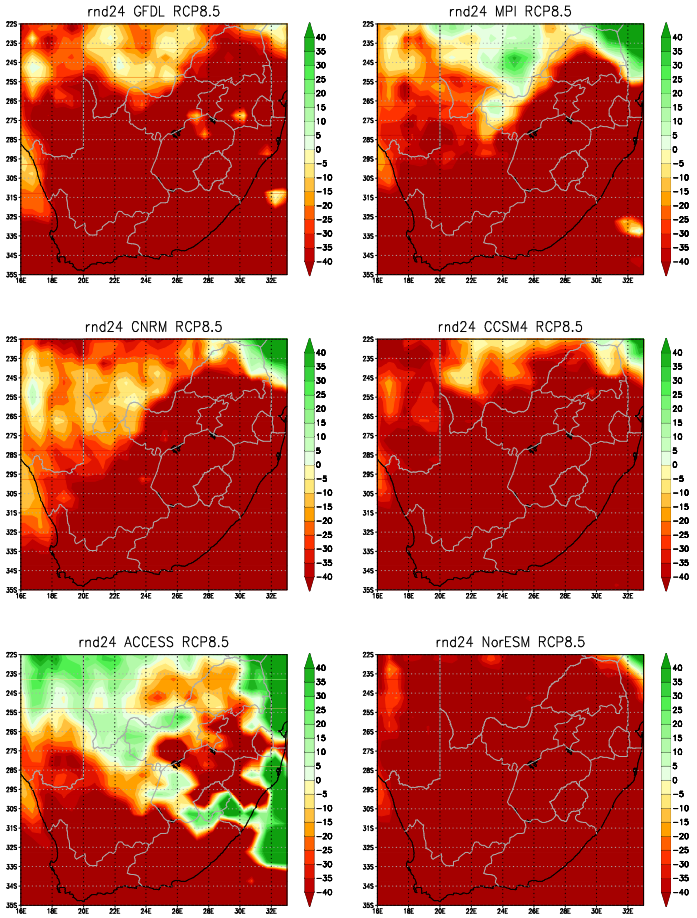
Figure shows the **projected changes in rainfall (mm)** over southern Africa for 2080-2100 relative to 1971-2000 for **RCP4.5** across 6 ensemble members (GCMs)

CSIR-CSIRO-CHPC-SASSCAL-ACCESS

CLIMATE CHANGE PROJECTIONS

Mitigation of GHGs can have an impact

PROJECTIONS OF CHANGES IN LONG-TERM RAINFALL: RCP 8.5



Regional Climate Model: CCAM

Figure shows the **projected changes in rainfall (mm)** over southern Africa for 2080-2100 relative to 1971-2000 for **RCP8.5** across 6 ensemble members (GCMs)

CSIR-CSIRO-CHPC-SASSCAL-ACCESS

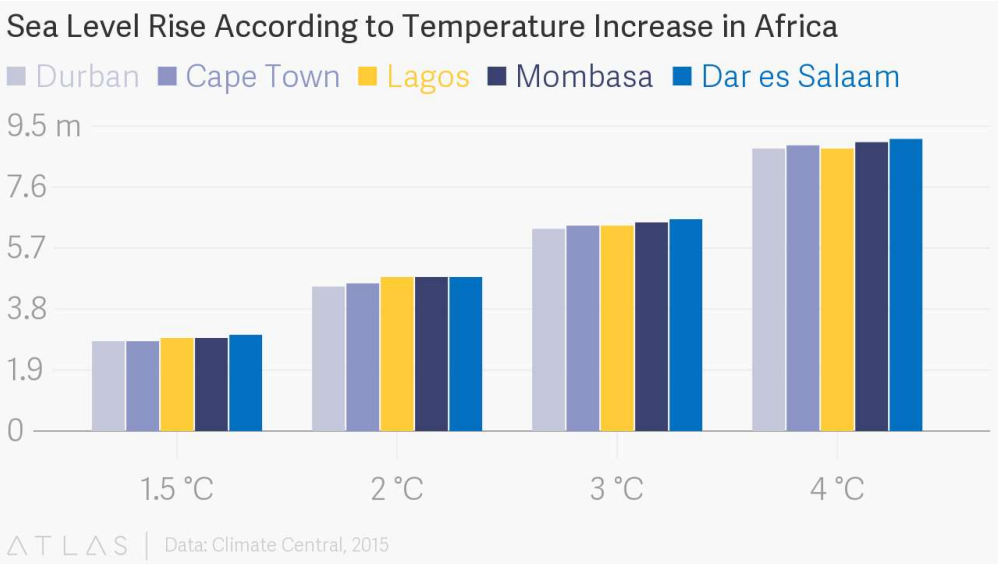
PROVINCIAL CLIMATE CHANGE PROJECTIONS

SUMMARY: WHAT DOES THIS MEAN FOR THE NOTHERN CAPE?

- Temperatures in the province will reach 2 °C warmer than the recent past by between 2040 and 2060
- This has important impacts on hot spells, with days exceeding 36 °C reaching 20-30 days a month in the north of the province in summer
- Reduced rainfall together with substantially higher temperatures combine to increase evaporation
- Places a strain on natural environments as well as dams for irrigation and human consumption.
- Groundwater is an important source of water in the west of the province, and reduced rainfall begins to reduce ground water recharge rates reducing well point yields.

SEA LEVEL RISE

The table below gives the percentage of the population for each of the listed coastal cities. Lower-lying cities such as Saldanha and Cape Town are much more threatened by SLR than elevated cities such as East London and Durban (Source: Davis-Reddy and Vincent 2018)



Relative vulnerability of South African coastal cities to SLR

City	100-m buffer line population percentage	1 000-m buffer line population number percentage	20-m contour line population percentage
Saldanha	8.29%	38.07%	43.25%
Cape Town	0.43%	4.62%	27.59%
Port Elizabeth	0.02%	2.61%	12.12%
East London	0.04%	4.48%	1.28%
Durban	0.32%	6.86%	6.35%
Richards Bay	0%	0.55%	16.44%

MANAGING RISK

- These climate risks or hazards do not operate in isolation but rather interact with an array of natural processes and human-driven effects in **complex and multidimensional ways**; at local and regional and global scales.

- They involve **multiple stakeholders**, multiple causes, symptoms and solutions (sometime opposing), and are constantly evolving.

- **Trade-offs:** all actions have certain costs and implications, and benefits and co-benefits. A range of scenarios need to be considered e.g. win-win, no-regrets or low regret actions.

- Varying degrees of **(un)Certainty** involved: the time scales over which the impact will occur, the scale of the impact and the intensity (significance) of the impact.

Location of NOAA's Global Historical Climate Network (GHCN) weather stations, as used by CRU, across Africa

Source: Davis-Reddy and Vincent 2017.

RELIABLE AND ACCESSIBLE INFORMATION IS KEY TO MANAGING RISKS

Challenges exist with availability and usability of of data by decision-makers (e.g. climate change projections).

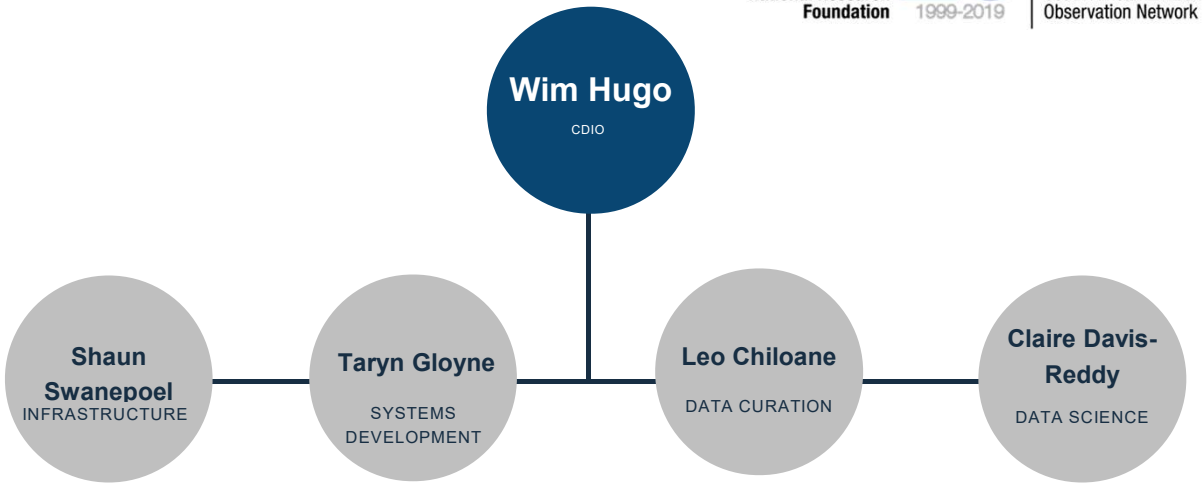
There is a need to:

1. Provide access to scientific data and observations of long-term environmental, societal and economic trends
2. Translate the data into useable, actionable and impactful information on the impacts, vulnerability, and feasible response actions
3. Ensure that data and associated information and decision-support tools are based on user-identified needs at appropriate time-scales

ORGANIZATIONAL CHART

ULWAZI NODE

uLwazi (meaning ‘knowledge’ in Nguni languages) is one of the seven nodes of the South African Environmental Observation Network (SAEON)



A team managing platforms based in Cape Town and at NRF in Pretoria, with significant storage capacity (reaching close to 1 PB at each site in the near future) and mirrored daily between sites.

A growing and diverse team capable of supporting Java, Python, C#, PHP, JavaScript, SQL, R, and on both Linux and Windows platforms. The team implements Agile systems development processes, aligned with formal systems engineering for architecture and design, and our systems are based on community and widely adopted interoperability and design specifications.

SAEON has a settled team assisting with description, preservation, and standardised dissemination of datasets and digital objects, including formal publication via DataCite with an associated Digital Object Identifier (DOI).

Conceptualisation, design, and development of new approaches to decision and policy support, research into data infrastructure and interoperability, and development of new tools, systems, and data products to assist with translation of scientific evidence into societal benefit.

GLOBAL CHANGE DATA CENTRE

- Traditional Spatial Data
- Multidimensional Data
- Physio-Chemical Observation Data
- Ecosystem Observation Data
- Custom relational databases

NRF National Research Foundation 20 1999-2019 | SAEON South African Environmental Observation Network

SARVA

Visualisation of vulnerability and exposure to environmental hazards within a particular location, through spatial and non-spatial data and information.

NCCIS

The NCCIS is part of the national effort to track South Africa's overall transition to a low carbon and climate resilient economy.

BIOENERGY ATLAS

Updates to BioEnergy Atlas, inclusion feasibility and viable projects for other renewables, updates to carbon distributions and invasive alien plants/ bush encroachment datasets.

RENEWABLE ENERGY ATLAS

Extension of the existing BioEnergy Atlas to include all renewable energy sources as well as inclusion of improvements including refinements to datasets such as spatial datasets and cost estimates included in the atlas, and improvement of the models to include multi-criteria optimisation.

SDG ATLAS

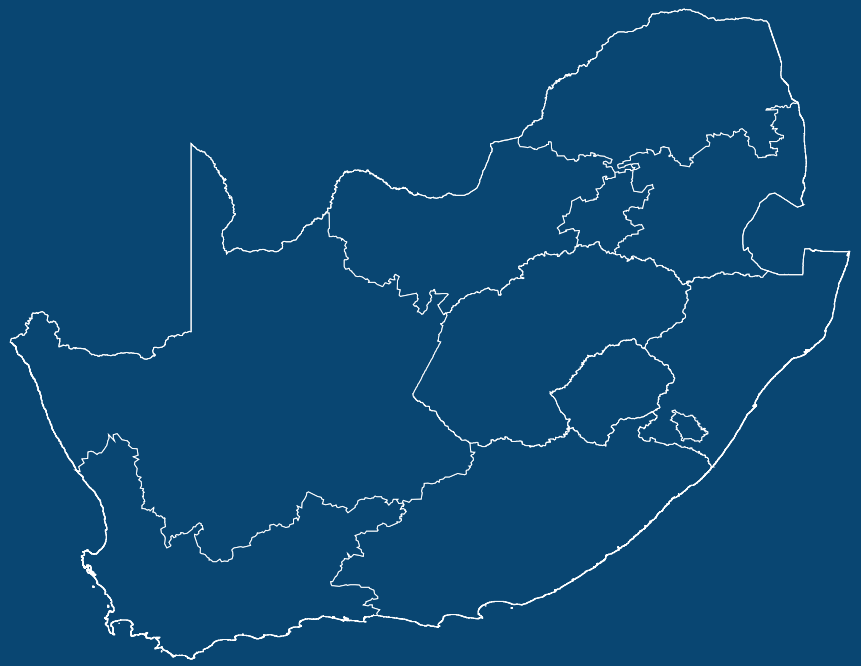
- SDG indicator data and reporting available at a high resolution to municipal planners
- Establishment of an SDG indicator atlas that aligns with national reporting to the UN and thus a single source of truth as to the indicator values

SASDI

The Department of Rural Development and Land Reform (DRDLR) is also funding the development of the South African Spatial Data Infrastructure (SASDI) and, linked to it, the National Spatial Planning Data Repository (NSPDR).

SARVA

Mapping the way to a resilient future



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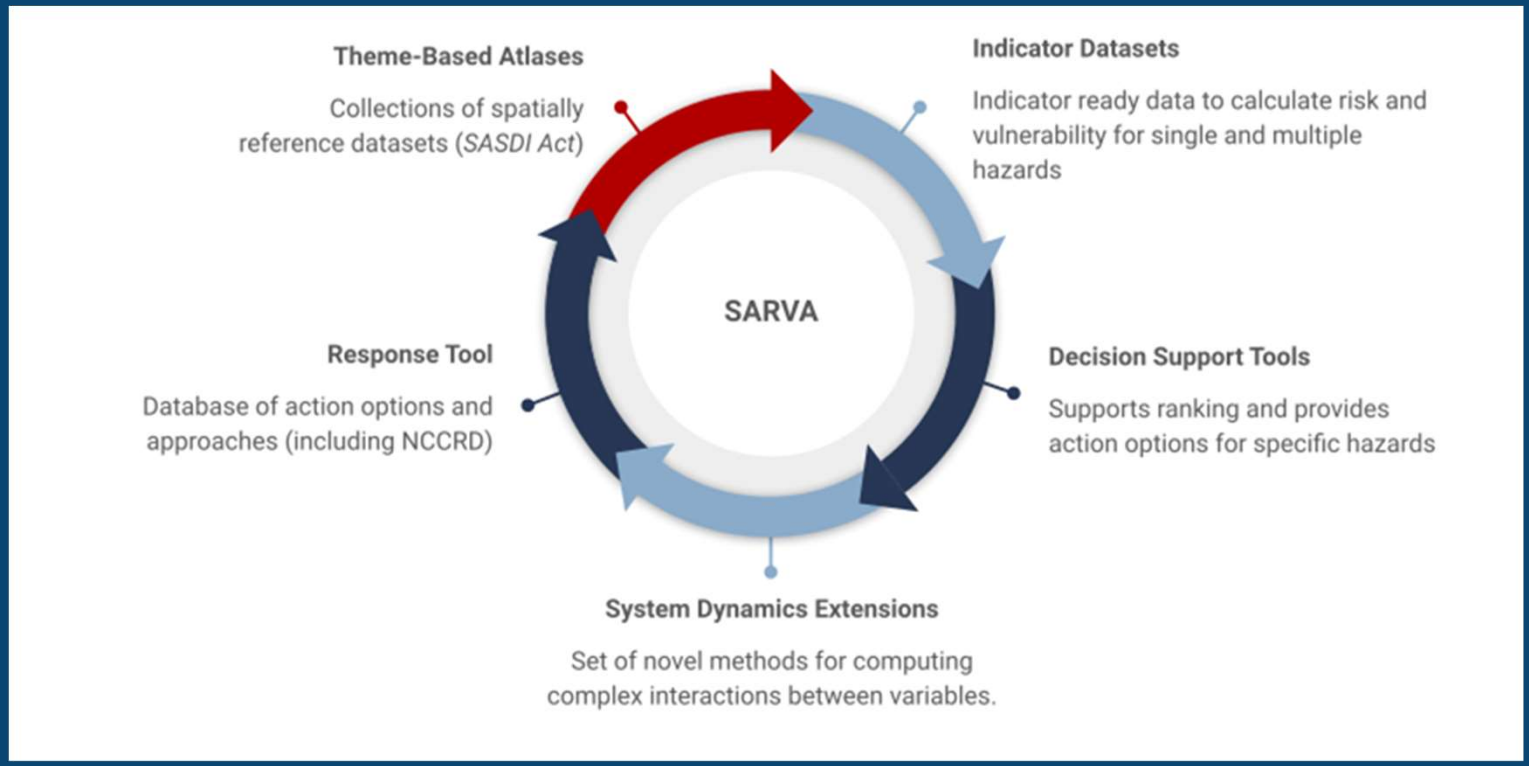
Integrated components

SARVA consists of 5 components that will be developed and released over the next 3 years



1

INDICATOR DATASETS

- Impact (e.g. hazardous events database)
- Exposure; Sensitivity; Adaptive Capacity
- Multi-criteria Indicators
- Climate Change Targets
- Indicator-frameworks (SDGs, NDP and Sendai)

2

DECISION-SUPPORT TOOLS

- Risk Profile Tool
- Multi-Hazard Detection Tool
- Spatio-temporal Interaction Analysis (Hot Spot Analysis)
- SDG Atlas

3

SYSTEM DYNAMICS EXTENSIONS

- Cost-Benefit Analysis
- Assessment of Trade-offs (e.g win-win, no regrets, low-regrets)
- Climate Finance & Incentives
- Validation Pipeline (Citizen Science, Crowdfunded Projects)

4

RESPONSE TOOL

- Adaptation & Mitigation Actions
- Researched Actions
- Feasibility Tested Actions

5

THEME-BASED ATLAS

- Sector Atlas's that link in all evidence and decision components of SARVA
- Dynamic R&V assessments and mapping
- Engagement with SAEON nodes: Case Studies

Agriculture
Biodiversity and Ecosystems
Water Resources
Forestry
Settlements
Industry: Energy, Tourism, Bulk Services
Health
Air Quality
Culture and Heritage
Livelihoods

A "driver" is defined as a long-term pattern or trend that could amplifying existing or create new risks and vulnerabilities and/or alter the relationship between them. These include changes in the climate system as well as changes in any biophysical and human system.

SARVA FOCUSES ON GLOBAL CHANGE DRIVERS

15 have been identified that are the most important in shaping development in South Africa over the next 10 years.

- Rising income & wealth disparity
- Growing middle class in emerging economies
- Shifting power
- Changing landscape of international governance
- Increasing polarisation of societies
- Increasing national sentiment societies
- Rising cyber dependency
- Rising geographic mobility
- Climate change
- Accelerating biodiversity loss
- Rising chronic diseases
- Degrading environment
- Rising urbanization
- Changing patterns of production & consumption
- Ageing population

Hazard Classification System

A hazard is defined as an uncertain event or condition that, if it occurs, can cause significant negative impact within the next 10 years.

120 hazards relevant to South Africa

Technological

- Breakdown of critical infrastructure & networks
- Adverse consequences of technological advances
- Structural collapse
- Transportation accidents
- Cyber-attacks
- Lack of innovation including resistance to change
- Impact of new technology (opportunity and risk)
- Disruptive technologies (AI, internet of things, robotisation)
- Information security: massive incident of data fraud / theft
- Energy transition readiness

Environmental

- Water-borne disease
- Vector-borne disease
- Air-borne disease
- Animal incidents
- Epidemics
- Epizootics
- Insect infestation
- Pandemics
- Plant disease
- Invasive Species
- Extra-terrestrial Impact
- Space weather
- Drought
- Wild Fire
- Fog
- Tropical Cyclone
- Earthquake
- Mass movement
- Geochemical hazards
- Salinization
- Extreme temperature
- Strong winds
- Flood
- Wave Action
- Salt water intrusion
- Ocean acidification
- Water pollution
- Air pollution
- Terrestrial pollution
- Oil Spill
- Chemical spill
- Radiation contamination
- Biodiversity loss
- Ecosystem collapse
- Sandstorm
- Soil Erosion
- Hailstorm
- Lightning
- Heavy rain
- Tornado

Economic

- Deflation in a major economy
- US interest rate hikes
- Asset bubbles in a major economy
- Fiscal crises in key economies
- Global political uncertainty/disruption
- High structural unemployment or underemployment
- Fiscal crisis and credit rating downgrades
- Currency devaluation
- Failure of a major financial mechanism or institution
- State Companies' Debts
- Failure/shortfall of critical infrastructure
- Corporate governance fraud
- Exchange Rate Fluctuations
- Unmanageable inflation
- Skills shortage including the ability to attract and retain top talent
- Energy price shock
- Illicit trade (e.g. tax evasion, organized crime, etc.)
- Commodity prices
- Business interruptions (e.g. production, supply chain)

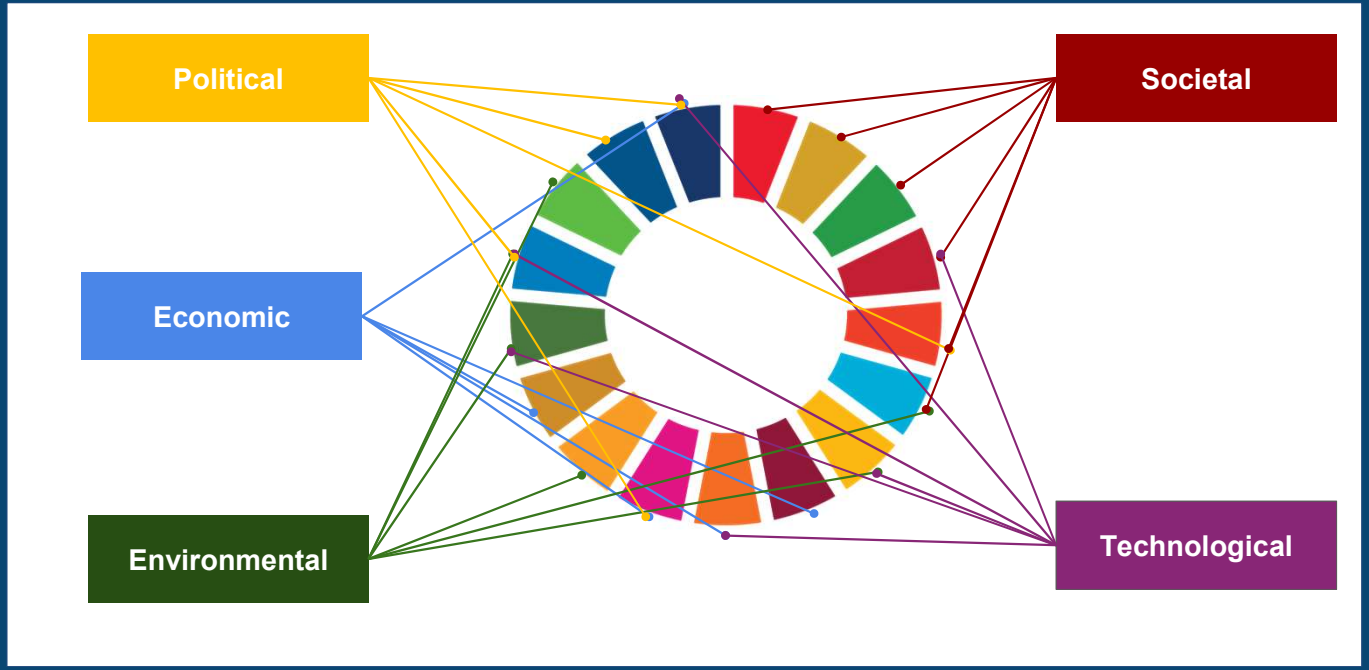
Political

- Failure of governance (private and public)
- Failure of regional or global governance
- Interstate conflict with regional consequences (e.g. US-China Trade War)
- Unmanageable fraud and corruption
- Government policy, legislative and regulatory changes and uncertainty
- National political uncertainty/instability
- Failure of state, a state crisis or a state collapse
- Lack of leadership
- Large-scale terrorist attacks
- Weapons of mass destruction

Societal

- Growing income disparity and inequality
- Failure of urban planning
- Failure of climate change mitigation and adaptation
- Chronic disease burden
- Social instability
- Large-scale involuntary migration
- Water crisis
- Food insecurity
- Insufficient supply of electricity
- Shifting societal values
- Gender inequality
- Inadequate and/or substandard education and skills development

Mapping the SDGs to SARVA Hazards



The SDG indicators form an integral part of risk and vulnerability assessment as indicators of susceptibility and adaptive capacity tied to specific hazards within the larger SARVA framework.

Renewable Energy Atlas

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REA

- The Renewable Energy Atlas project aims to establish a decision support system for the food, water, energy nexus, utilising the latest available information to assist with the integration of renewable energy sources into South Africa's energy economy and assist South Africa with meeting international climate objectives.
- Integration of the Renewable Energy Atlas with SARVA allows for the provision of feasibility tested options for energy supply.
- Can be used to provide adaptation options for local planners.
- Allows planners to assess the viability and impacts on water resources, job creation and potential power generation of suite of renewable energy options.

FOCUS AREAS

- Sourcing and refinement of decision ready datasets to be utilised for decision support.
  - Biomass estimates,
  - Availability analysis for each of the energy sources,
  - Improved cost estimates for extraction, processing and generation,
  - Network analysis for transportation of material
  - Creation of a cost surface for energy distribution into the national electricity grid.

- Development of a multicriteria decision modelling platform
  - Assessments of the viability and scoping of use scenarios for renewable energy provision using multi-objective decision analysis.

- Publication of feasibility analyses
  - Use scenarios for each of the Energy Sources,
  - Provision of Data and Information in an easy to use, accessible manner,
  - Integration with REIPPP, the NCCRD and SARVA enables the scenarios generated by REA to be utilised for adaptation planning

SDG Atlas

The SGD Atlas is envisaged as a decision support tool for municipal planners to gather data on where their municipalities stand with regard to sustainable development and as a way to directly tie national SDG indicator reporting into local reporting and resource pools. Currently, pertinent SDG indicators are being classified into relevant global change ontological categories and will form an integral aspect of Risk and Vulnerability analysis for South African local governments through SARVA.

EXPECTED OUTCOMES

- To make SDG indicator data and reporting available at a high resolution to municipal planners as a way of interrogating sustainable development within their communities;
- To contextualise the SDGs for South African local government in a way that is directly applicable to their planning and reporting processes;
- To streamline the incorporation of SDG indicators into government portals;
- To establish a ‘living atlas’ or a platform that is automatically updated when new information becomes available to make the data most relevant to the South African people (from dedicated official sources only);
- To establish an SDG indicator atlas that aligns with national reporting to the UN and thus a single source of truth as to the indicator values;
- To open additional avenues of funding for a wide variety of end users for actions associated with responding to specific indicators.

SDGs as context in other systems: Some examples for REA

17.7.1 Total amount of approved funding for developing countries to promote the development, transfer, dissemination and diffusion of environmentally sound technologies

1.2.2 Proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions

15.1.1 Forest area as a proportion of total land area

4.a.1a: Percentage of schools with access to electricity

Indicators contributing to a greater understanding of South Africa's *Renewable Energy* context

7. Ensure access to affordable, reliable, sustainable and modern energy for all

11.3.1 Ratio of land consumption rate to population growth rate

BioEnergy Atlas III

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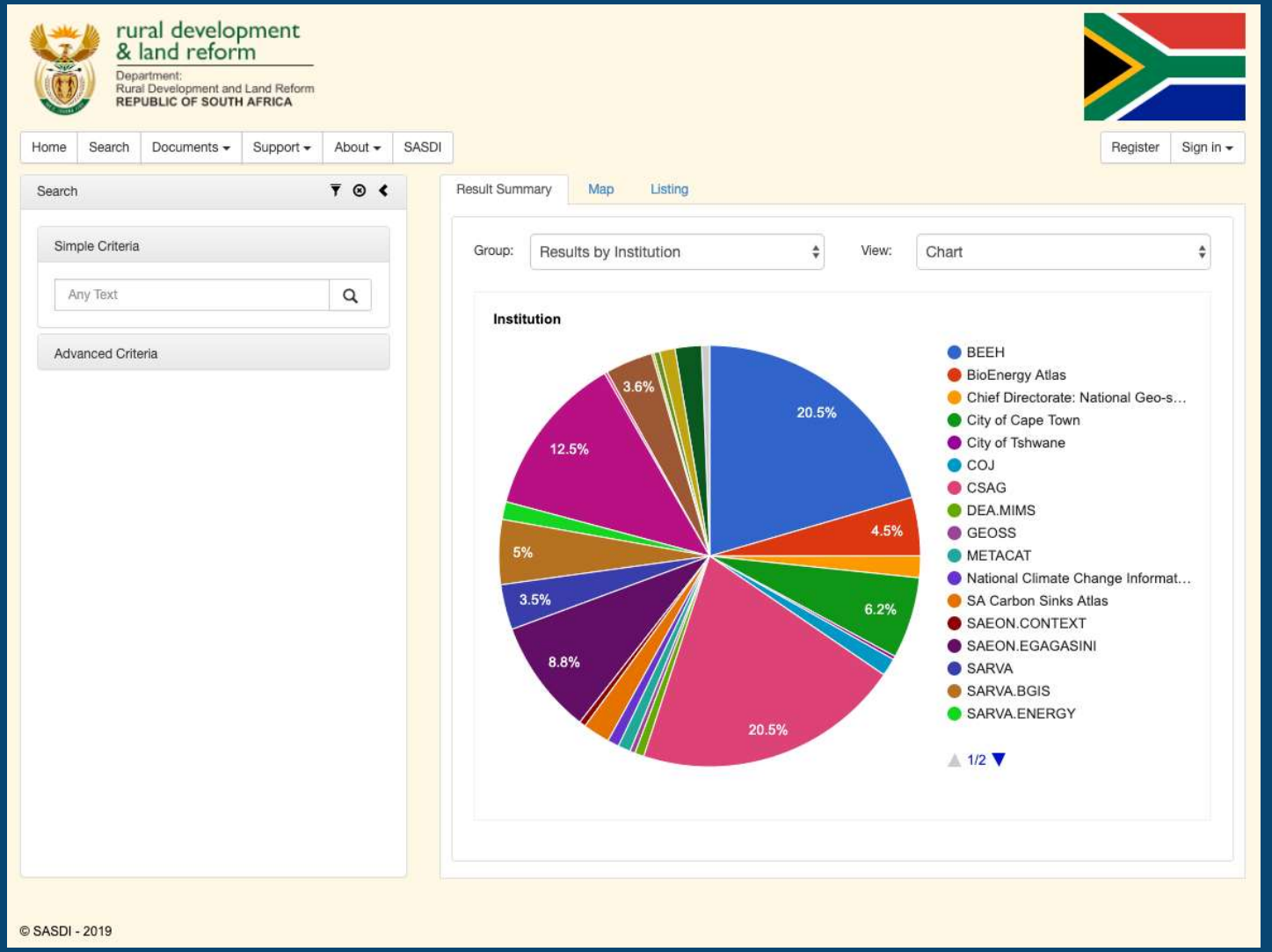
BIOENERGY ATLAS

- The goal of the BioEnergy Atlas III is to provide the tools and data to assist with the scoping, feasible utilisation and integration of BioEnergy into the Energy mix of South Africa.
- It will achieve this by meeting the following objectives:
    - Data Improvements to ensure that the data used for modelling is the most up to date version and meets the project specifications for decision ready data, modelling to create feasible scenarios for BioEnergy and Hybrid BioEnergy systems.
    - Research to ensure that knowledge gaps are identified and that NRF funding is allocated to address the knowledge shortfall.
    - Integration of the feasibility tested scenarios for hybrid BioEnergy systems into policy tools
    - Implementation of feasibility tested scenarios by members of the private sector for planning purposes by updating the existing online data publication platform and engaging with selected programmes

SASDI

http://www.sasdi.net



Thank you

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