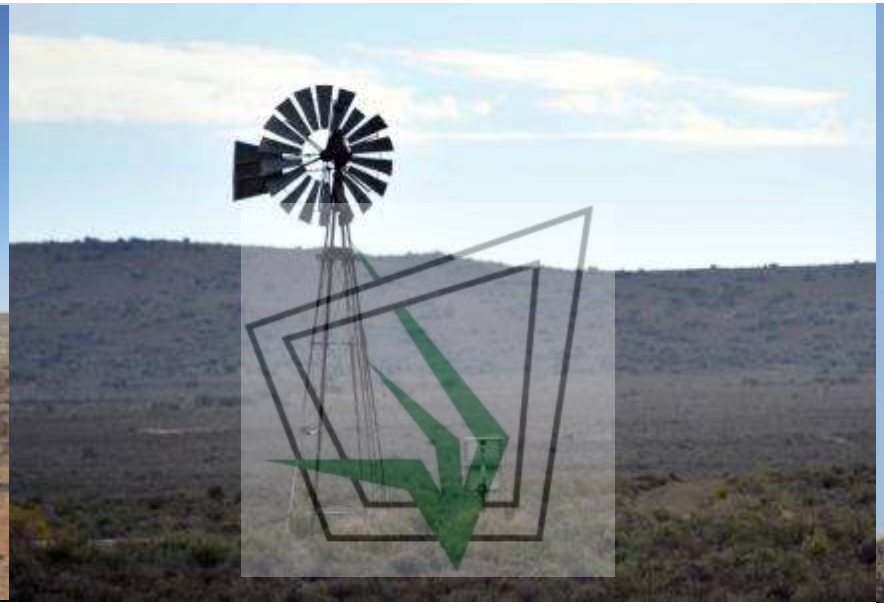
Karoo
Trajectories of Change in the Anthropocene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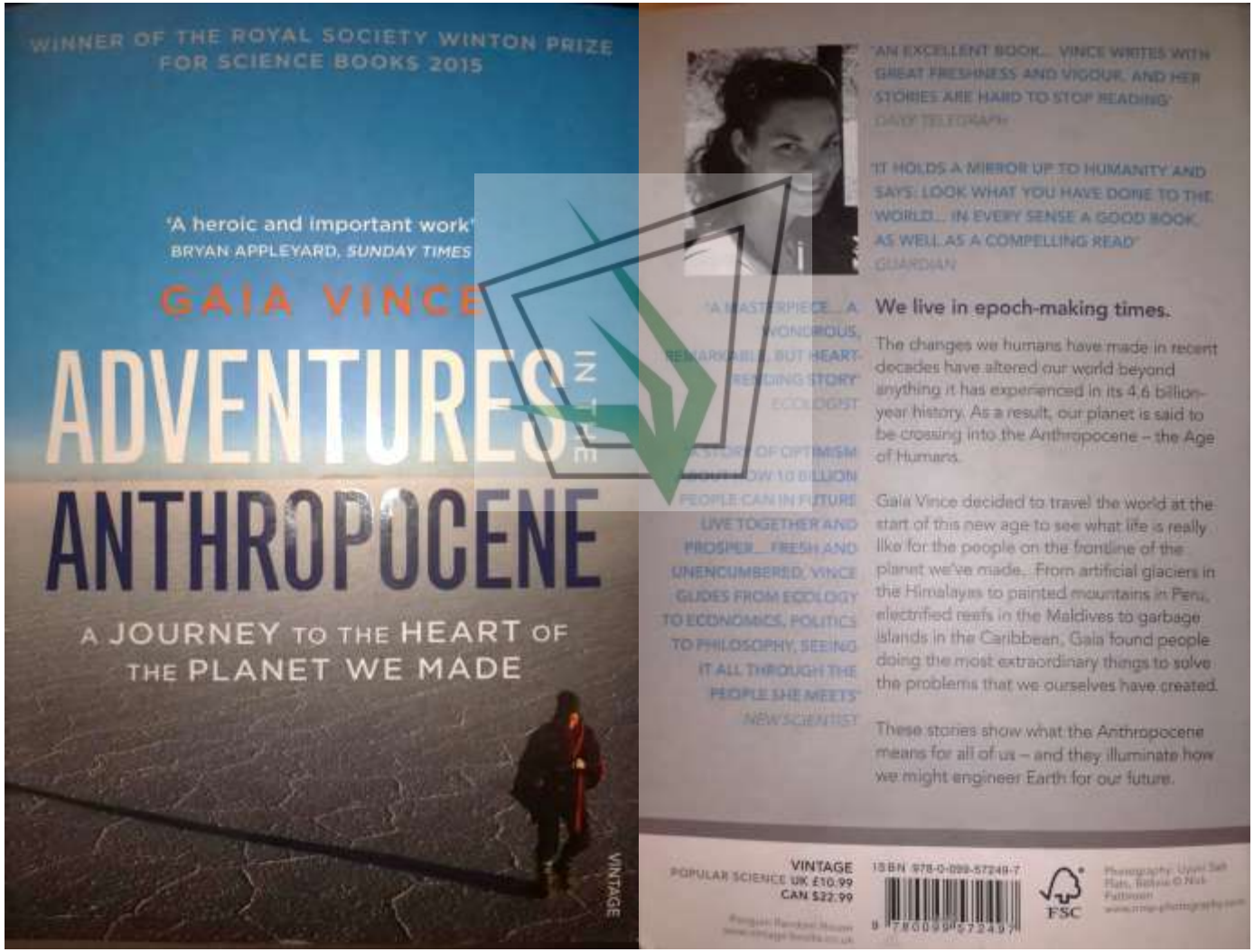
science & technology
Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA

Advancing knowledge. Transforming lives. Inspiring a nation.

NRF National Research Foundation
SAEON South African Environmental Observation Network

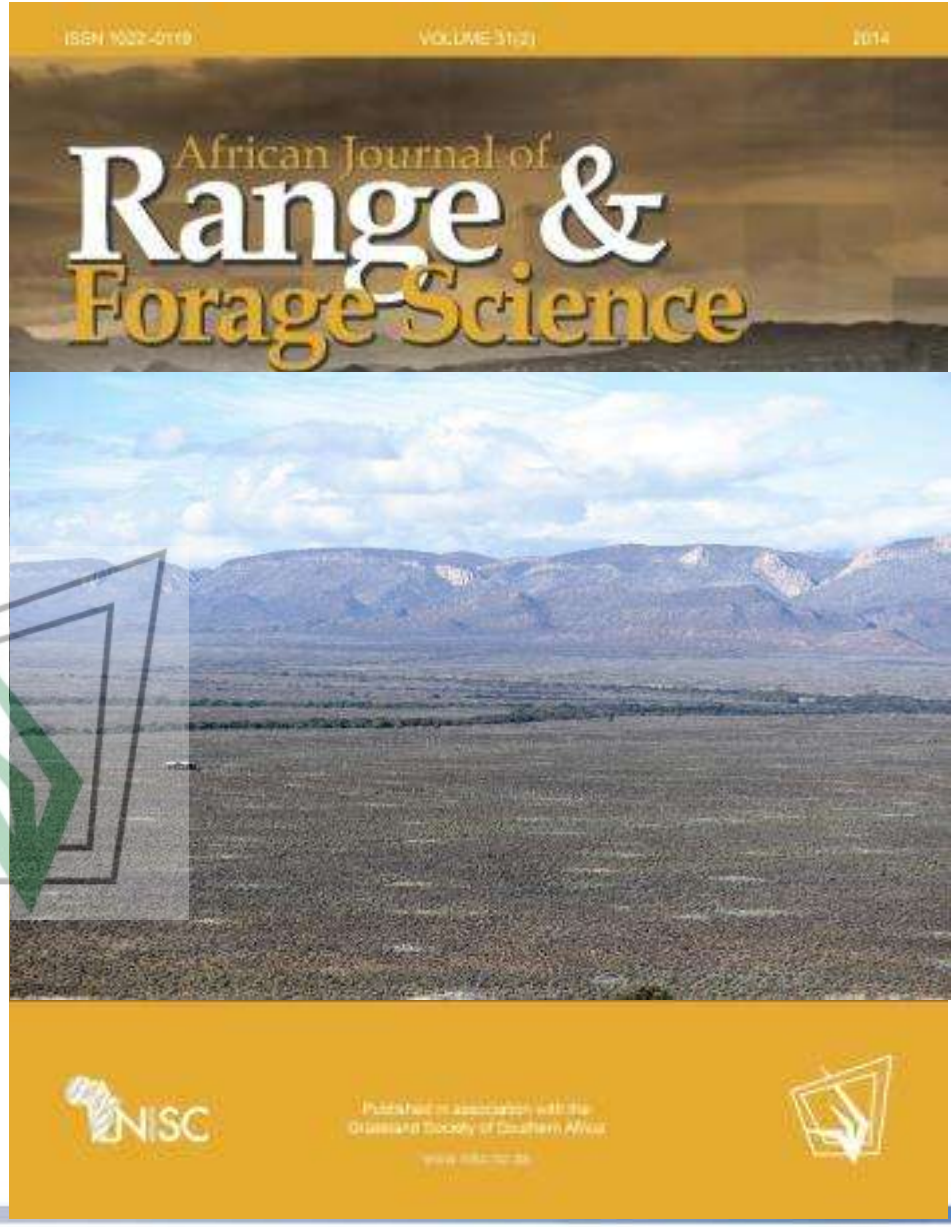
Anthopocene

Planetary change driven by humans in this generation transforming Earth's environmental and social systems



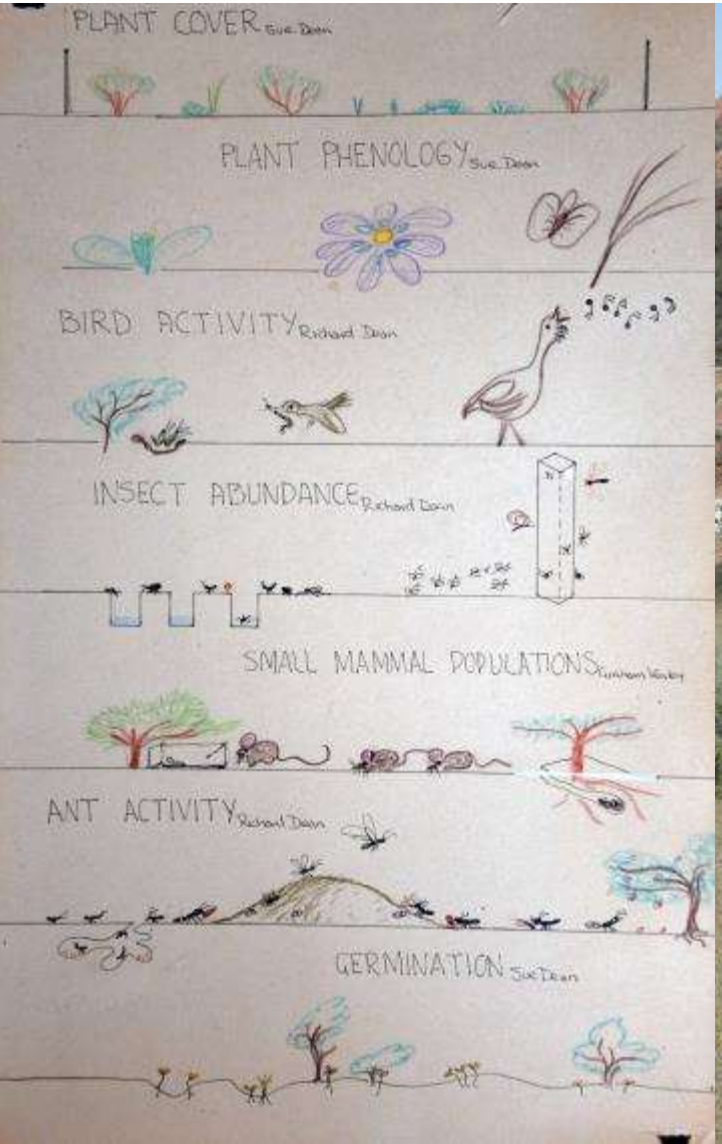
African Journal of Range and Forage Science

Karoo Special Issue



Social-Ecological Systems

complex interaction of social and ecological dynamics in the environment on which life depends (humans are part of nature)



Social-Ecological Research
Multi- Inter- Trans- Disciplinary

- Difficult for Scientists due to Incompatibilities
  - uni-disciplinary training
  - literature
  - jargon
  - data systems
  - viewpoints of a problem
  - methodologies/epistemologies
- Social sciences e.g.
  - livelihoods, household dynamics, social inequality, political economy, power
- Ecology e.g.
  - ecosystem dynamics, land use effects, climate, substrates, abundance and distribution of species

Karoo Special Issue

inter-disciplinary collaboration of editors

articles from multiple disciplines (inter-, trans-)

Editor in Chief

- Pieter Swanepoel

Guest Editors

- Joh Henschel
- Cherryl Walker
- Timm Hoffman

11 Associate Editors

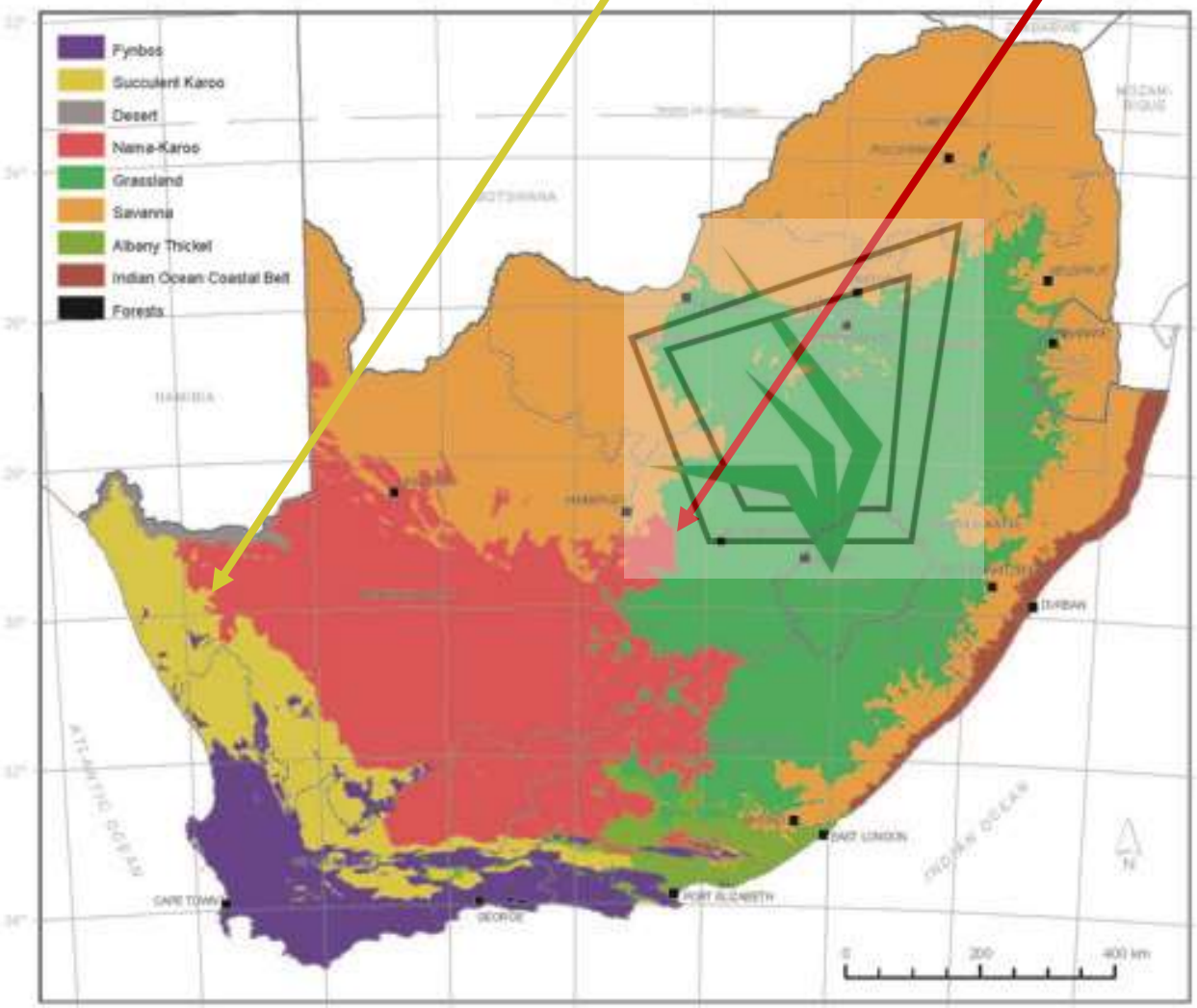
- Casper Crous
- Sue Milton
- Nicoli Nattrass
- Chrizette Neethling
- Tim O'Connor
- André Pelser
- Igshaan Samuels
- Ute Schmiedel
- Helga van der Merwe
- Gretel van Rooyen
- Noel van Rooyen

Karoo Special Issue
social and ecological contents

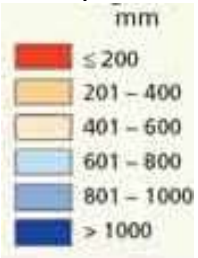
SECTIONS

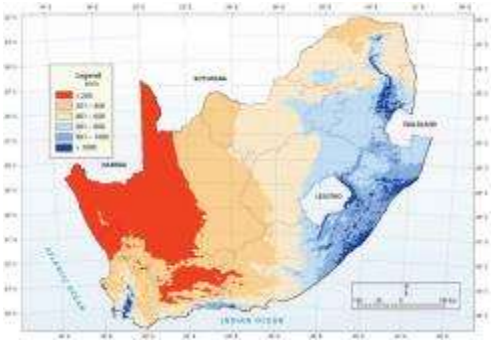
- Climate in the Anthropocene
- Gharo across History
- Long-term Trends and Processes
- Dynamics of Current Developments
- Farming Impacts
- Ecosystem Processes and Rehabilitation

Succulent Karoo & Nama Karoo



Mean Annual Precipitation





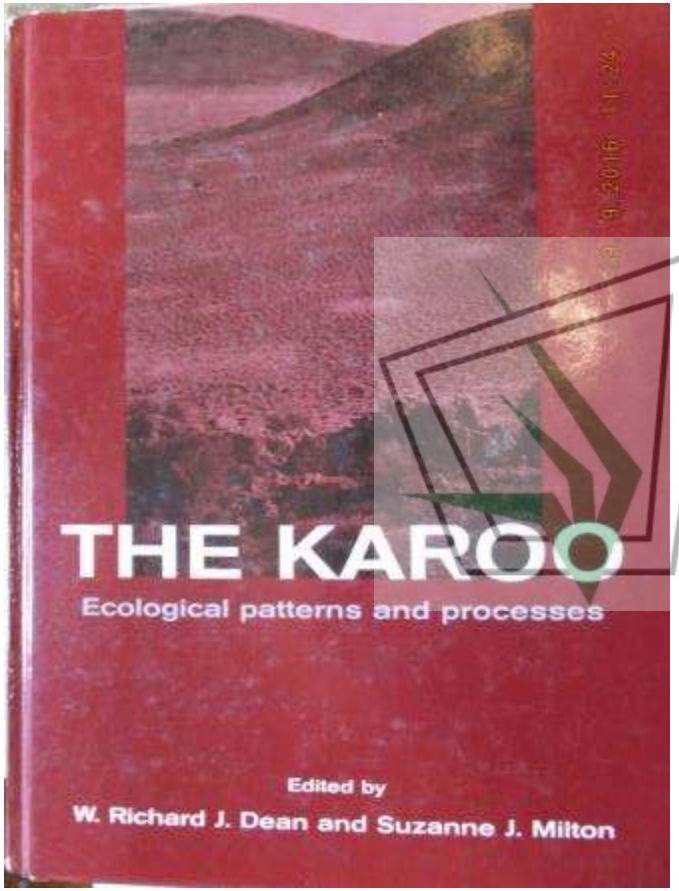
Two Karoos

	Succulent Karoo	Nama Karoo
Bioregions	6	3
Biodiversity	high	low
Endemism	high	low
Vegetation	succulents dominate	non-succulent shrubs, partly grassy
Atmospheric moisture	fog, dew, rain	rain
Rainfall season	winter	bioregions differ mid/late summer
Variability of rain	relatively low	high
Variability of temperature	relatively low	high
Conservation areas	many	few
Communal farming	more	fewer
Commercial farming	fewer	more
Urban/rural population	70% rural	75% urban

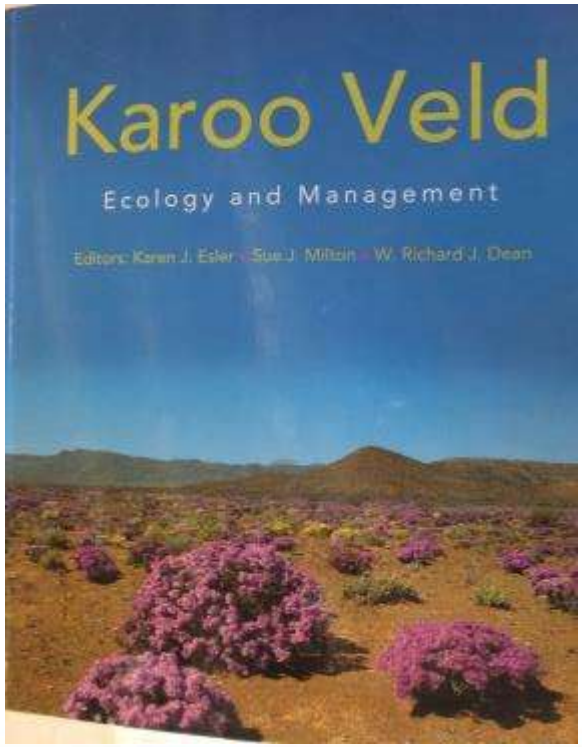
KSI in Context

Previous Karoo Overviews

- 1999



2006



KSI context (ctd)

Previous Special Issues

- 1999 Special Issue, *Plant Ecology:* "Namaqualand, South Africa – an overview of a unique winter-rainfall desert ecosystem" (edited by Cowling, Esler and Rundel);
- 2007 Special Issue, *Journal of Arid Environments:* "Sustainable land use in Namaqualand" (edited by Hoffman, Allsopp and Rohde);
- 2010 *BIOTA book set:* "Biodiversity in southern Africa" (edited by Jürgens, Schmiedel and Hoffman)
- 2016 book: "Hydraulic fracturing in the Karoo – critical legal and environmental perspectives" (edited by Glazewski and Esterhuyse);
- 2019 Special Issue: "Karoo Futures? Astronomy in place and space" (edited by Walker et al 2019);
- Numerous single scientific papers, also social sciences, e.g., "Marginalisation and demographic change in the semi-arid Karoo, South Africa" (Nel & Hill 2008)

KSI context (ctd)

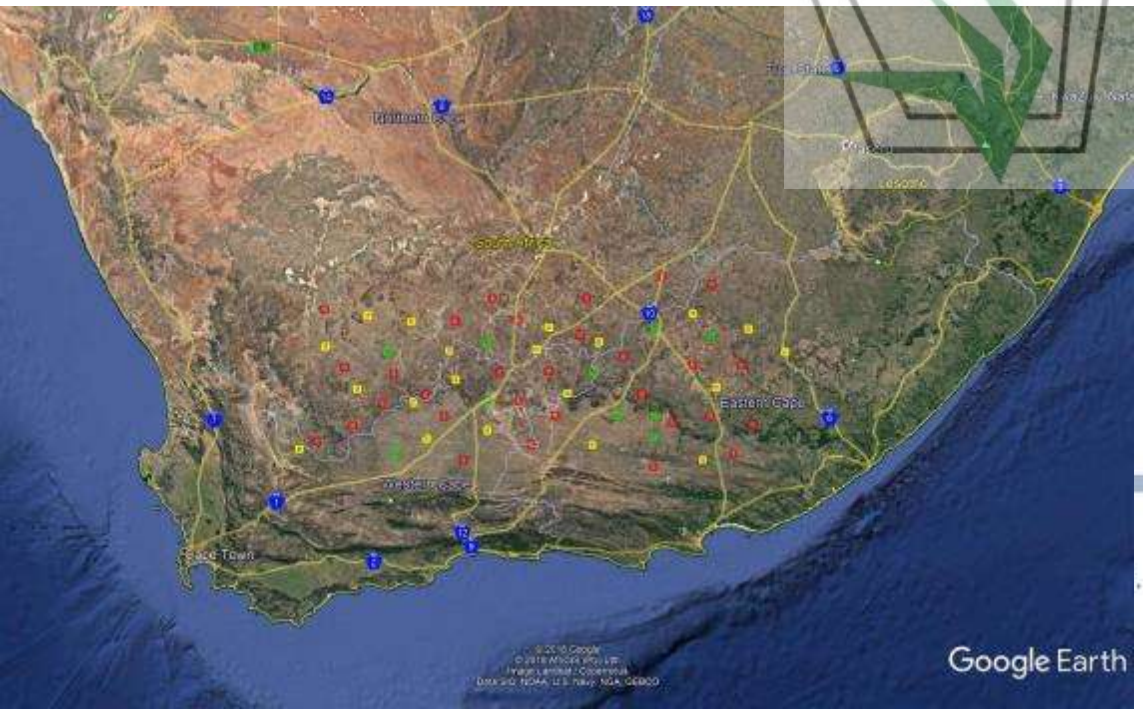
Comprehensive Specialist Reports and Reviews for Strategic Environmental Assessments (CSIR)

- 2015: Wind and solar photovoltaic energy
  (eds. van der Westhuizen, Cape-Ducluzeau, Lochner);
- 2016: *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks*
  (eds. Scholes, Lochner, Schreiner, Snyman-Van der Walt, de Jager),
  especially:
  - "Impacts on social fabric" (Atkinson et al.)
  - "Biodiversity and ecological impacts" (Holness et al.);
- 2017: South African Radio Astronomy Square Kilometre Array, SKA Phase 1 (ed. Cape)

KSI context (ctd)

ongoing project

Address lack of biodiversity data for the Karoo through:
1) integrating and upgrading existing data located in museums and herbaria
2) conducting detailed surveys for 11 representative taxonomic groups in selected study sites (30 Square Kilometre Observatories)



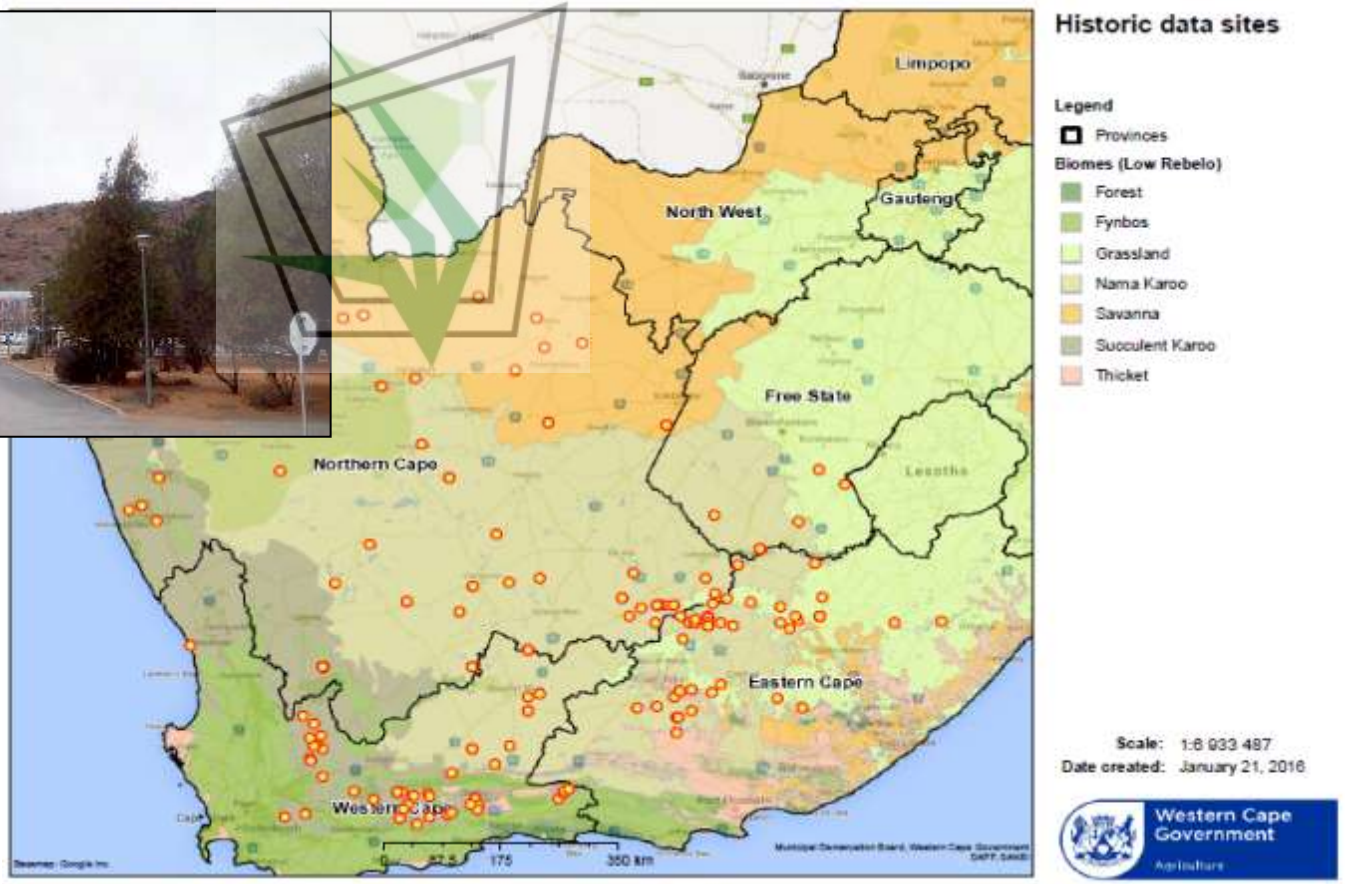
These data will also be useful for monitoring long-term effects of shale gas extraction.

. Inspiring a nation.

KSI context (ctd)

>100 years agricultural surveys and experiments (analyses initiated, not yet synthesised)

- Grootfontein Agricultural Development Institute (DAFF) and provincial departments



- Historic datasets, some currently being resurveyed

Research leading towards the KSI

founded on a generation of a dozen leading scientists

Ecologists

- Sue Milton
- Richard Dean
- Richard Cowling
- Karen Esler
- Graham Kerley
- Timm Hoffman
- Guy Midgley
- Gretel van Rooyen
- William Bond

Social Scientists

- Doreen Atkinson
- Trevor Hill
- Etienne Nel

KSI Celebration of Achievements by Sue Milton and Richard Dean

- Most prolific Karoo scientists
  - together >300 papers (each 200, many jointly), most on Karoo
  - collaboration with numerous scientists, attracted to Karoo
  - Inspired and trained numerous postgraduate students

- Founders of Tierberg LTER (aka TKRC) in 1987, made it 'window' to Karoo ecology

- Pioneered transdisciplinary research encompassing conservation and periurban socio-economic dynamics

- Catalysts of social-ecological research approaches and intergenerational equity practices in the Karoo

Karoo Special Issue: Contents

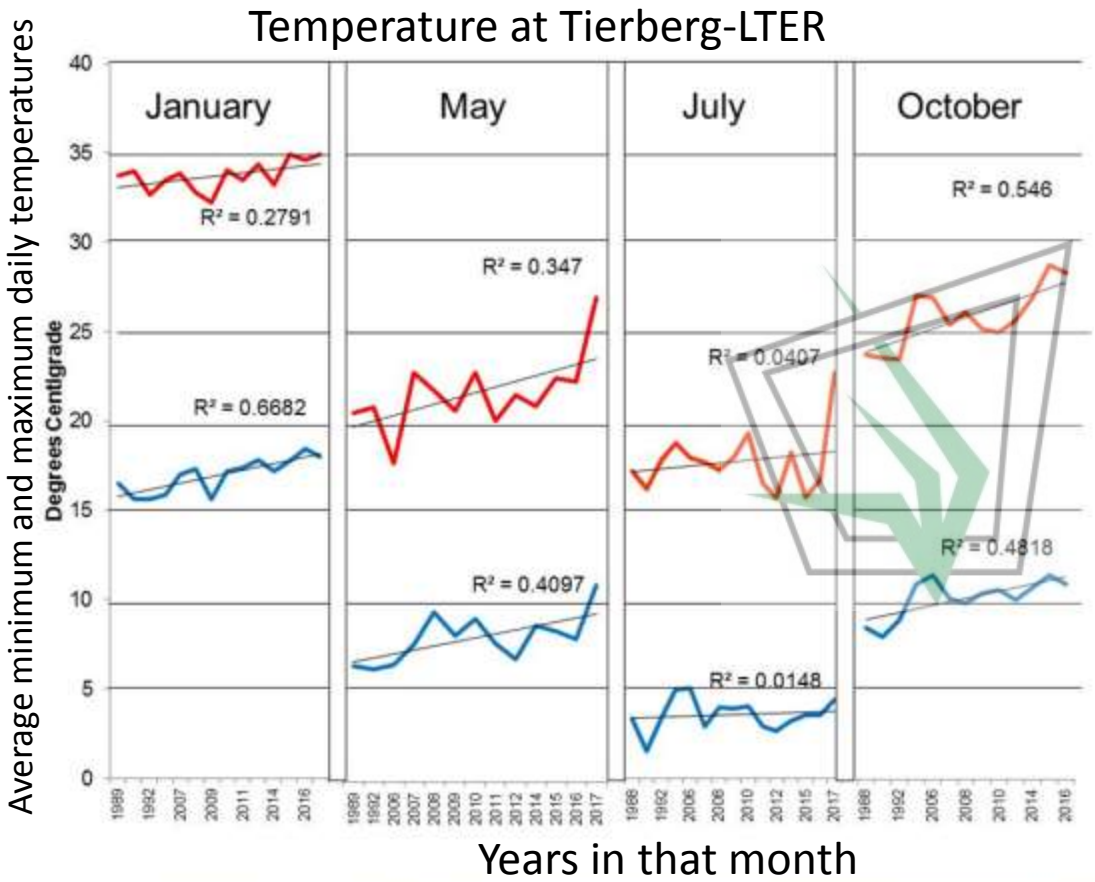
Drivers of Change

- Type
  - Global Change
  - Land Use Change
  - Human wellbeing
- Context
  - History
  - Social, Economic, Policy/Governance
  - Ecosystems

History of change in Karoo

Start of period	Cause of change	Social change	Rangeland change
2 M years ago	San hunter-gatherers		
2 k years ago	Khoekhoen pastoralists	Dominated over San	Domestic grazing started
1740	Dutch settlers	San & Khoekhoen societies unravel	Grazing intensified
1850	-church towns -fences, boreholes -market-oriented farming	-farms and towns control social fabric	-heavy overgrazing -species extinctions -landscape fragmentation
1930	23 million sheep	-growing prosperity	land degradation
1970	farm consolidation	-growing inequality	reduced grazing
1994	-democracy -Karoo partitioned	-intensified marginalisation	land use diversification

Climate change - global driver



↑ temperatures

↑ evapotranspiration

↑ carbon

Δ precipitation

Δ droughts

Land use changes - local drivers

Land use changes - external drivers

Human wellbeing - social driver

Change brings New Opportunities

e.g. Honey from solar power generators

Challenge: Effective management of social-ecological change

- Safe boundaries for environmental change to avoid irreversibly failure of ecosystems
  → environmental sustainability

- Governance, eradicate poverty and inequality, adapt to changes, societal self-empowerment
  → environmental sustainability

Lead Article

- Drivers and trajectories of social and ecological change in the Karoo, South Africa

Climate in the Anthropocene

- Will the Karoo see fundamental shifts in vegetation due to climate and land use change this century?

Gharo across History

- Before the Anthropocene: human pasts in Karoo landscapes
- An overview of themes in the agrarian and environmental history of the Karoo since c.1800
- Long-term changes in land use, land cover and vegetation in the Karoo drylands of South Africa: Implications for degradation monitoring

Long-term trends and processes

- Reflections, applications and future directions of Long-Term Ecological Research at Tierberg
- Plant diversity and species-specific responses to seasonal rainfall patterns in the Namaqualand Hardeveld – 17 years of plot-based annual monitoring
- Long-term vegetation change (> 20 years) in the plains habitat on the Goegap Nature Reserve, Succulent Karoo, South Africa

Dynamics of Current Developments

- Efficiency, vulnerability and land use change in the Karoo Region of South Africa, 2012-2014
- By their own bootstraps: Municipal commonage farmers as an emerging agrarian class in the Karoo
- Population change in the Karoo
- Linear structures in the Karoo

Farming impacts

- Interactions of grazing and rainfall on vegetation at Grootfontein in the eastern Karoo
- Long-term impacts of livestock grazing in the Succulent Karoo: A 20-year study of vegetation change under different grazing regimes in Namaqualand
- Trampling tolerance of Karoo plants ‘using sheep as proxies for trekking springbok’
- Web spider abundance is affected by sheep farming in the Karoo
- Estimating mammal diversity in the shale gas footprint
- Spatio-temporal patterns of perceived conflict between small-livestock farmers and three predators in the Karoo

Ecosystem Processes and Rehabilitation

- Biological soil crusts of the Succulent Karoo
- The composition of soil seedbank and its role in ecosystem dynamics and rehabilitation potential in the arid Tankwa Karoo Region, South Africa
- Improving the success of rehabilitation through experimentation on a coastal mineral sands mine in Namaqualand, South Africa
- Response of arthropod communities to plant-community rehabilitation efforts after strip mining on the semi-arid west coast of South Africa

Thank you