

# Karoo

## Trajectories of Change in the Anthropocene

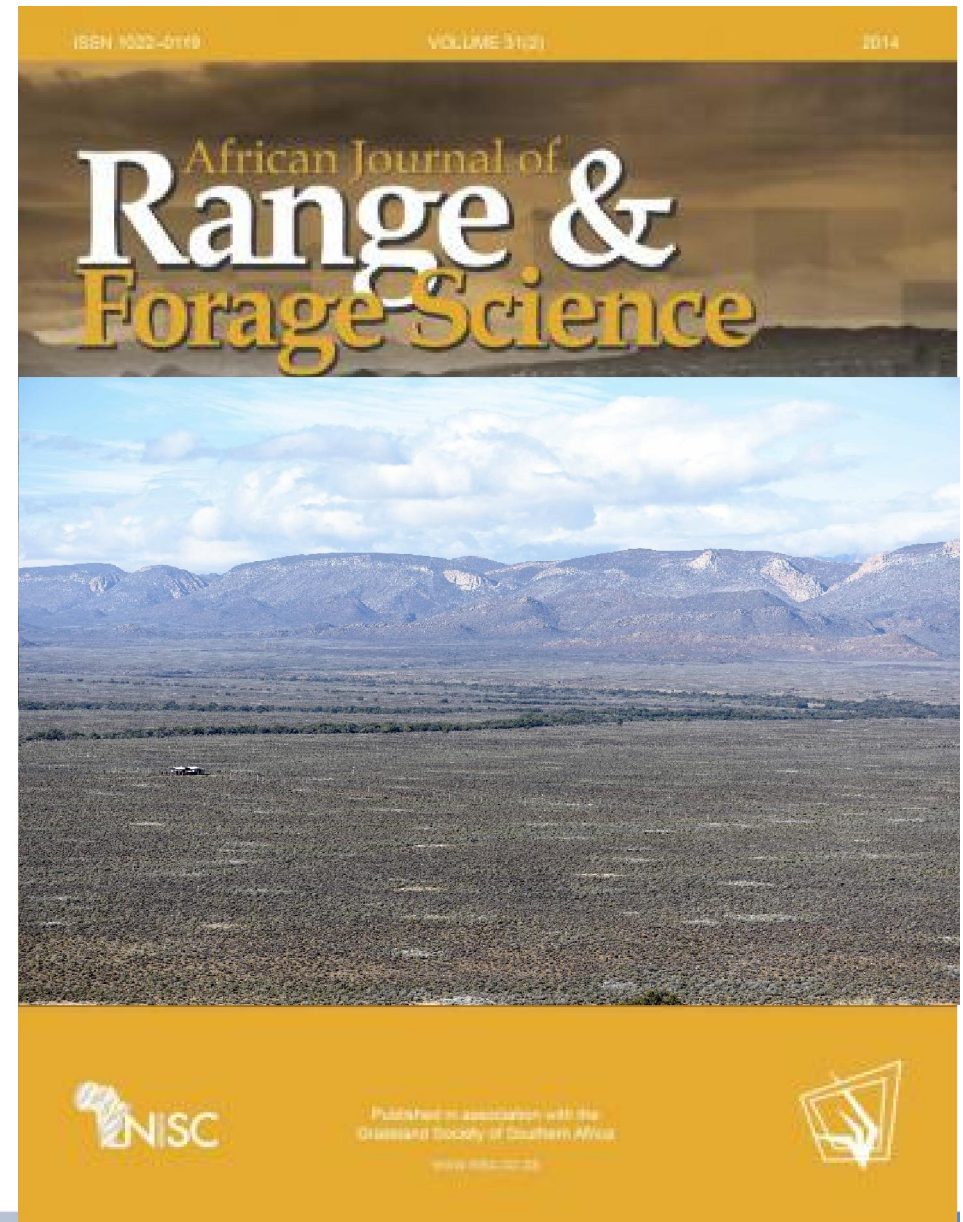


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South African Environmental Observation Network  
Stellenbosch University  
University of Cape Town

# African Journal of Range and Forage Science

## Karoo Special Issue



science  
& technology

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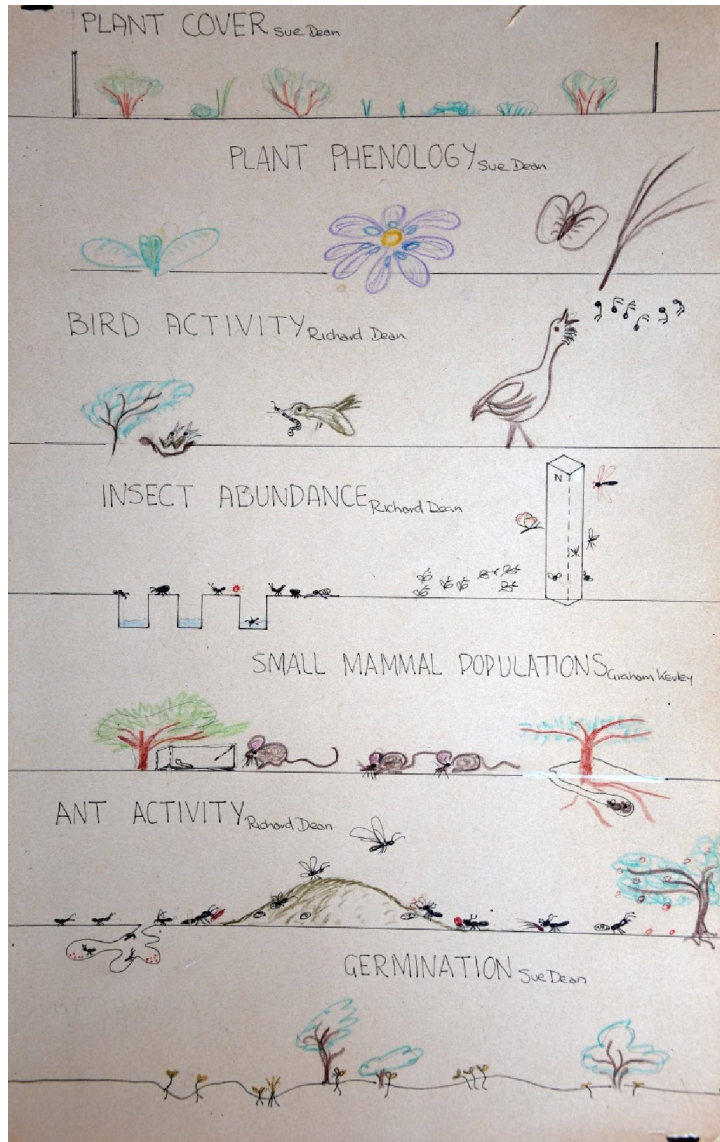
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# Social-Ecological Systems

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



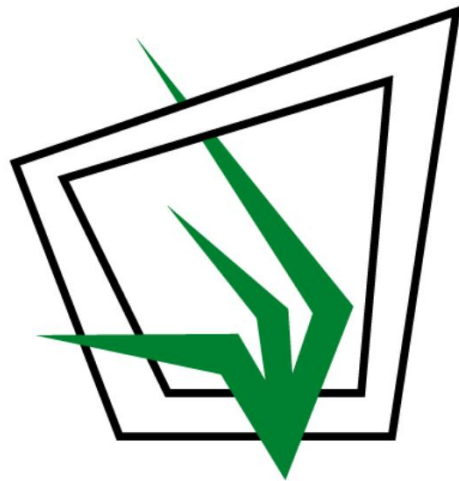
# Social-Ecological Research

## 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-)



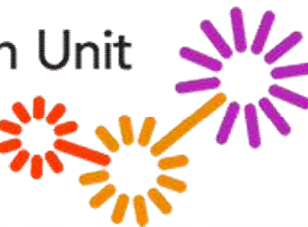
## Editor in Chief

- Pieter Swanepoel



COSMOPOLITAN  
K A R O O  
S U S T A I N A B L E   D E V E L O P M E N T

Plant Conservation Unit



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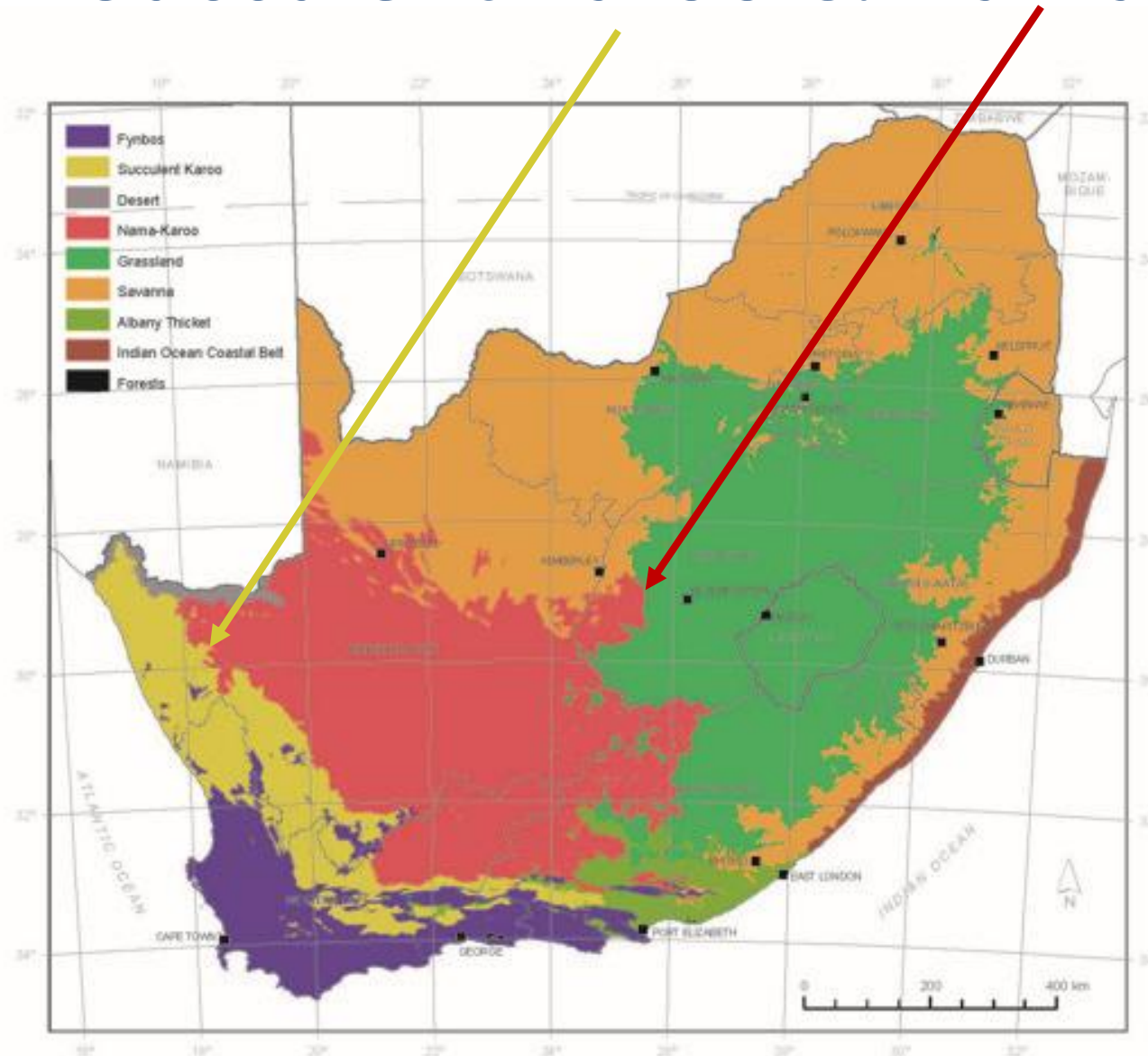
# Karoo Special Issue

## social and ecological contents

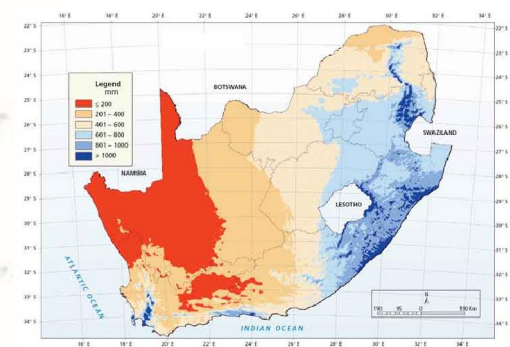
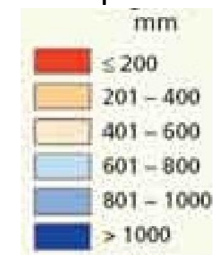
### SECTIONS

- 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



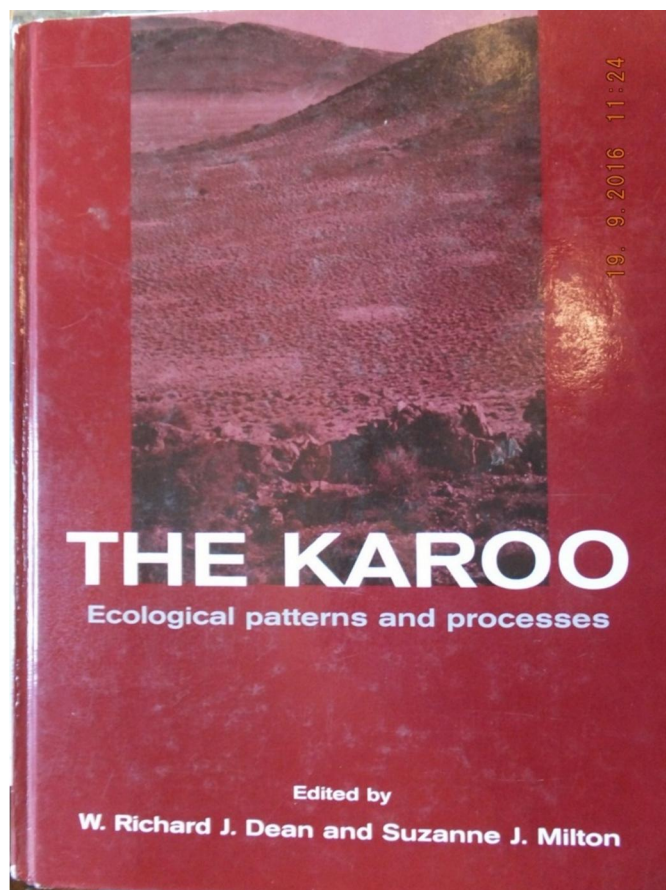
# Two Karoos

	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

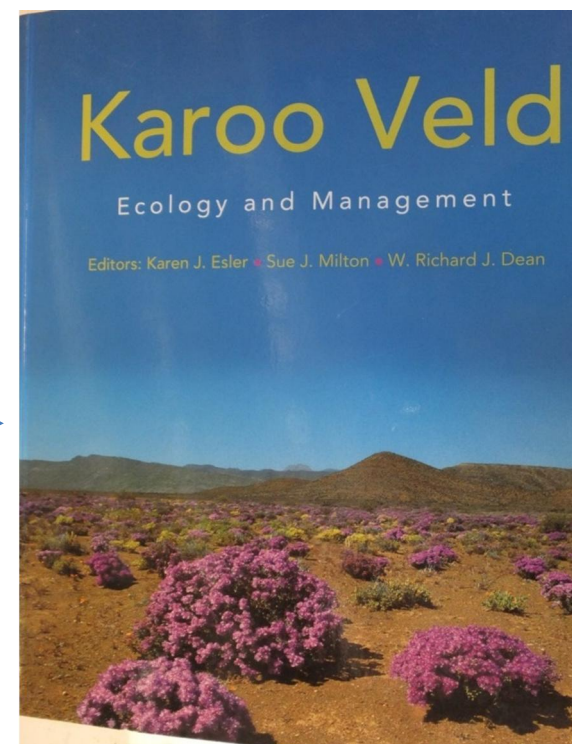
# KSI in Context

## Previous Karoo Overviews

- 1999



2006



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# 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)

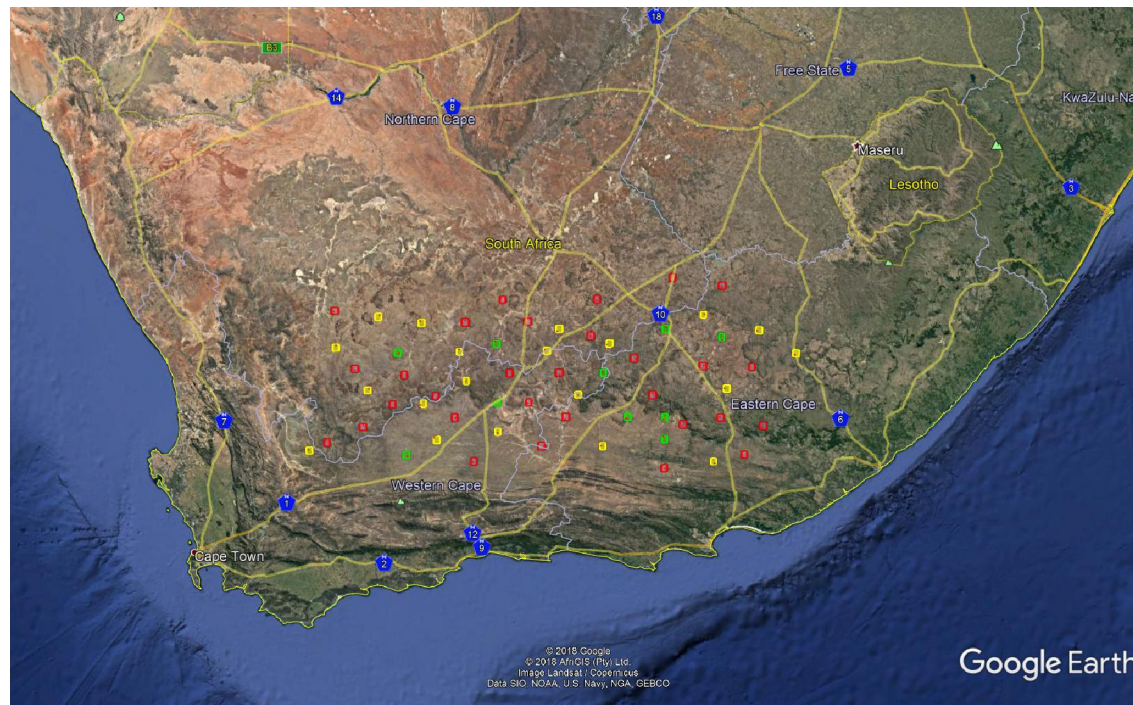
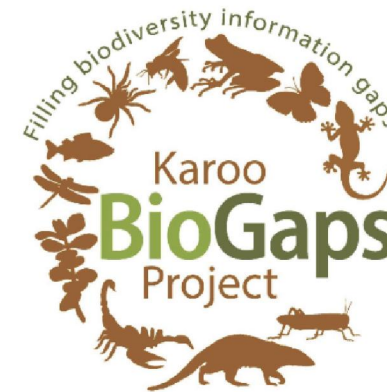
- 2015: Wind and solar photovoltaic energy  
(eds. van der Westhuizen, Cape-Ducluzeau, Lochner);
- 2016: *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks*  
(eds. Scholes, Lochner, Schreiner, Snyman-Van der Walt, de Jager),  
especially:
  - “Impacts 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.

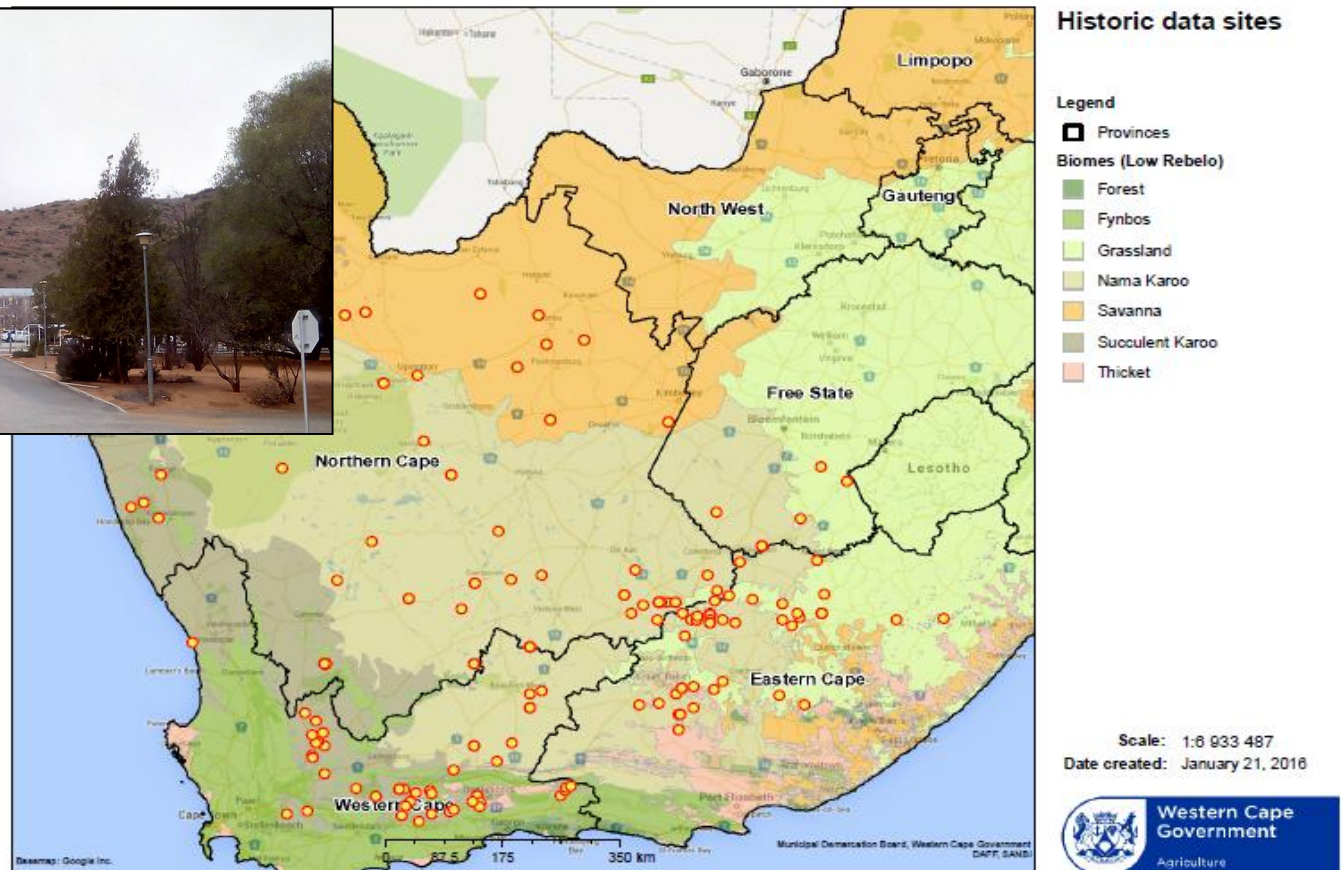


# KSI context (ctd)

- >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 (24 papers)

## **Editorial: Introduction**

**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

## **Editorial: Synthesis & Gaps**

# Drivers of Change

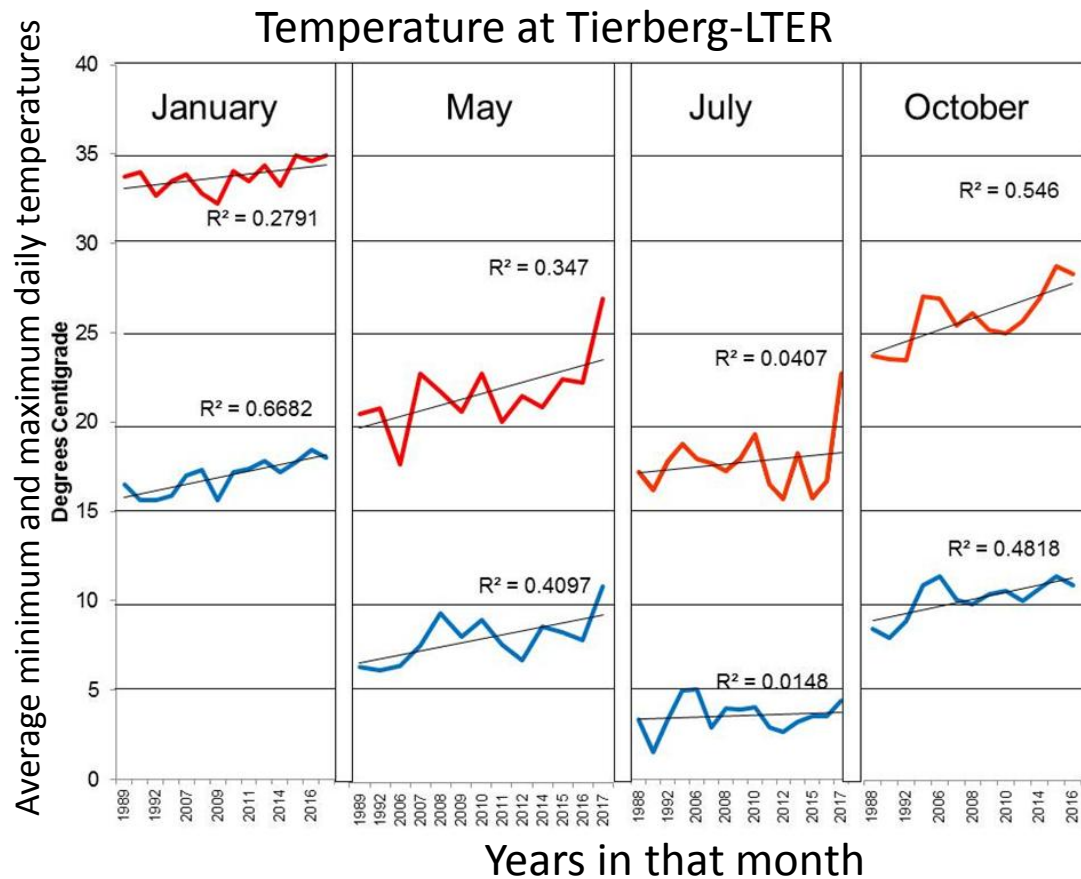
- Type
  - Global Change
  - Land Use Change
  - Human wellbeing
- Context
  - History
  - Social, Economic, Policy/Governance
  - Ecosystems

# History of changes in Karoo

Start of period	Cause of change	Social change	Rangeland change
2 M year ago	Humanoids		
?	San hunter-gatherers		
2 k years ago	Khoekhoen pastoralists	Dominated over San	Domestic grazing started
1740	Dutch settlers in Karoo	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

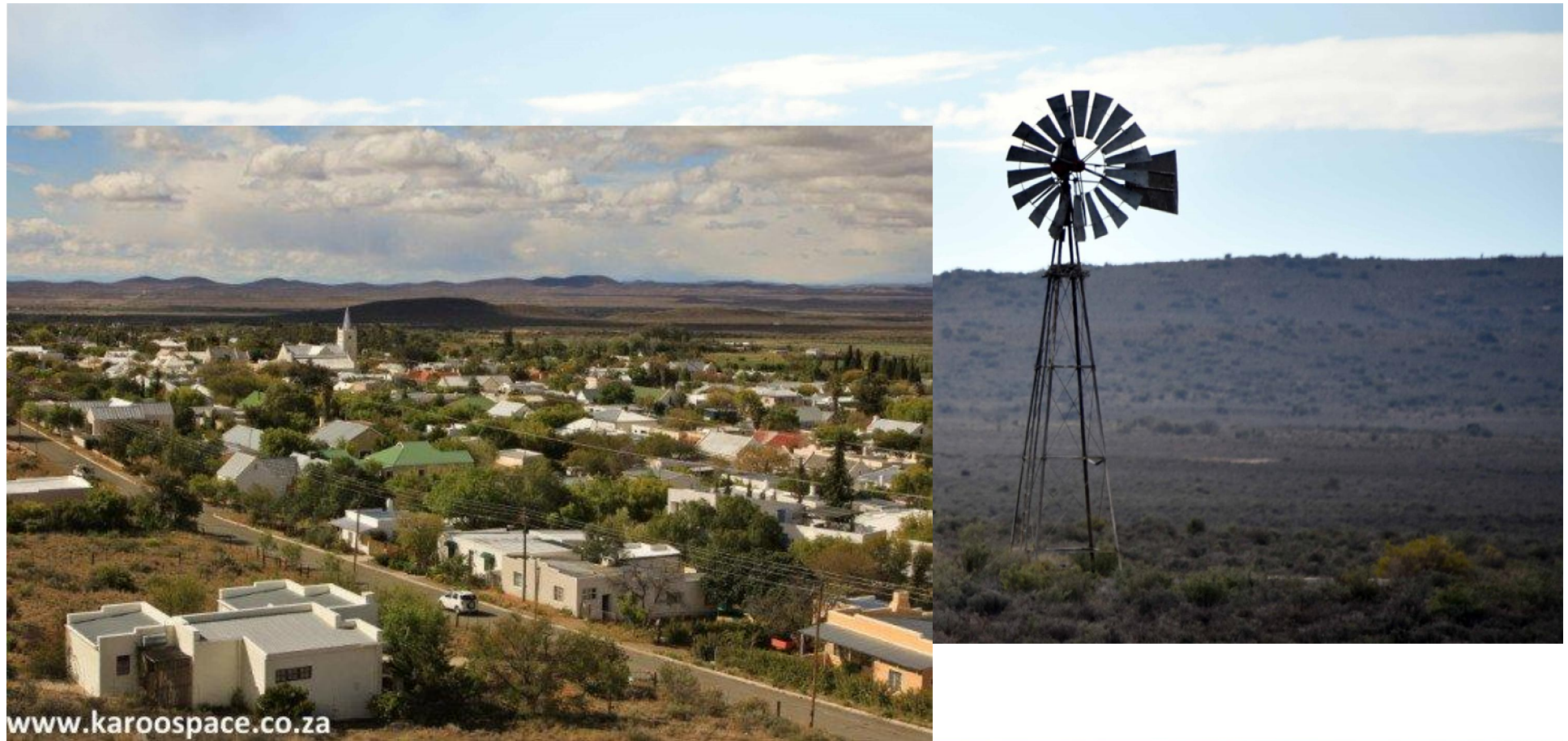
# Land use changes - local drivers



# Land use changes - external drivers



# Human wellbeing - social driver



# Change brings New Opportunities



e.g.  
Honey  
from  
solar  
power  
generators



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# 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

# Can a Karoo-Gardenroute LTSER Platform address these challenges?

- **Human ecosystem complex** (steep rainfall gradient; contrasting biomes; transformed ecosystems; ecosystem services; global significance; socio-economical uses & impacts including agriculture, forestry & recreation; development and global change impacts & threats; impact of local policies/infrastructure or lack thereof; etc)
- **Broad encompassing research agenda & design** (social-ecological conditions, power relations and decision-making)
- **Field Sites and Remote Sensing**
- Past, current or future **research projects, data sources and research infrastructure**
- **Transformative** policy feed forward & citizen science
- **Institutional** capacity, arrangements, coordination and commitments

Thank you



marie clark  
2015