# A world upside down:

## Academic and citizen science to understand vulnerability of endemics in southern Africa


168
108

**Phoebe Barnard**

**South African National Biodiversity Institute**

**also University of Cape Town and**

**University of Stellenbosch**

# Phoebe Barnard

**Climate Change BioAdaptation Program &**
**Biodiversity Futures Program**
**South African National Biodiversity Institute**

**African Climate & Development Initiative, and**
**Centre of Excellence at the FitzPatrick Institute of**
**African Ornithology, University of Cape Town**

**Institute for Futures Research,**
**Stellenbosch University School of Business**

ACDI African Climate & Development Initiative

University of Cape Town · iYunivesithi yaseKapa · Universiteit van Kaapstad

SPES BONA

Percy FitzPatrick Institute

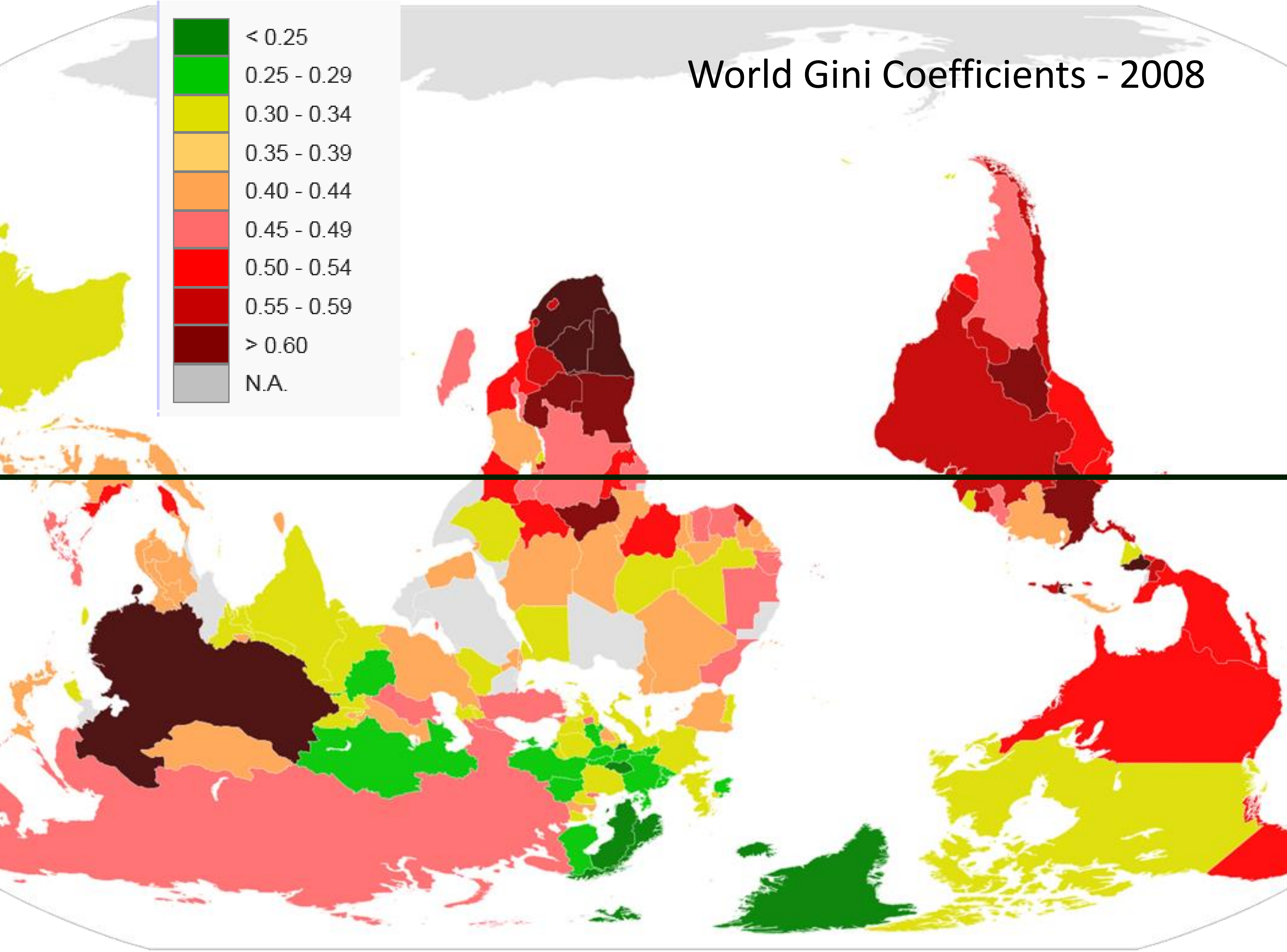
SANBI Biodiversity for Life
South African National Biodiversity Institute

# Roadmap….

View from ‘a world upside down’
Data and societal self-determination
Climate and biodiversity futures
Mixing toolboxes to map the road ahead

# 1 A view from a world upside down

# World Gini Coefficients - 2008



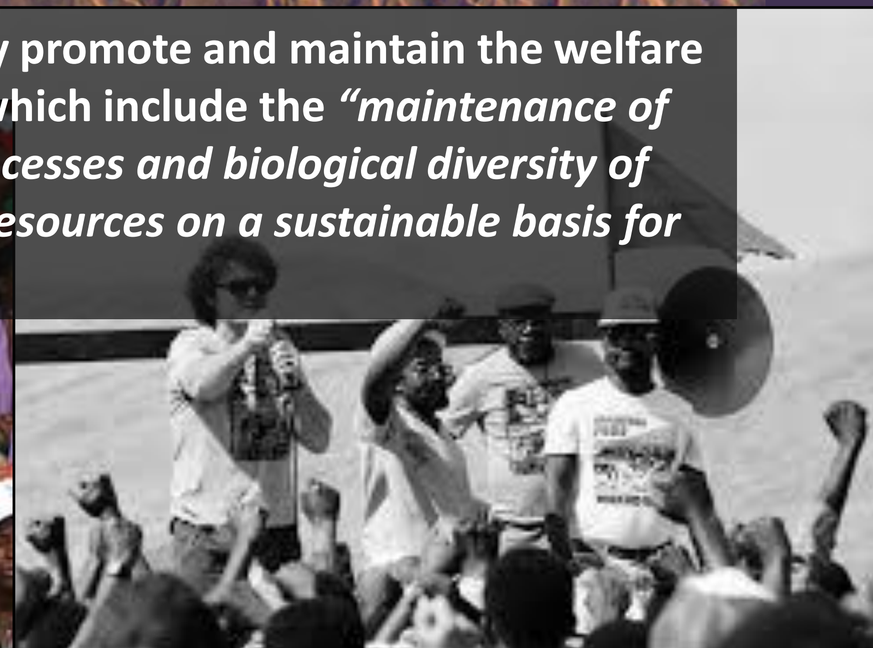

AS SEEN ON
The Pinnacle List
ANTONI
associates


N
S


Arctic Ocean
Greenland Sea
Kara Sea
Laptev Sea
Beaufort Sea
Baffin Bay
Barents Sea
East Siberian Sea
Norwegian Sea
Hudson Bay
Labrador Sea
Gulf of Alaska
North Sea
Sea of Okhotsk
Bering Sea
North Pacific Ocean
North Atlantic Ocean
Med. Sea
North Pacific Ocean
Gulf of Mexico
East China Sea
Caribbean Sea
Arabian Sea
Bay of Bengal
South China Sea
South Atlantic Ocean
Indian Ocean
Coral Sea
South Pacific Ocean
Tasman Sea
© 2007 Geology.com

## 2 A kind of societal self-determination

Article 95 (l): the state shall actively promote and maintain the welfare of the people by adopting policies which include the *"maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and use of living natural resources on a sustainable basis for the benefit of all Namibians…"*






National development, poverty, illiteracy, restitution, economic growth, biodiversity conservation, sustainable development

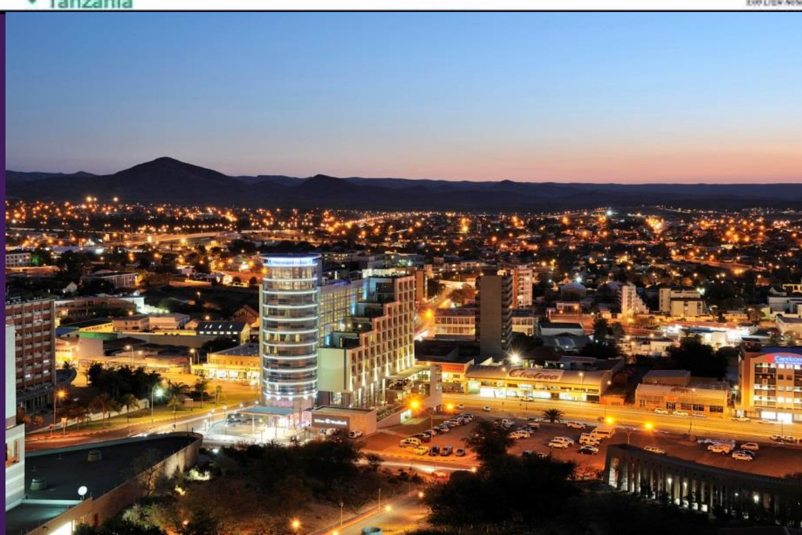
wicked problems

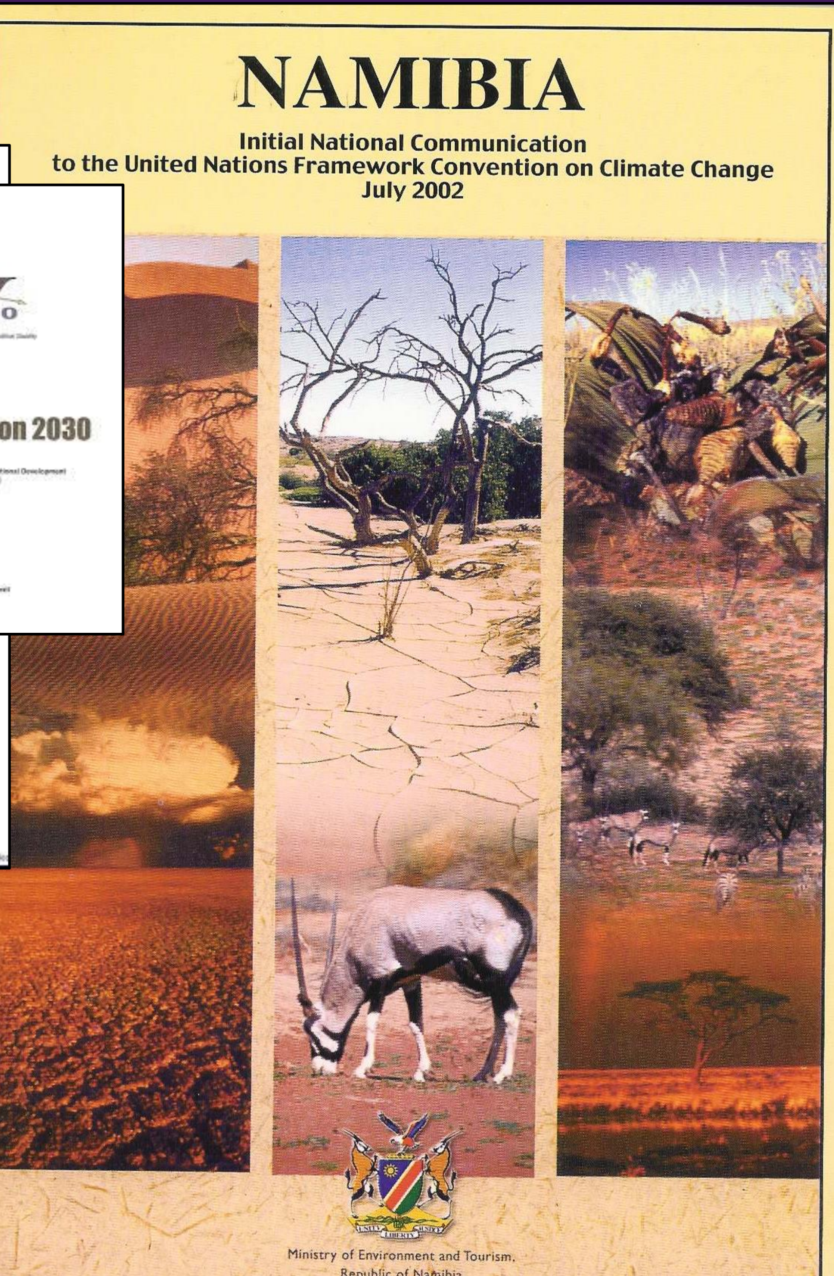
But not with some imagination and sensitivity to history….


BIOLOGICAL DIVERSITY
IN NAMIBIA
– a country study
BIODIV. PROGRAM
Biodiversity
and
Conservation
VOLUME 7 NUMBER 4 1998
ISSN 0960-3115
Special Issue:
The Biological Diversity of Namibia
CHAPMAN & HALL
http://www.thomsonscience.com
Biodiversity and Development
in Namibia
Namibia's ten-year strategic plan
of action for sustainable development
through biodiversity conservation
2001-2010

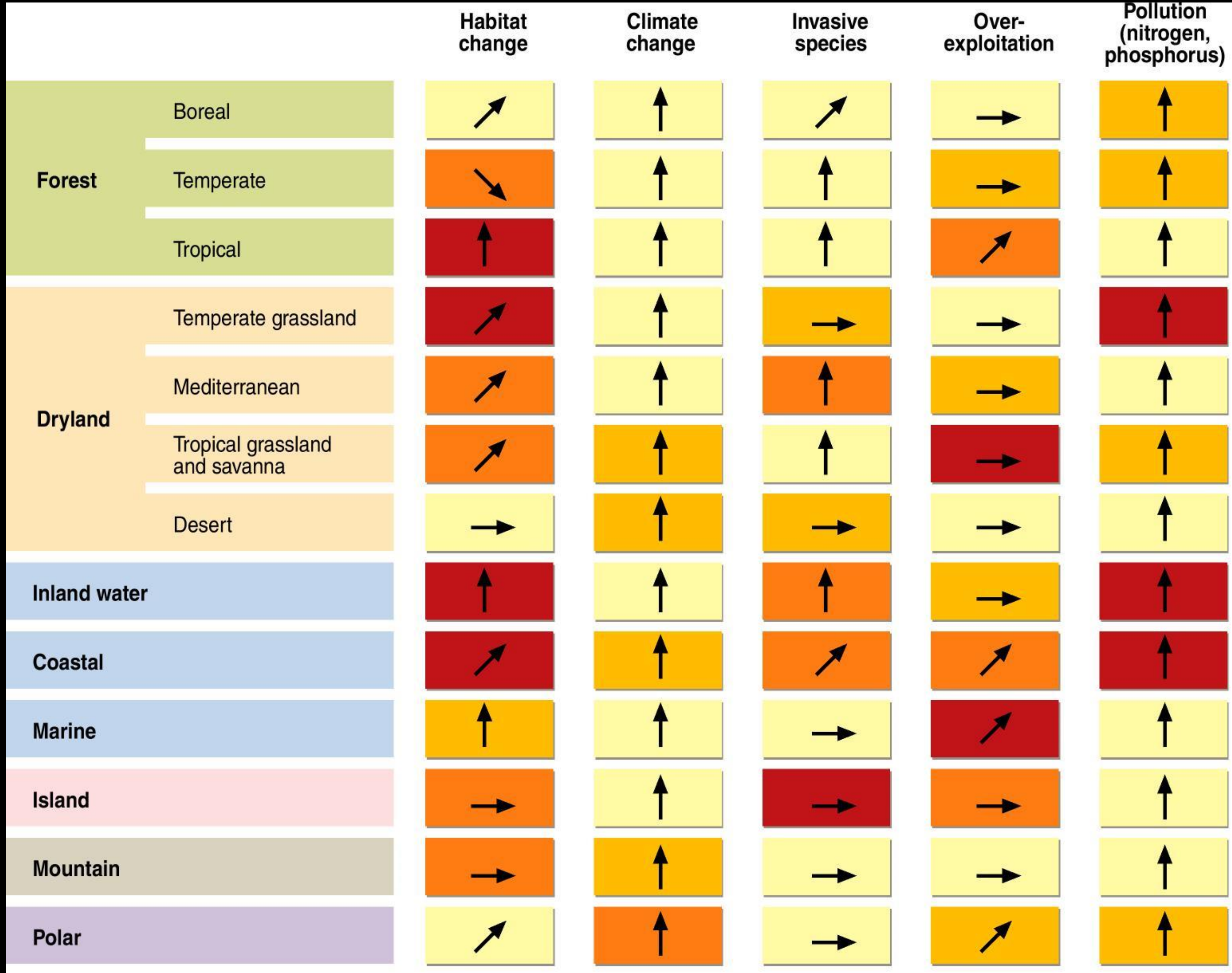

ILTER
Official ILTER Networks
Research Network
Australia
Brazil
Canada
China
China–Taipei
Colombia
Costa Rica
Czech Republic
Hungary
Israel
Mongolia
Namibia
Poland
Slovakia
South Korea
Switzerland
Ukraine
United Kingdom
United States
Uruguay
Venezuela
ILTER Networks in development, awaiting formal recognition from their governments
Argentina
France
Ireland
Japan
Mexico
Morocco
Paraguay
Romania
South Africa
Tanzania
Countries expressing interest in developing a network of LTER sites
Austria
Bolivia
Chile
Croatia
Ecuador
India
Indonesia
Italy
Kenya
Malaysia
Norway
Philippines
Portugal
Singapore
Slovenia
Spain
Sweden
Thailand
Zambia


V2030
Namibia Vision 2030

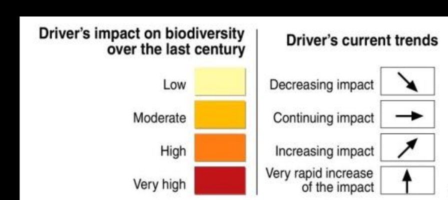



NAMIBIA
Initial National Communication
to the United Nations Framework Convention on Climate Change
July 2002
Ministry of Environment and Tourism,
Republic of Namibia

BLACKSASH
MAKING HUMAN RIGHTS REAL




# Trends in impacts of environmental drivers




Source: Millennium Ecosystem Assessment

South Africa's a world leader in **biodiversity mainstreaming** in the **industrial and subsistence economies**, and in **integrating conservation planning into land-use planning** at local, provincial and national levels

# South Africa's commitment to a **low-carbon economy** (despite intensive investment in brown coal and synthetic fuels) and **biodiversity-based sustainable development** through **restoration ecology**

*(Great on paper, struggling rather too much in implementation)*


THINKING

# Project overview

- Client is South African National Biodiversity Institute (SANBI)
- Professional fees: A$2.4 million
- 3 year appointment
- Aurecon involved countrywide (several offices throughout South Africa)
- Wetland ecologists sub-consult to Aurecon

aurecon

# SANBI Working for Wetlands

- Nationwide programme to rehabilitate wetlands
- Started in Working for Water as alien clearing
- Annual budget of A$ 9.7 million
- Uses SMME principles
- Restore ±100 wetlands/year
- Creates ±2100 jobs/year

aurecon

The south offers an opportunity to effect change at a very concrete level – by countries' willingness to ask:

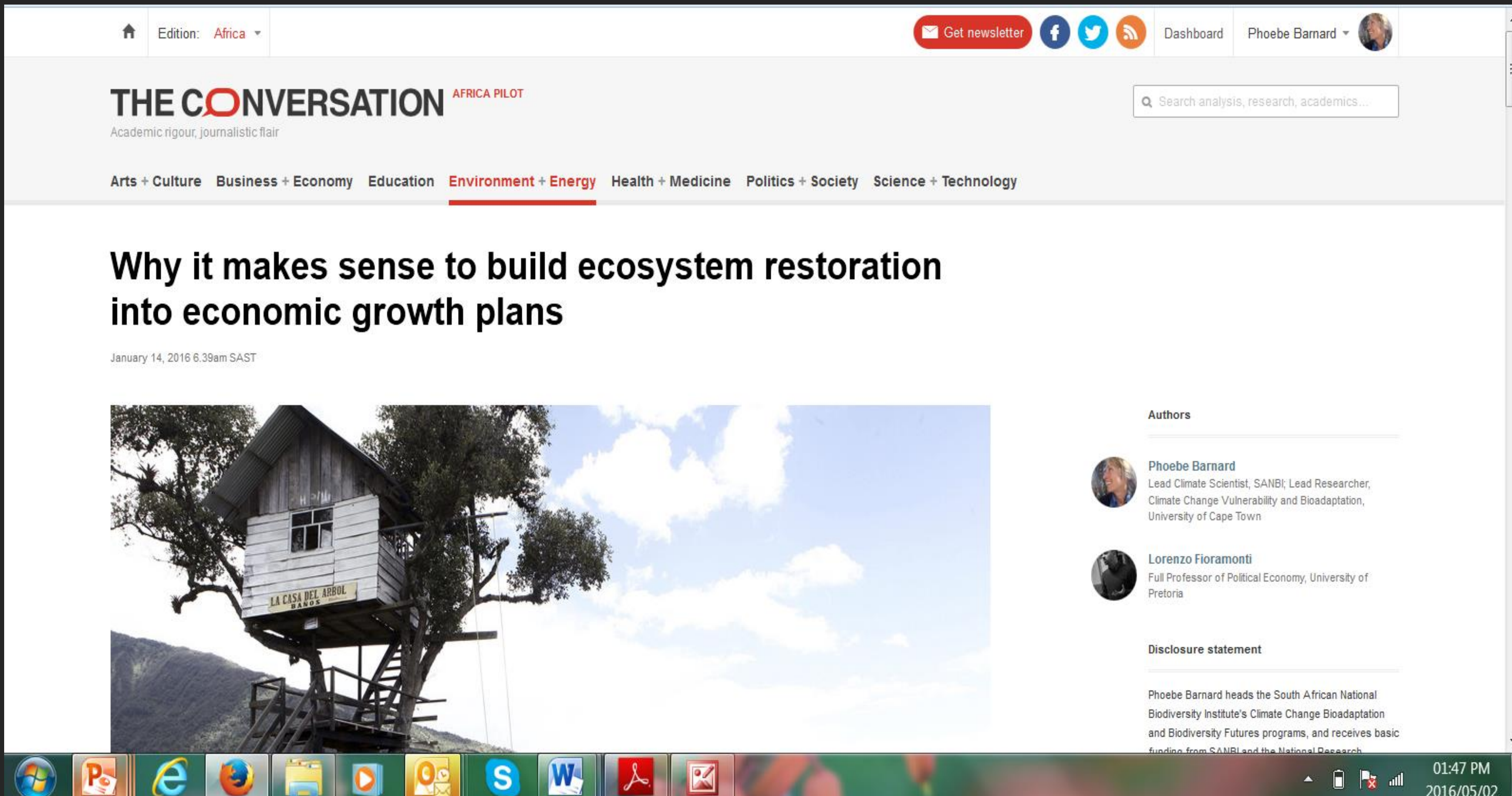
## "what kind of a society do we want?"

…. and to answer it (relatively) freely in

## policy, planning and implementation.

## Moving towards an economy based on

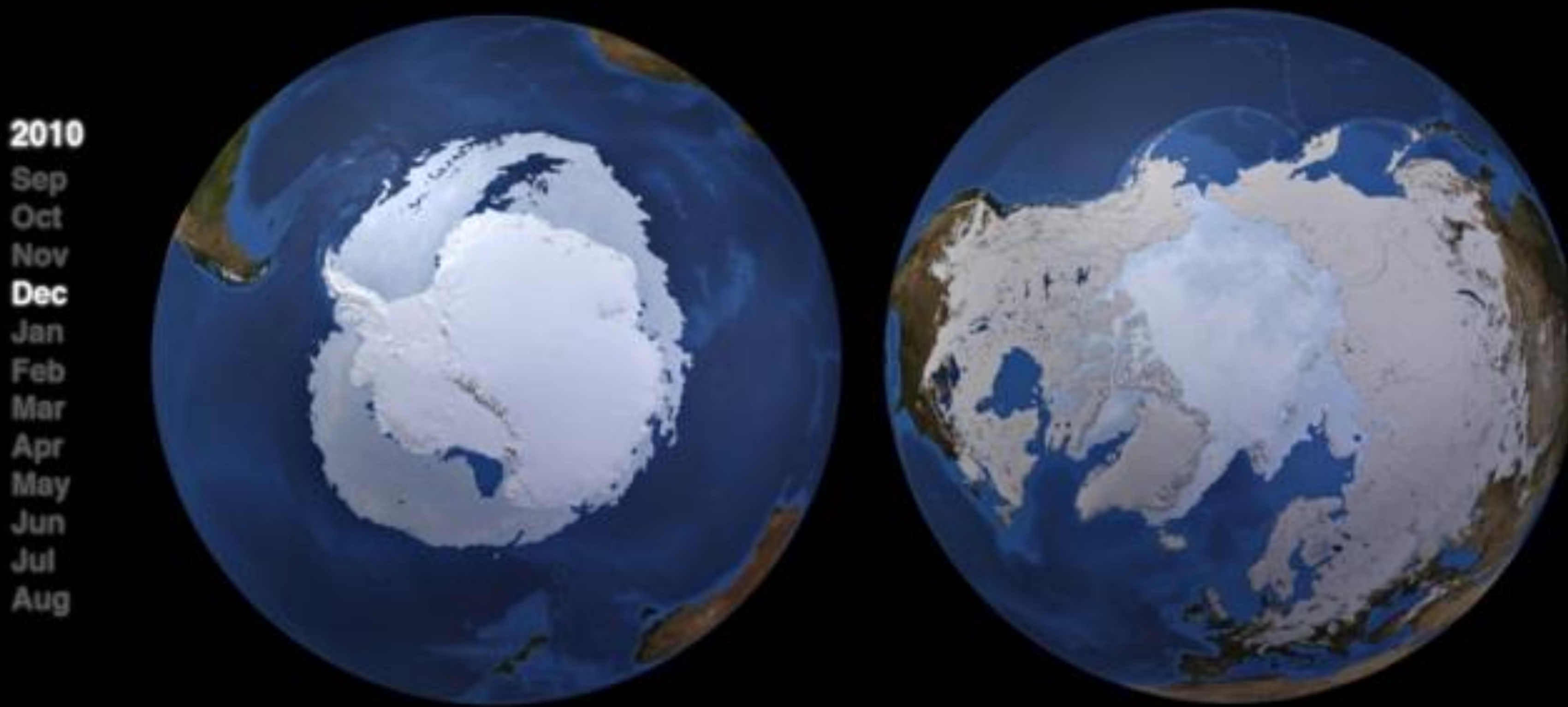
# restoration of natural capital (and social capital?)




## …. rather than on the exploitation of natural resources and labor.

# 3 Climate and biodiversity futures

The (very different) southern hemisphere has dawdled in fields from climate change to sociology to environmental futures.



OPEN ACCESS Freely available online · PLOS | ONE

# Phenological Changes in the Southern Hemisphere

Lynda E. Chambers[1]*, Res Altwegg[2,15], Christophe Barbraud[3], Phoebe Barnard[2,16], Linda J. Beaumont[4], Robert J. M. Crawford[5], Joel M. Durant[6], Lesley Hughes[4], Marie R. Keatley[7], Matt Low[8], Patricia C. Morellato[9], Elvira S. Poloczanska[10], Valeria Ruoppolo[11,12], Ralph E. T. Vanstreels[12], Eric J. Woehler[13], Anton C. Wolfaardt[14]

1 Centre for Australian Weather and Climate Research, Melbourne, Victoria, Australia, 2 Kirstenbosch Research Centre, South African National Biodiversity Institute, Cape Town, South Africa, 3 CEBC, CNRS - UPR 1934, Villiers en Bois, France, 4 Department of Biological Sciences, Macquarie University, Sydney, New South Wales, Australia, 5 Department of Environmental Affairs and Tourism, Cape Town, South Africa, 6 Centre for Ecological and Evolutionary Synthesis, Department of Biosciences, University of Oslo, Oslo, Norway, 7 Department of Forest and Ecosystem Science, University of Melbourne, Creswick, Victoria, Australia, 8 Department of Ecology, Swedish University of Agricultural Sciences, Uppsala, Sweden, 9 Laboratorio de Fenologia, Departamento de Botânica, Instituto de Biociências, UNESP Universidade Estadual Paulista, São Paulo, Brazil, 10 Climate Adaptation Flagship, CSIRO Marine and Atmospheric Research, Brisbane, Queensland, Australia, 11 International Fund for Animal Welfare, Yarmouth Port, Massachusetts, United States of America, 12 Laboratory of Wildlife Comparative Pathology, Faculty of Veterinary Medicine, University of São Paulo, São Paulo, Brazil, 13 Institute for Marine and Antarctic Studies, University of Tasmania, Sandy Bay, Tasmania, Australia, 14 Joint Nature Conservation Committee of the UK, Stanley, Falkland Islands, 15 Animal Demography Unit, University of Cape Town, Rondebosch, South Africa, 16 Percy FitzPatrick Institute of African Ornithology, DST/NRF Centre of Excellence, University of Cape Town, Rondebosch, South Africa

## Abstract

Current evidence of phenological responses to recent climate change is substantially biased towards northern hemisphere temperate regions. Given regional differences in climate change, shifts in phenology will not be uniform across the globe, and conclusions drawn from temperate systems in the northern hemisphere might not be applicable to other regions on the planet. We conduct the largest meta-analysis to date of phenological drivers and trends among southern hemisphere species, assessing 1208 long-term datasets from 89 studies on 347 species. Data were mostly from Australasia (Australia and New Zealand), South America and the Antarctic/subantarctic, and focused primarily on plants and birds. This meta-analysis shows an advance in the timing of spring events (with a strong Australian data bias), although substantial differences in trends were apparent among taxonomic groups and regions. When only statistically significant trends were considered, 82% of terrestrial datasets and 42% of marine datasets demonstrated an advance in phenology. Temperature was most frequently identified as the primary driver of phenological changes; however, in many studies it was the only climate variable considered. When precipitation was examined, it often played a key role but, in contrast with temperature, the direction of phenological shifts in response to precipitation variation was difficult to predict *a priori*. We discuss how phenological information can inform the adaptive capacity of species, their resilience, and constraints on autonomous adaptation. We also highlight serious weaknesses in past and current data collection and analyses at large regional scales (with very few studies in the tropics or from Africa) and dramatic taxonomic biases. If accurate predictions regarding the general effects of climate change on the biology of organisms are to be made, data collection policies focussing on targeting data-deficient regions and taxa need to be financially and logistically supported.

**Citation:** Chambers LE, Altwegg R, Barbraud C, Barnard P, Beaumont LJ, et al. (2013) Phenological Changes in the Southern Hemisphere. PLoS ONE 8(10): e75514. doi:10.1371/journal.pone.0075514

**Editor:** Bruno Hérault, Cirad, France

**Received** April 22, 2013; **Accepted** August 15, 2013; **Published** October 1, 2013

**Copyright:** © 2013 Chambers et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

**Funding:** This work is based upon research supported by the National Research Foundation of South Africa to RA, PB, and RJMC, and by the Applied Centre for Climate and Earth System Science to RA. LPCM and the Phenology Laboratory at UNESP are supported by FAPESP (São Paulo Research Foundation grant # 2010/50713-5 and # 2010/52113-5); LPCM receives a Research Productivity Fellowship and grant from CNPq (National Council for Science). ML is supported by the Swedish research council (FORMAS). LJB was supported by a Macquarie University New Staff Grant. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

**Competing Interests:** Please note that one of the coauthors, Eric Woehler, is a PLOS ONE Editorial Board Member. This does not alter the authors' adherence to all the PLOS ONE policies on sharing data and materials.

* E-mail: L.Chambers@bom.gov.au

## Introduction

The relationship between the timing of life-cycle events and seasonal climatic patterns (i.e. phenology) is a fundamental biological process in both natural and managed systems. Phenology is a major driver in determining population dynamics, species interactions, animal movement and the evolution of life histories [1,2]. Population-limiting factors are closely linked to seasonal or interannual phenological events, and shifts in phenology can affect ecosystems through changes in ecological interactions such as predator-prey and plant-pollinator dynamics [3–6] and the epidemiology of infectious diseases [7,8]. Warming is hypothesised to lead to earlier spring events such as breeding onset, timing of flowering, breeding migration; delayed autumn events such as leaf fall, non-breeding migration; and a longer summer growing season [9]. Changing phenologies will contribute to shifts in species distributions, population viability and reproductive successes [10,11] and in turn will affect climate via biogeochemical processes and the physical properties of the biosphere [12]. As such, phenological changes will have profound





# Southern Hemisphere biodiversity and global change: Data gaps and strategies

LYNDA E. CHAMBERS,[1] PHOEBE BARNARD,[2,3] ELVIRA S. POLOCZANSKA,[4,5] ALISTAIR J. HOBDAY,[6]* MARIE R. KEATLEY,[7] NICKY ALLSOPP[8] AND LES G. UNDERHILL[9]

[1]*Australian Bureau of Meteorology, Melbourne, Victoria, Australia,* [2]*Climate Change Bioadaptation and Biodiversity Futures Programs, South African National Biodiversity Institute, Cape Town, South Africa,* [3]*DST-NRF Centre of Excellence, Percy FitzPatrick Institute of African Ornithology, University of Cape Town, Cape Town, South Africa,* [4]*CSIRO Oceans and Atmosphere, Brisbane, Queensland, Australia,* [5]*Global Change Institute, University of Queensland, Brisbane, Queensland, Australia,* [6]*CSIRO Oceans and Atmosphere, Hobart, Tasmania, Australia (Email: Alistair.Hobday@csiro.au),* [7]*School of Ecosystem and Forest Sciences, The University of Melbourne, Melbourne, Victoria, Australia,* [8]*South African Environmental Observation NetworkSAEON Fynbos NodeCape Town, South Africa and* [9]*Animal Demography Unit, Department of Biological Sciences, University of Cape Town, Cape Town, South Africa*

**Abstract** Long-term datasets needed to detect the impacts of global change on southern biodiversity are still scarce and often incomplete, challenging adaptation planning and conservation management. Biological data are probably most limited in arid countries and from the oceans, where natural environmental variability ('noise') means that long time series are required to detect the 'signal' of directional change. Significant national and international investment and collaboration are needed for most southern nations to reliably track biodiversity trends and improve conservation adaptation to rapid climate change. Emerging early warning systems for biodiversity, incorporating regional environmental change drivers, citizen science and regional partnerships, can all help to compensate for existing information gaps and contribute to adaptation planning.

**Key words:** adaptation, citizen science, climate change, data recovery, early warning systems.

UNCORRECTED PROOF

## INTRODUCTION

Warming of the climate system is 'unequivocal', with almost the entire globe experiencing surface warming over the last hundred years (IPCC 2014). However, impacts on atmospheric and oceanic processes, climatic trends and ecosystem processes tend to be regional in terms of their manifestation and implications (Hewitson *et al.* 2014; IPCC 2014). The substantial regional variation in observations of climate change impacts arises as the impacts themselves vary across the globe and because of regional differences in research effort and investment (Hewitson *et al.* 2014). For example, there are few observations of impacts on natural systems from the equatorial regions or the Southern Hemisphere ocean and land masses compared with the temperate regions of the Northern Hemisphere (Rosenzweig *et al.* 2007, 2008; Chambers *et al.* 2014; Hansen & Cramer 2015; Pearce-Higgins *et al.* 2015). Consequently, a lack of impacts attributed to climate change within a region does not necessarily imply that such impacts have not occurred but is the result of factors such as a lack of data of sufficient resolution and length or scientific studies to provide process understanding (Hansen & Cramer 2015).

The sensitivity and vulnerability of natural systems to climatic change are determined by a number of factors that may all be changing simultaneously. Regional variation in natural climate variability such as the El Niño–Southern Oscillation (ENSO) or Pacific Decadal Oscillation and in other anthropogenic drivers of change such as land use change mean that understanding of climate and other drivers of responses and subsequent adaptation planning are not necessarily applicable across all regions (e.g. Boulton *et al.* 2008; Ruane *et al.* 2015). For example, attribution of species responses to climate change is overwhelmingly based on work in northern temperate regions, particularly the North American and European land masses where current species distributions are heavily influenced by the retreat and configuration of ice sheets after the Last Glacial Maximum (e.g. Huntley 2005). These factors of bias and data availability and quality can have important policy and conservation implications, given that some of the least well-observed regions (e.g. central Africa

*Corresponding author.
Accepted for publication April 2016.

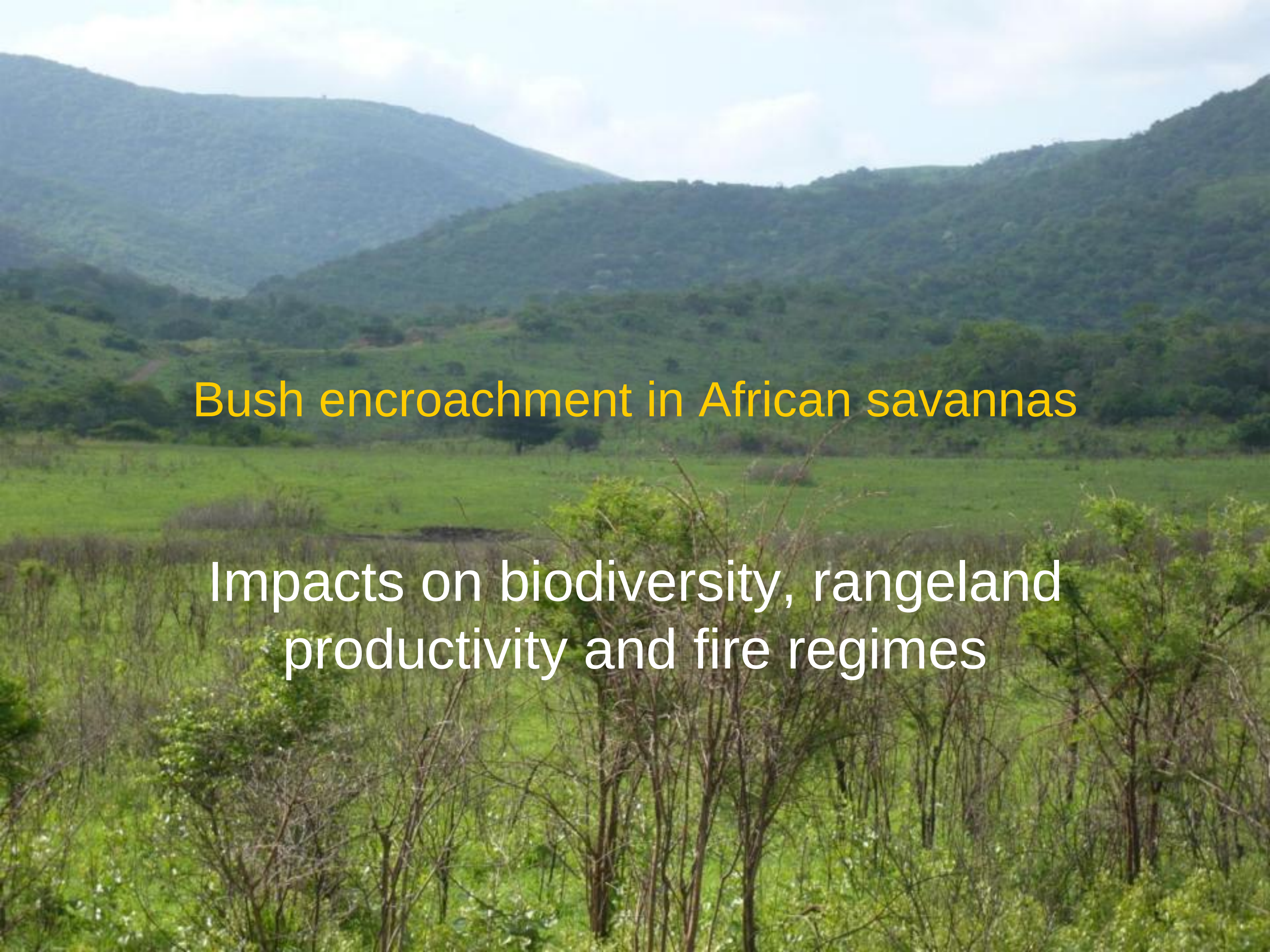
© 2016 Ecological Society of Australia doi:10.1111/aec.12391

# Fire -- major driver of ecosystem change

in savannas, fynbos, kwongan, matorral (and increasingly other systems)

Fire frequency increasing in fynbos and other ecosystems

- human-ignited & natural fires
- increases in hot, dry, windy conditions

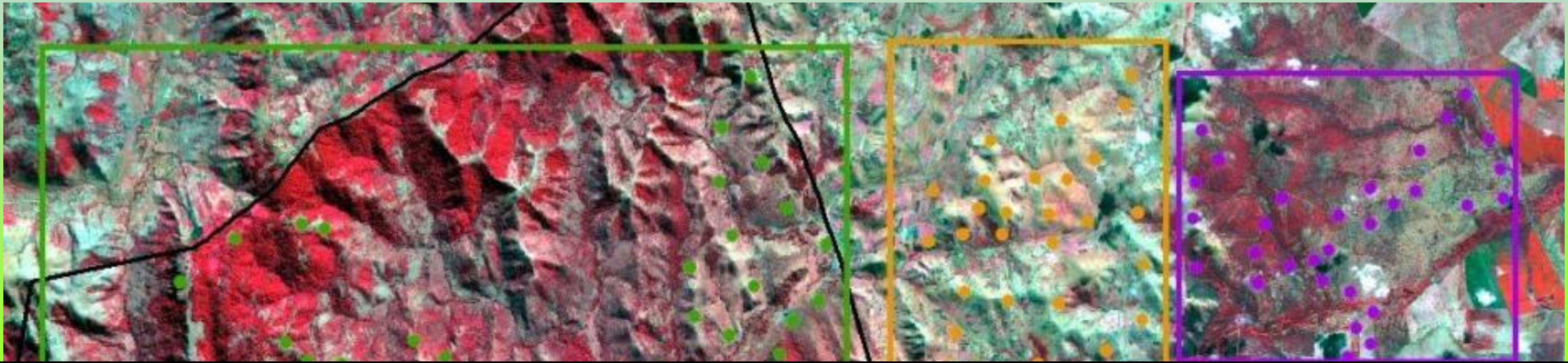


# Bush encroachment in African savannas

## Impacts on biodiversity, rangeland productivity and fire regimes

# ….profoundly affecting ecological communities

Hluhluwe Game Reserve and surroundings – Sirami et al. 2014



# Strategic South-South and South-North collaboration to fill conceptual gaps, data gaps, modeling gaps

UNIVERSITY OF CAMBRIDGE

C•I•B
DST-NRF Centre of Excellence for Invasion Biology

University of Cape Town • iYunivesithi yaseKapa • Universiteit van Kaapstad
SPES BONA

IIASA
International Institute for Applied Systems Analysis

Durham University

**Risk, vulnerability and resilience in environmental futures – tradeoffs between biodiversity, infrastructure, food security, climate change**

**Systems analysis**, **ecosystem-based adaptation**, and **resilience planning**

UNIVERSITY OF CAMBRIDGE

C·I·B
DST-NRF Centre of Excellence for Invasion Biology

University of Cape Town · iYunivesithi yaseKapa · Universiteit van Kaapstad
SPES BONA

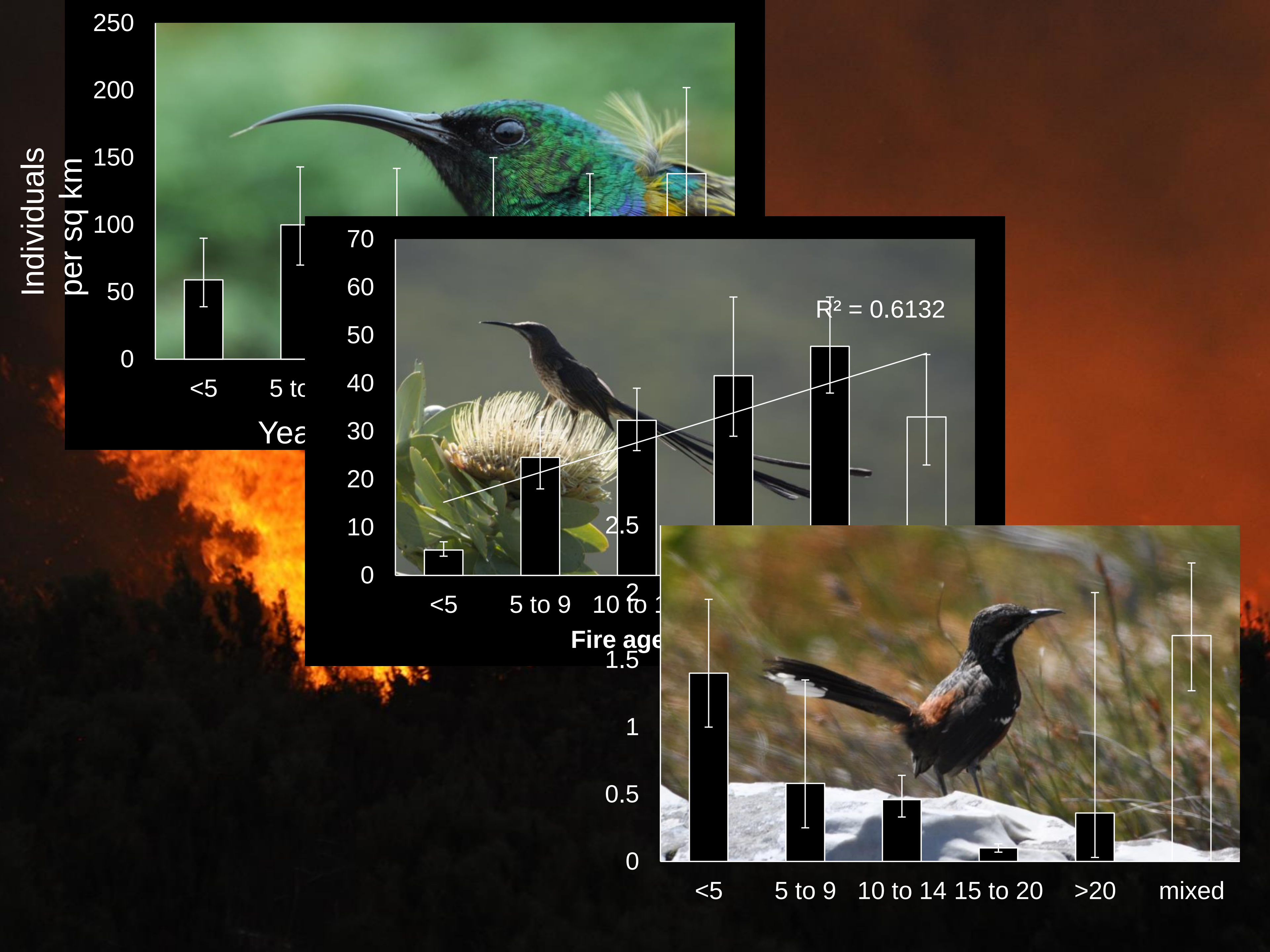
IIASA
International Institute for Applied Systems Analysis

Durham University

Centre for Studies in COMPLEXITY

SANBI
Biodiversity for Life
South African National Biodiversity Institute

# 4 Mixing toolboxes to map the road ahead



250
200
150
100
50
0
Individuals per sq km
<5
5 to
Yea
70
60
50
40
30
20
10
0
$R^2$ = 0.6132
<5
5 to 9
10 to 1
Fire age
2.5
2
1.5
1
0.5
0
<5
5 to 9
10 to 14
15 to 20
>20
mixed

Journal of Biogeography (J. Biogeogr.) (2016)

SPECIAL PAPER

# Explaining patterns of avian diversity and endemicity: climate and biomes of southern Africa over the last 140,000 years

Brian Huntley[1*], Yvonne C. Collingham[1], Joy S. Singarayer[2], Paul J. Valdes[3], Phoebe Barnard[4,5,6], Guy F. Midgley[7], Res Altwegg[6,8] and Ralf Ohlemüller[9]

[1]School of Biological and Biomedical Sciences, Durham University, South Road, Durham DH1 3LE, UK, [2]Department of Meteorology and Centre for Past Climate Change, University of Reading, Earley Gate, PO Box 243, Reading RG6 6BB, UK, [3]School of Geographical Sciences, University of Bristol, University Road, Bristol BS8 1SS, UK, [4]Climate Change BioAdaptation, South African National Biodiversity Institute, Kirstenbosch Research Centre, P/Bag X7, Claremont 7735 Cape Town, South Africa, [5]Percy FitzPatrick Institute of African Ornithology, DST-NRF Centre of Excellence, University of Cape Town, Rondebosch 7701 Cape Town, South Africa, [6]African Climate and Development Initiative, University of Cape Town, Rondebosch 7701 Cape Town, South Africa, [7]Department. of Botany and Zoology, Stellenbosch University, Private Bag X1, Matieland 7602, South Africa, [8]Statistics in Ecology, Environment and Conservation, Department of Statistical Sciences, University of Cape Town, Rondebosch 7701 Cape Town, South Africa, [9]Department of Geography, Richardson Building, University of Otago, PO Box 56, Dunedin, New Zealand

*Correspondence: Prof Brian Huntley, School of Biological and Biomedical Sciences, Durham University, South Road, Durham DH1 3LE, UK.
E-mail: brian.huntley@durham.ac.uk

## ABSTRACT

**Aim** Test hypotheses that present biodiversity and endemic species richness are related to climatic stability and/or biome persistence.

**Location** Africa south of 15° S.

**Methods** Seventy eight HadCM3 general circulation model palaeoclimate experiments spanning the last 140,000 years, plus a pre-industrial experiment, were used to calculate measures of climatic variability for 0.5° grid cells. Models were fitted relating distributions of the nine biomes of South Africa, Lesotho and Swaziland to present climate. These models were used to simulate potential past biome distribution and extent for the 78 palaeoclimate experiments, and three measures of biome persistence. Climatic response surfaces were fitted for 690 bird species regularly breeding in the region and used to simulate present species richness for cells of the 0.5° grid. Species richness was evaluated for residents, mobile species (nomadic or partially/altitudinally migrant within the region), and intra-African migrants, and also separately for endemic/near-endemic (hereafter 'endemic') species as a whole and those associated with each biome. Our hypotheses were tested by analysing correlations between species richness and climatic variability or biome persistence.

**Results** The magnitude of climatic variability showed clear spatial patterns. Marked changes in biome distributions and extents were projected, although limited areas of persistence were projected for some biomes. Overall species richness was not correlated with climatic variability, although richness of mobile species showed a weak negative correlation. Endemic species richness was significantly negatively correlated with climatic variability. Strongest correlations, however, were positive correlations between biome persistence and richness of endemics associated with individual biomes.

**Main conclusions** Low climatic variability, and especially a degree of stability enabling biome persistence, is strongly correlated with species richness of birds endemic to southern Africa. This probably principally reflects reduced extinction risk for these species where the biome to which they are adapted persisted.

**Keywords**
atmosphere–ocean general circulation model, biome persistence, birds, Cape Floristic Region, climatic stability, Heinrich Events, Last Glacial–Interglacial cycle, species richness

Journal of Biogeography



Diversity and Distributions, (Diversity Distrib.) (2012) 1–13

BIODIVERSITY RESEARCH

# Potential impacts of climatic change on southern African birds of fynbos and grassland biodiversity hotspots

Brian Huntley[1*] and Phoebe Barnard[2,3]

[1]School of Biological and Biomedical Sciences, Durham University, South Road, Durham DH1 3LE, UK, [2]Birds & Environmental Change Programme, Climate Change and BioAdaptation Division, South African National Biodiversity Institute, Kirstenbosch Research Centre, P/Bag X7, Claremont 7735, Cape Town, South Africa, [3]Percy FitzPatrick Institute of African Ornithology, DST/NRF Centre of Excellence, University of Cape Town, Rondebosch 7701, South Africa

*Correspondence: Brian Huntley, School of Biological and Biomedical Sciences, Durham University, South Road, Durham DH1 3LE, UK.
E-mail: brian.huntley@durham.ac.uk

## ABSTRACT

**Aim** To examine potential impacts of climatic change on bird species richness of the fynbos and grassland biomes, especially on species of conservation concern, and to consider implications for biodiversity conservation strategy.

**Location** Southern Africa, defined for this study as South Africa, Lesotho and Swaziland.

**Methods** Climate response surfaces were fitted to model relationships between recorded distributions and reporting rates of 94 species and current bioclimatic variables. These models were used to project species' potential ranges and reporting rates for future climatic scenarios derived from three general circulation models for 30-year periods centred on 2025, 2055 and 2085. Results were summarized for species associated with each biome and examined in detail for 12 species of conservation concern.

**Results** Species richness of fynbos and grassland bird assemblages will potentially decrease by an average of 30–40% by 2085 as a result of projected climatic changes. The areas of greatest richness are projected to decrease in extent and to shift in both cases. Attainment of projected shifts is likely to be limited by extent of untransformed habitat. Most species of conservation concern are projected to decrease in range extent, some by > 60%, and to decrease in reporting rate even where they persist, impacts upon their populations thus being greater than might be inferred from decreases in range extent alone. Two species may no longer have any areas of suitable climatic space by 2055; both already appear to be declining rapidly.

**Main conclusions** Species losses are likely to be widespread with most species projected to decrease in range extent. Loss of key species, such as pollinators, may have far-reaching implications for ecosystem function and composition. Conservation strategies, and identification of species of conservation concern, need to be informed by such results, notwithstanding the many uncertainties, because the certainties of climatic change make it essential that likely impacts not to be ignored.

**Keywords**
Conservation strategy, fynbos biome, grassland biome, red list species, southern Africa, species' distribution models.

## INTRODUCTION

Changes in global climate forecast for the present century (Meehl *et al.*, 2007) are of sufficient magnitude and expected to take place at such a rapid rate that species are expected to respond principally by shifting their geographical ranges to continue to occupy climatically suitable areas (Huntley *et al.*, 2010). Changes in abundance of species are also expected to occur (Huntley *et al.*, 2011), and such changes are often likely to be realized more rapidly than potential range shifts. It also is expected that many species may suffer a heightened risk of extinction as a result of reductions in extent of areas of suitable

Diversity and Distributions A Journal of Conservation Biogeography

SANBI Climate Change Bioadaptation Monitoring Strategy

2016-2020

# Building an early warning system for monitoring biodiversity under climate change

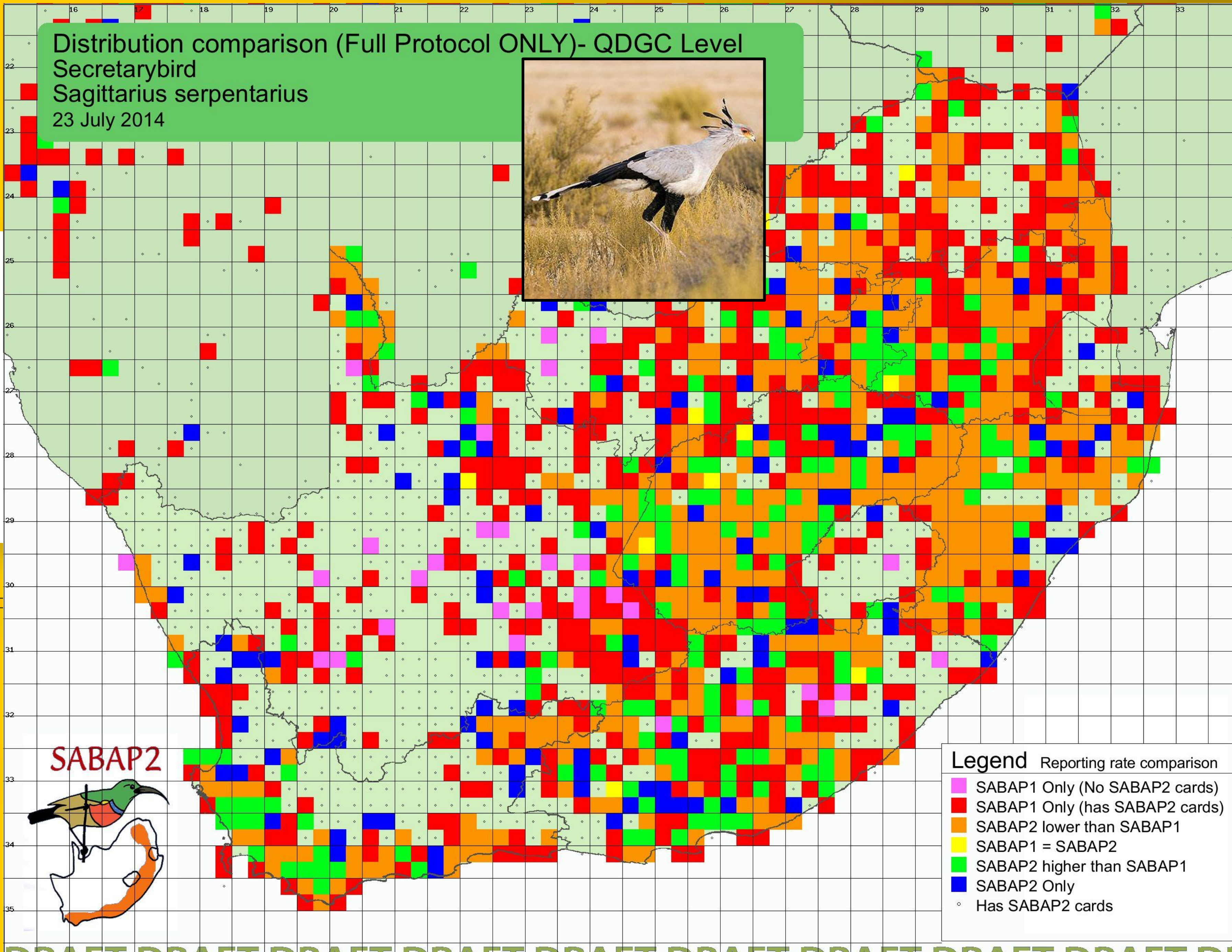
# The quick version….

**1** Resources are never enough (funds, skills, enthusiasm, political will)

**2** SA has strategic advantages (incl. great data and citizen science)

**3** We need to capitalize on existing investments & partnerships

**Need to integrate planning and build on investments cost-effectively**


Distribution comparison (Full Protocol ONLY)- QDGC Level
Secretarybird
Sagittarius serpentarius
23 July 2014
SABAP2
Legend Reporting rate comparison
SABAP1 Only (No SABAP2 cards)
SABAP1 Only (has SABAP2 cards)
SABAP2 lower than SABAP1
SABAP1 = SABAP2
SABAP2 higher than SABAP1
SABAP2 Only
Has SABAP2 cards

# Using southern African citizen science data to understand climate & global change

Use of existing data

Changing phenology

PROCEEDINGS OF THE ROYAL SOCIETY B

FirstCite e-publishing

Proc. R. Soc. B
doi:10.1098/rspb.2011.1897
Published online

## Novel methods reveal shifts in migration phenology of barn swallows in South Africa

Res Altwegg[1,2,*], Kristin Broms[4], Birgit Erni[2], Phoebe Barnard[1,3], Guy F. Midgley[1] and Les G. Underhill[2]

[1]South African National Biodiversity Institute, Private Bag X7, Claremont 7735, South Africa
[2]Animal Demography Unit, Department of Zoology and Department of Statistical Sciences, and [3]Percy FitzPatrick Institute of African Ornithology, DST/NRF Centre of Excellence, University of Cape Town, Rondebosch 7701, South Africa
[4]Quantitative Ecology and Resource Management, University of Washington, Seattle, WA 98195, USA

Many migratory bird species, including the barn swallow (*Hirundo rustica*), have advanced their arrival date at Northern Hemisphere breeding grounds, showing a clear biotic response to recent climate change. Earlier arrival helps maintain their synchrony with earlier springs, but little is known about the associated changes in phenology at their non-breeding grounds. Here, we examine the phenology of barn swallows in South Africa, where a large proportion of the northern European breeding population spends its non-breeding season. Using novel analytical methods based on bird atlas data, we show that swallows first arrive in the northern parts of the country and gradually appear further south. On their north-bound journey, they leave South Africa rapidly, resulting in mean stopover durations of 140 days in the south and 180 days in the north. We found that swallows are now leaving northern parts of South Africa 8 days earlier than they did 20 years ago, and so shortened their stay in areas where they previously stayed the longest. By contrast, they did not shorten their stopover in other parts of South Africa, leading to a more synchronized departure across the country. Departure was related to environmental variability, measured through the Southern Oscillation Index. Our results suggest that these birds gain their extended breeding season in Europe partly by leaving South Africa earlier, and thus add to scarce evidence for phenology shifts in the Southern Hemisphere.

**Keywords:** climate change; bird migration; life cycle timing; phenology shift; Southern Oscillation Index



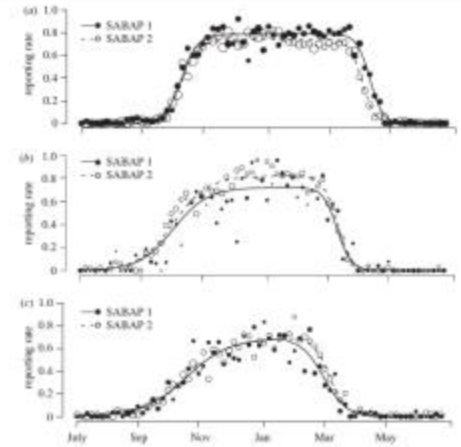
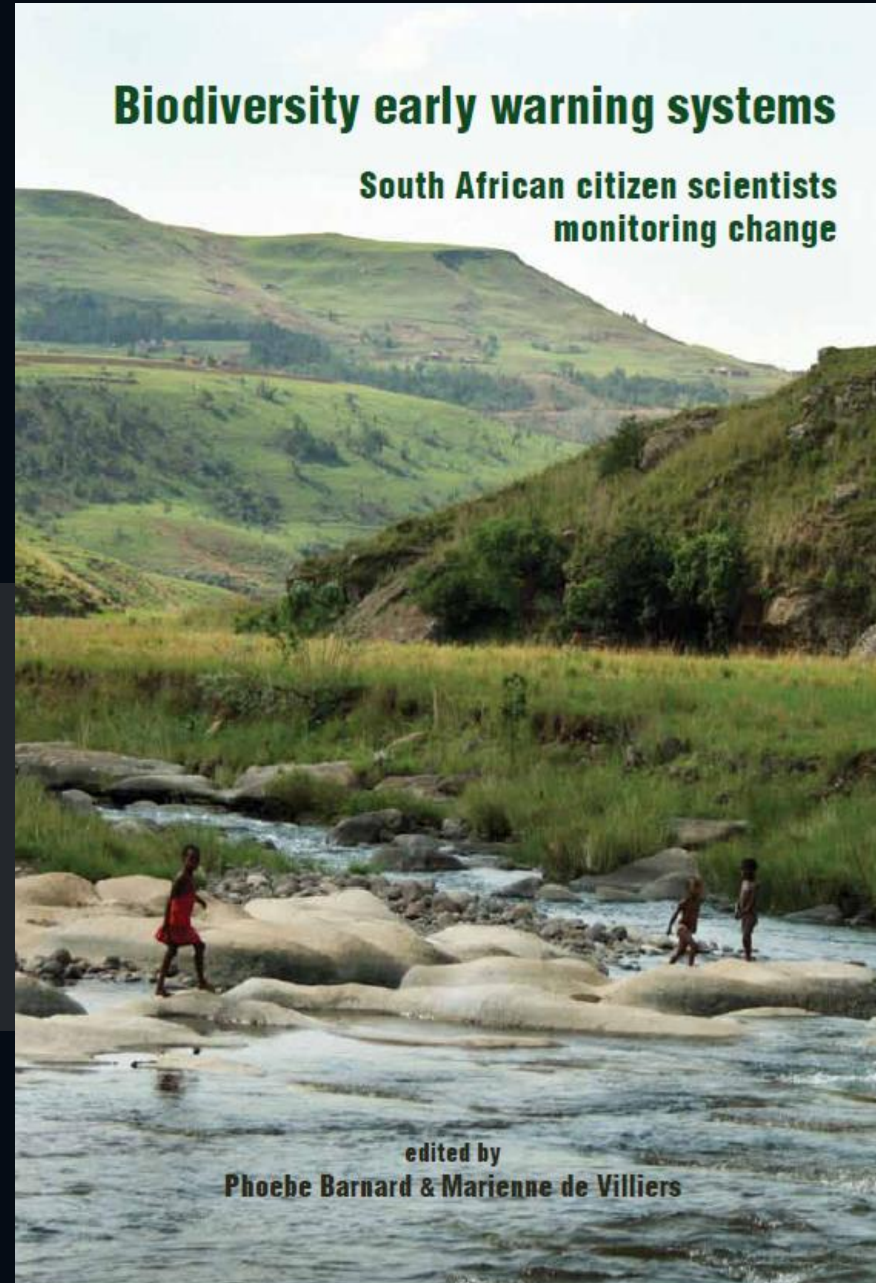


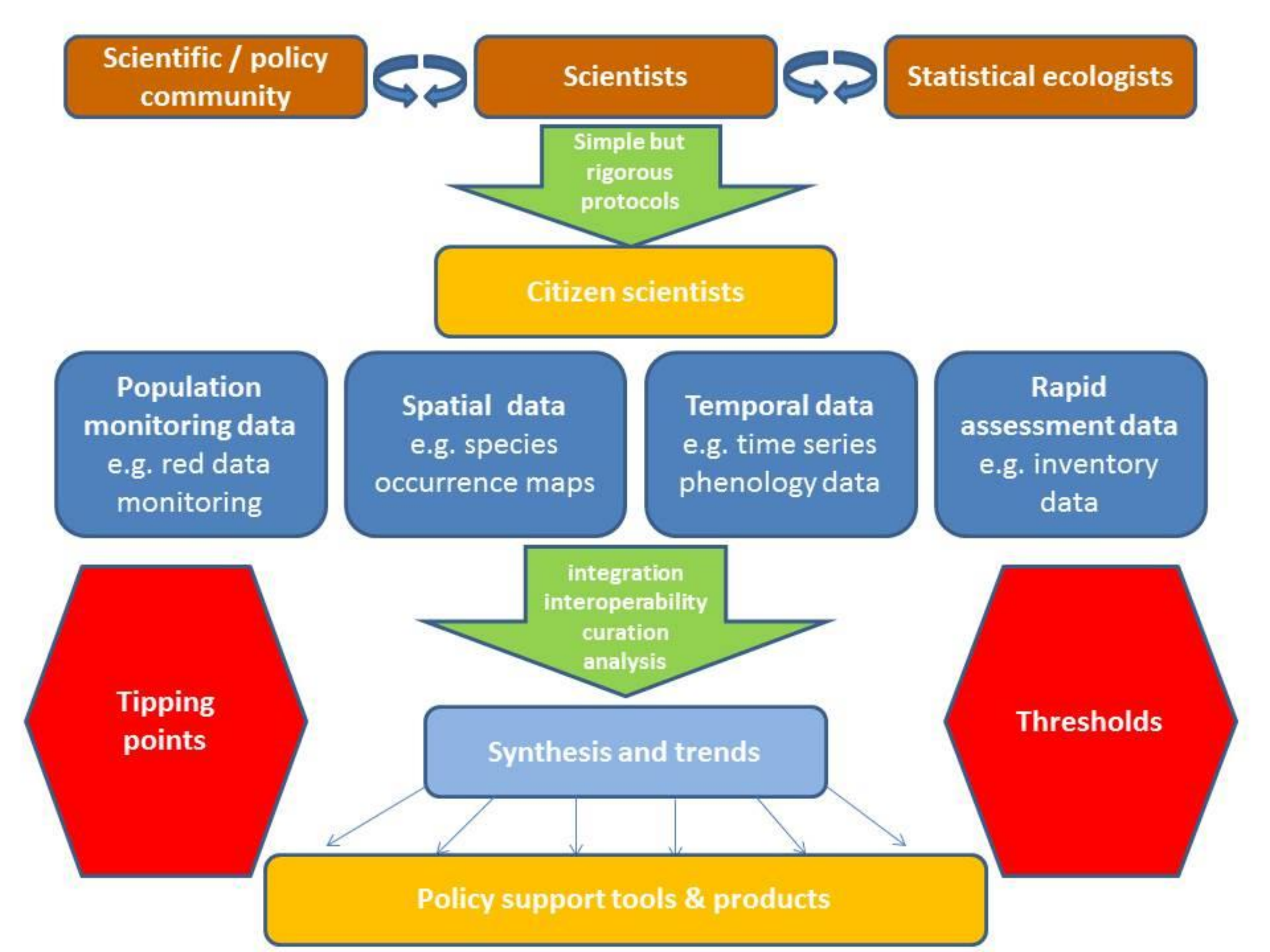

Figure 1. The proportion of checklists recording barn swallows throughout the year in three different areas of South Africa during 1987–1991 (SABAP1, solid lines with filled circles) and 2007–2011 (SABAP2, dashed lines with open circles): (a) Gauteng, (b) KwaZulu-Natal and (c) Western Cape. The circles show the observed proportions per 5-day interval and the lines are the best-fitting curves produced by the model with the lowest AIC value (table 1). The area of the symbols is proportional to the number of checklists, with the circles depicted in the legend representing 40 lists (same scale in all three panels).


# Using **virtual museums** for **Early Warning Systems for Biodiversity**


Birds and Environmental Change:
building an
early warning system in South Africa
edited by
Marienne S. de Villiers


Biodiversity early warning systems
South African citizen scientists
monitoring change
edited by
Phoebe Barnard & Marienne de Villiers

# Early warning systems for biodiversity in southern Africa



# Messages

- The global South differs from the North in many ways – very useful departure points for sustainability planning
- New societies perhaps better able to take fresh steps towards self-determination
- Climate and biodiversity futures influenced strongly by different drivers, e.g. fire and bush encroachment, as well as societal curve-balls
- Citizen science a fabulous growth point in southern Africa – mixed toolboxes of traditional science, statistical ecology, systems analysis, modeling and scenarios to solve problems