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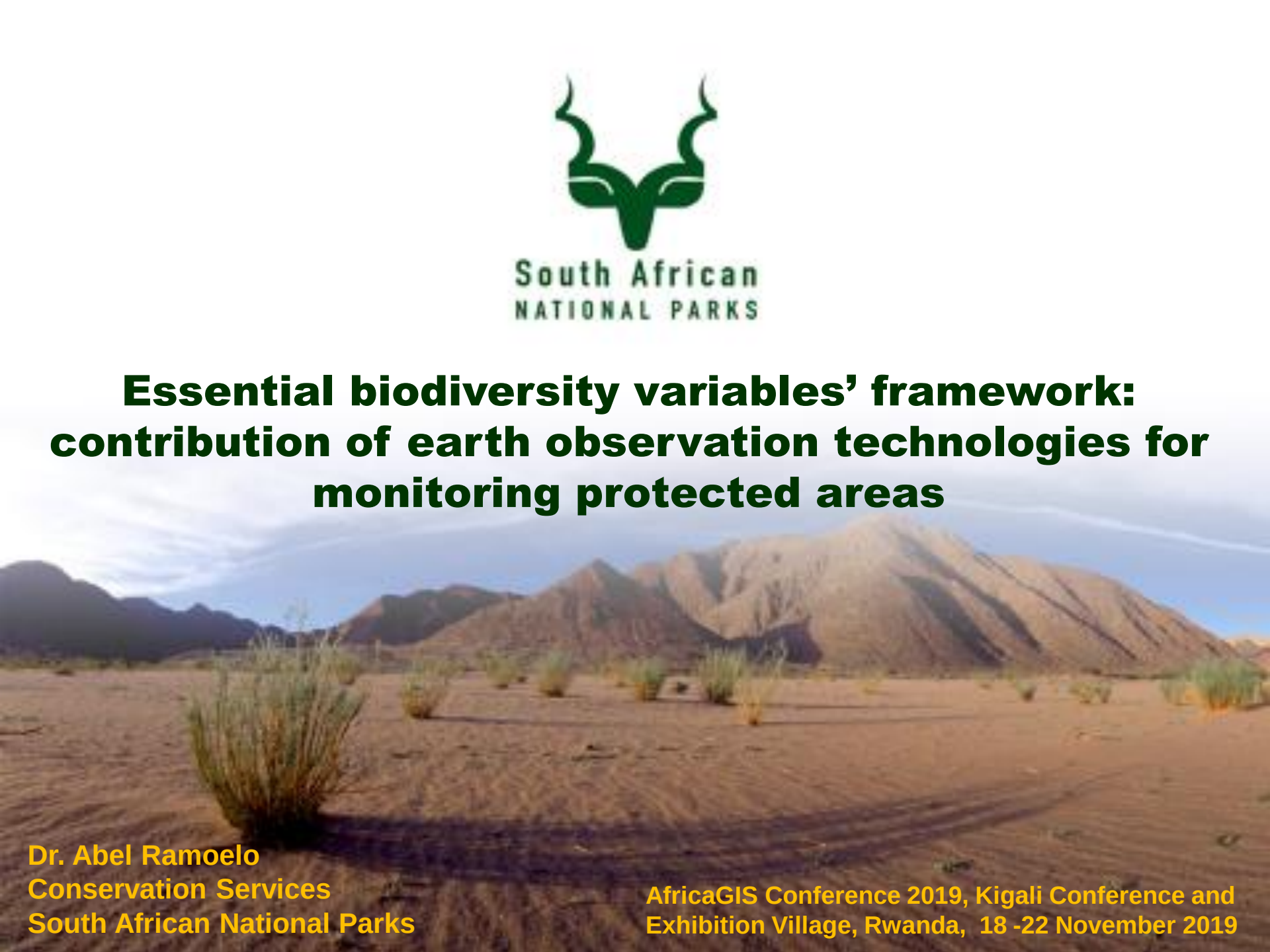
Essential biodiversity variables' framework: contribution of earth observation technologies for monitoring protected areas



Dr. Abel Ramoelo
Conservation Services
South African National Parks

AfricaGIS Conference 2019, Kigali Conference and Exhibition Village, Rwanda, 18 -22 November 2019




Presentation Outline

- Global Perspectives
- Impacts of Global Environmental Change
- Introducing EBVs
- RS EBVs
- Objectives
- Analysis Framework
- Examples of these EBVs
- Summary and key questions to note

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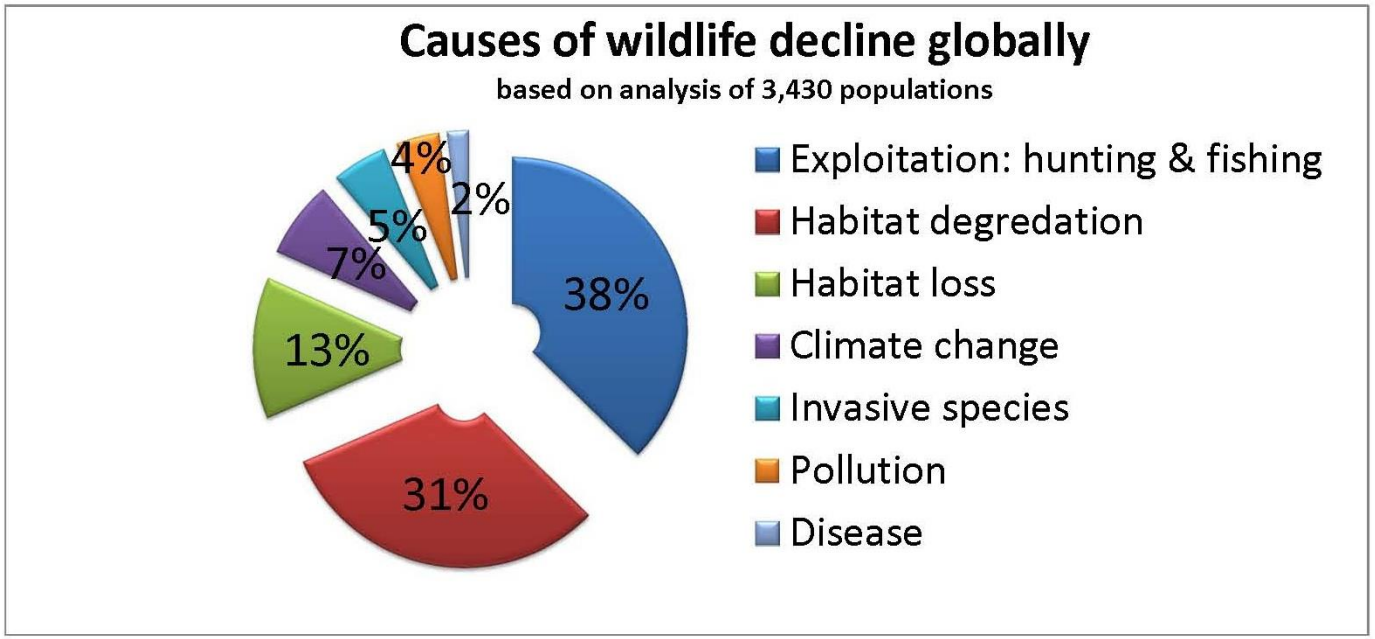

https://www.un.org/sustainabledevelopment/blog/2019/05/nature-decline-unprecedented-report/

IPBES Global Assessments, WWF Living Planet Report 2018

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Introduction (cont.)

- SANParks manage about **four** million ha of land, with about **19** National Parks

- Of all the parks, smaller parks require intensive management, which entails understanding about;
  - **Vegetation condition** and **animal numbers**
  - Land degradation
    - **Erosion, invasive species, fire, bush encroachment, overgrazing**
  - Climate Change - high frequency of drought, erratic rainfalls, and severe storms

- **There is a need for earth observation technologies**

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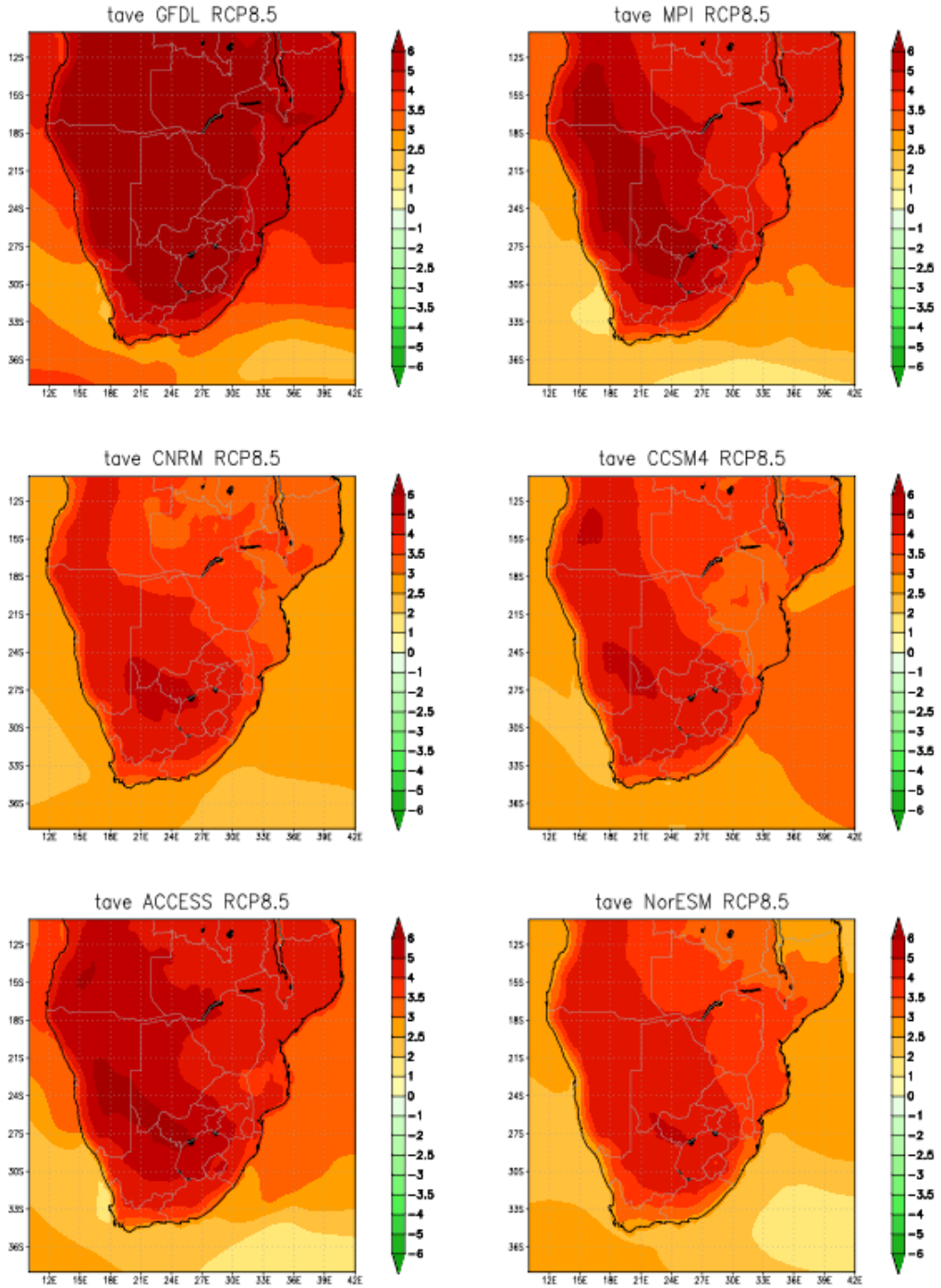

Projections of changing annual average temperature (degrees C) over southern Africa for the period 2070-2099 relative to 1961-1990

Source: CSIR-CHPC

- **…increase in drought frequencies**

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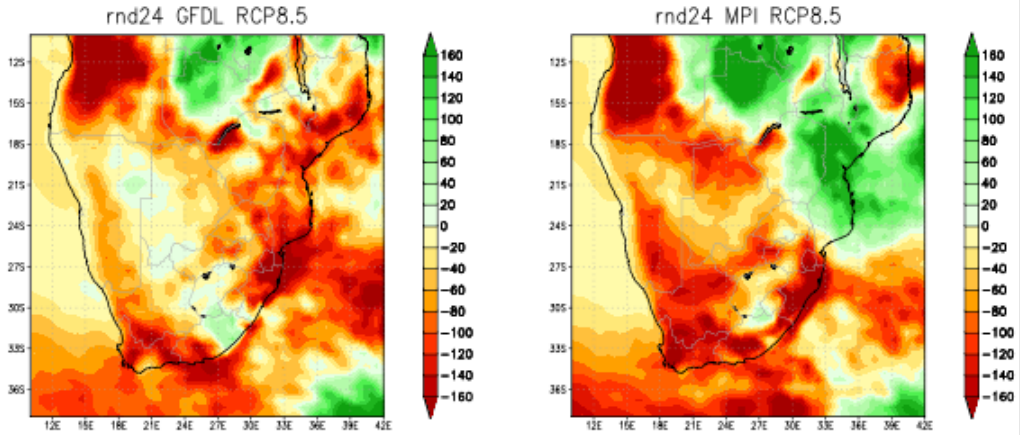

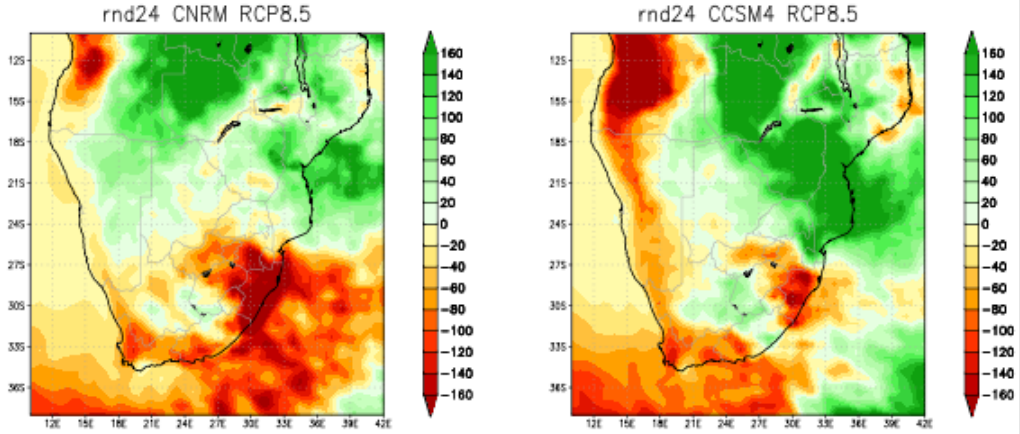

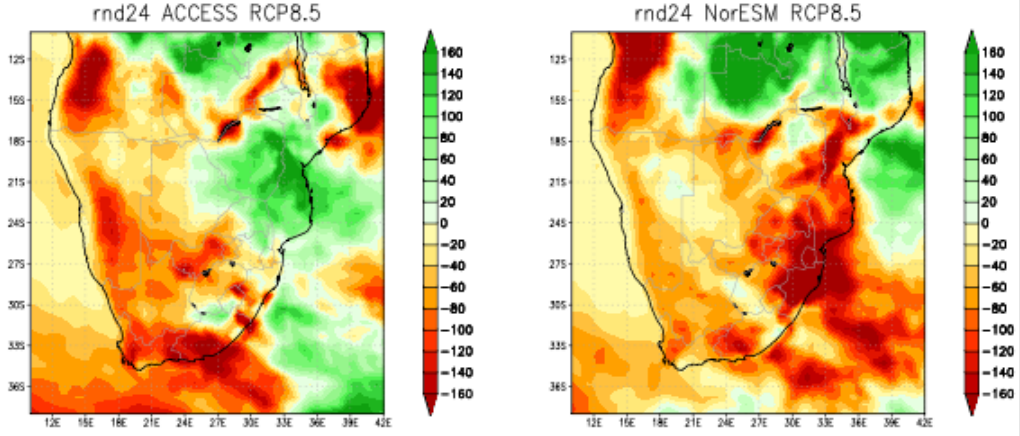

Projections of changing annual rainfall over southern Africa for the period 2070-2099 relative to 1961-1990

Source: CSIR-CHPC

- …Erratic precipitation

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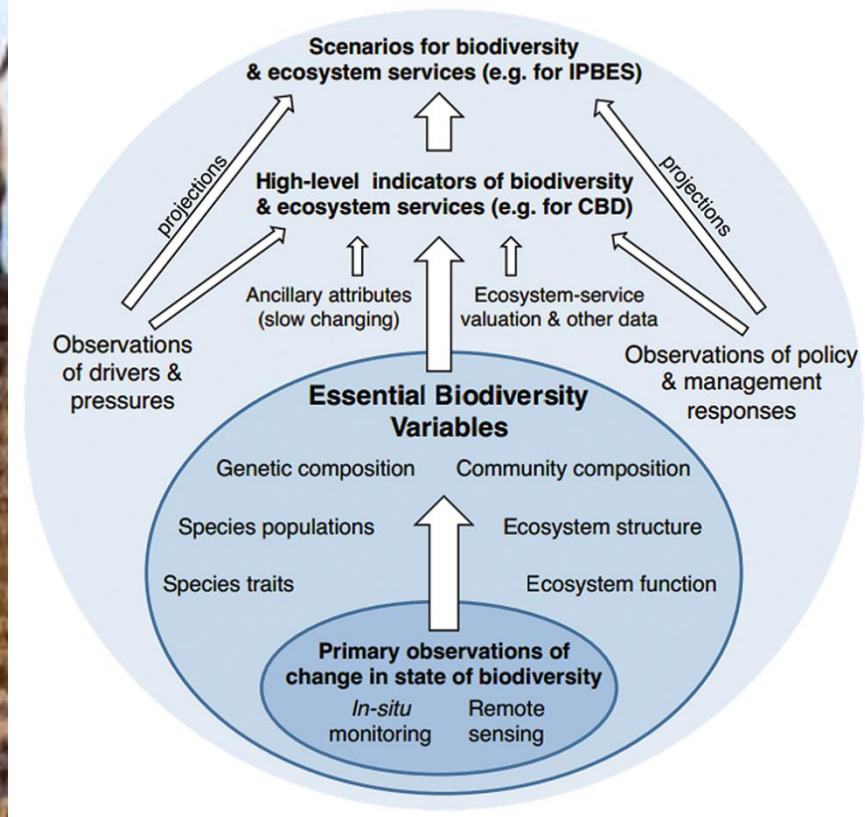
Essential Biodiversity Variables (EBVs)



Source: GEOBON

Criteria of EBVs

- capture critical scales and dimensions of biodiversity
- biological
- a state variable (in general)
- sensitive to change
- ecosystem agnostic (to the degree possible)
- technically feasible, economically viable and sustainable in time

Rationale

- Local and regional policies, PA env. monitoring needs
- Aichi Biodiversity Targets by CBD, SDGs
- Limited harmonized observation system for delivering regular, timely data on biodiversity change

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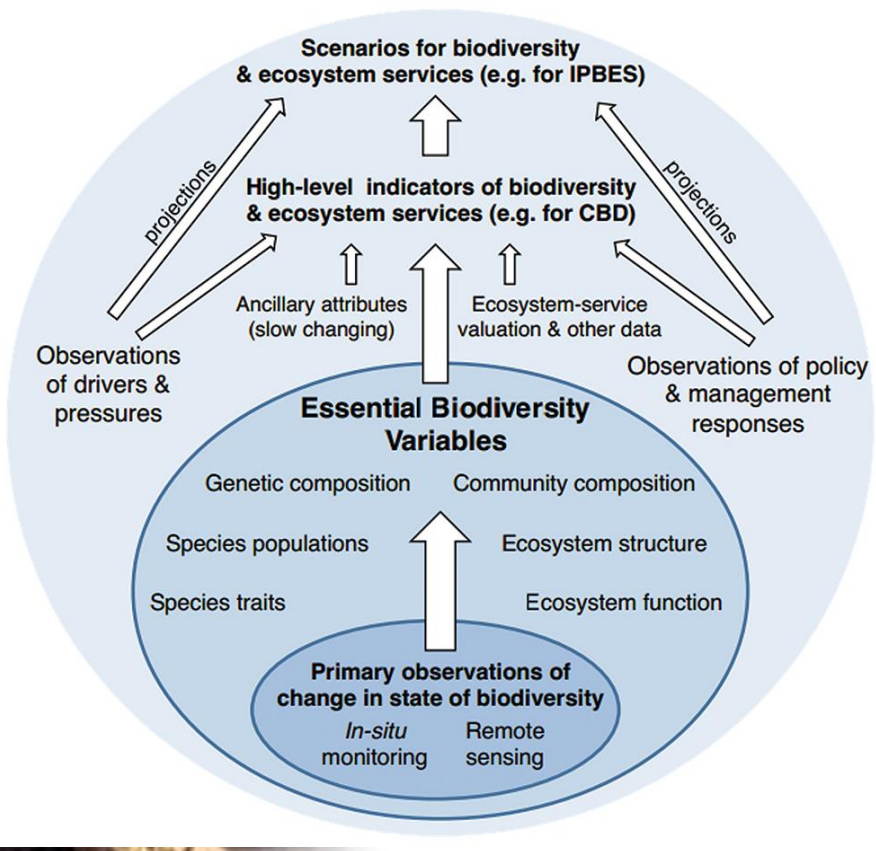
Satellite Remote Sensing (SRS) - EBVs



Source: GEOBON

Agree on biodiversity metrics to track from space

Ecologists and space agencies must forge a global monitoring strategy, say **Andrew K. Skidmore**, **Nathalie Pettorelli** and colleagues.

Global biodiversity loss is intensifying. But it is hard to assess progress towards the Aichi Biodiversity Tar-

Satellite remote sensing is crucial getting long-term global coverage. It c rapidly reveal where to reverse the loss

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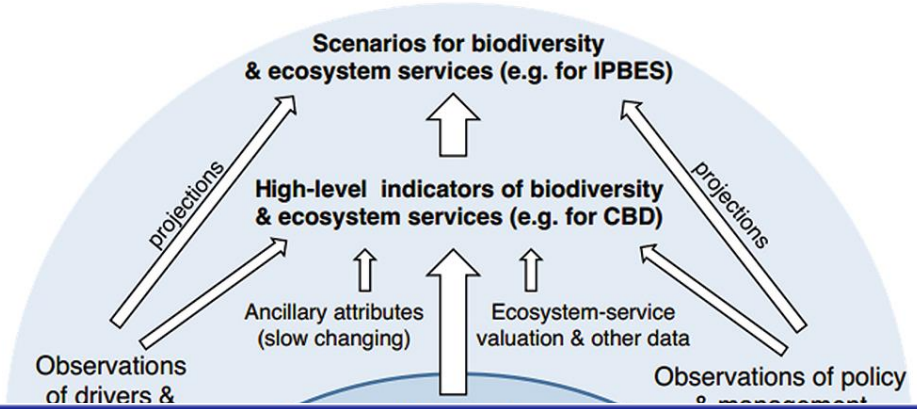
Satellite Remote Sensing – EBVs (cont.)



TRACKING BIODIVERSITY

Ten variables

Proposed variables for satellite monitoring of progress towards the Aichi Biodiversity Targets.

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POLICY FORUM

Framing the concept of satellite remote sensing essential biodiversity variables: challenges and future directions

Nathalie Pettorelli[1], Martin Wegmann[2,3], Andrew Skidmore[4], Sander Mücher[5], Terence P. Dawson[6], Miguel Fernandez[7,8], Richard Lucas[9], Michael E. Schaepman[10], Tiejun Wang[4], Brian O'Connor[11], Robert H.G. Jongman[5], Pieter Kempeneers[12], Ruth Sonnenschein[13], Allison K. Leidner[14], Monika Böhm[1], Kate S. He[15], Harini Nagendra[16], Grégoire Dubois[12], Temilola Fatoyinbo[17], Matthew C. Hansen[18], Marc Paganini[19], Helen M. de Klerk[20], Gregory P. Asner[21], Jeremy T. Kerr[22], Anna B. Estes[23,24], Dirk S. Schmeller[25], Uta Heiden[3], Duccio Rocchini[26], Henrique M. Pereira[7], Eren Turak[27,28], Nestor Fernandez[7,29], Angela Lausch[25], Moses A. Cho[30], Domingo Alcaraz-Segura[31], Mélodie A. McGeoch[32], Woody Turner[33], Andreas Mueller[3], Véronique St-Louis[34,35], Johannes Penner[36], Petteri Vihervaara[37], Alan Belward[12], Belinda Reyers[38,39] & Gary N. Geller[40]

Objective of the talk

To explore the concept of remote sensing EBVs as a framework for monitoring protected areas

Implementation objectives

- *To determine, collate, develop and package EBVs to inform decision making at multiple scales*
- *To develop long-term and near real time monitoring of specific EBVs in the protected areas*
- *To determine landscape changes based on long term EBV observations*

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Pathways to satellite remote sensing (SRS) EBV generation

Field Data

Ancillary data

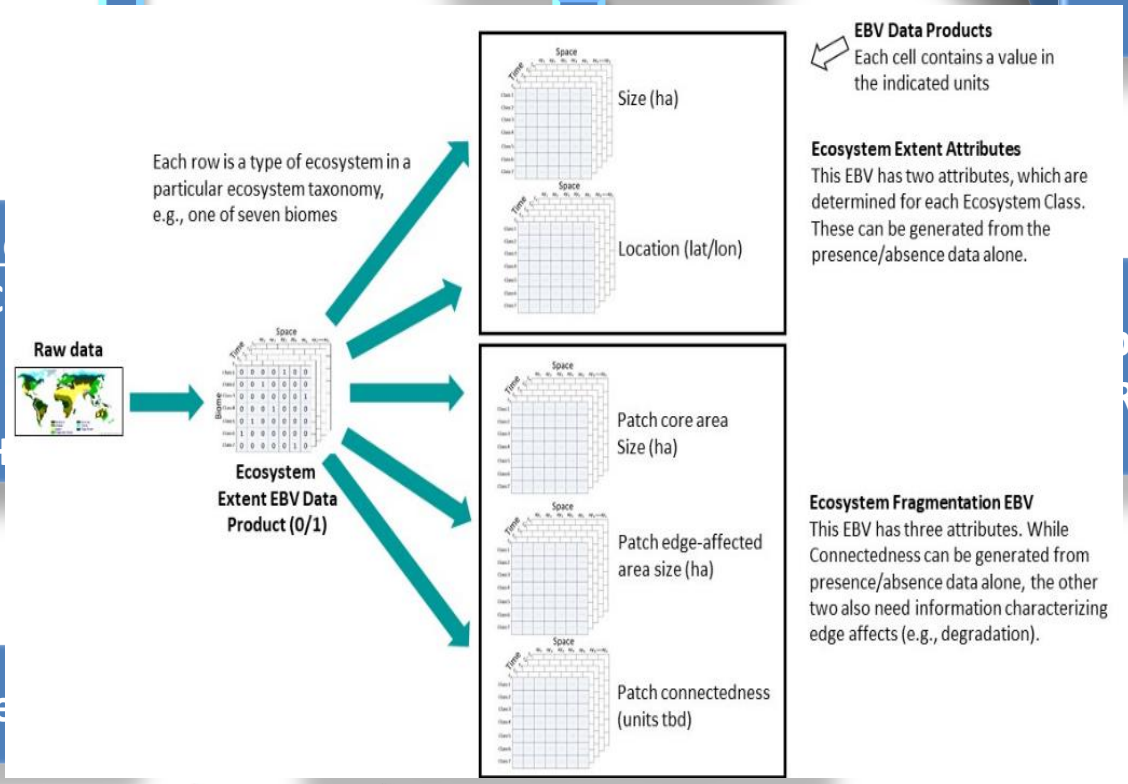
Big Data

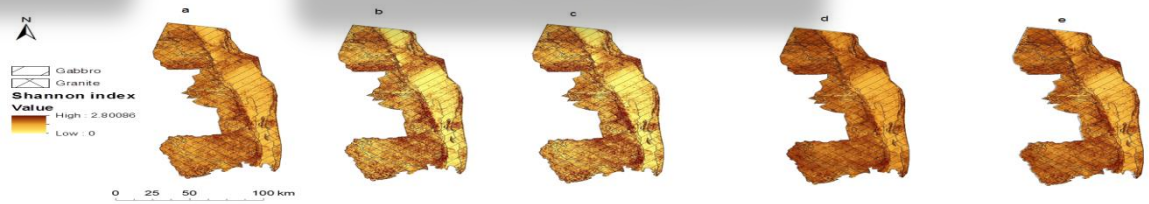
Raw SRS Data

Bi C H

rocessed RS data

Accuracy Asse





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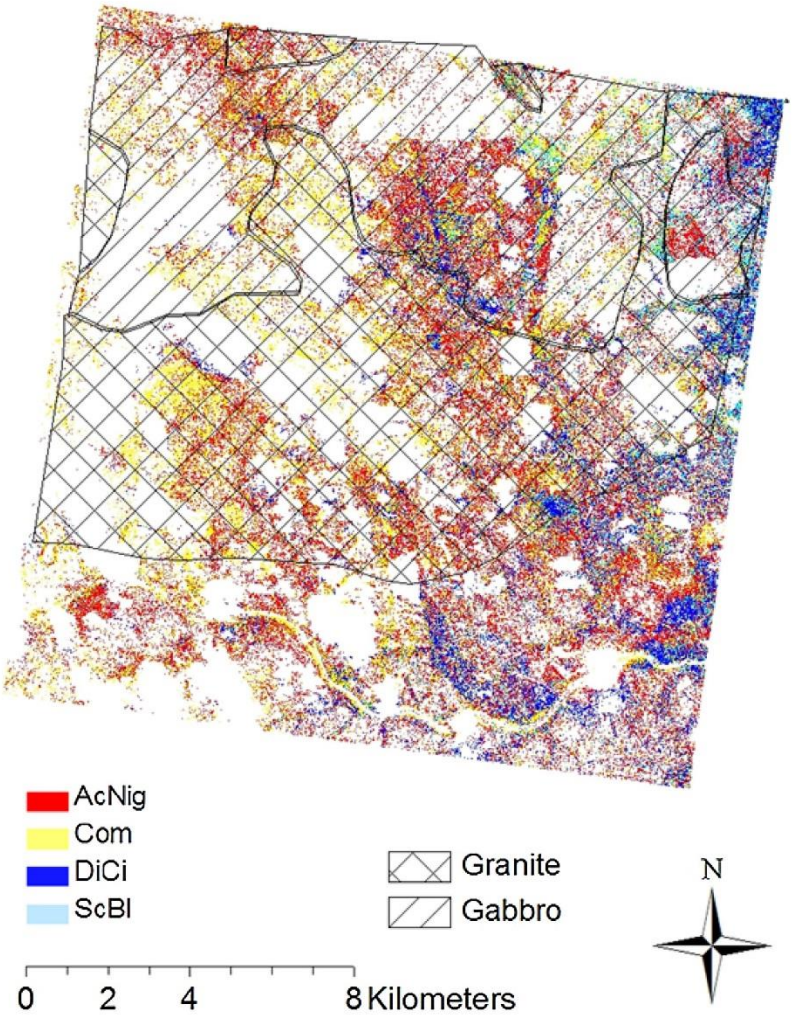
Tree composition mapping – multi-phenology approach



- Lowveld tree species map for optimal period: April – WorldView-2 images
- 80% of the overall accuracy

International Journal of Applied Earth Observation and Geoinformation 58 (2017) 65–73

Contents lists available at ScienceDirect

International Journal of Applied Earth Observation and Geoinformation

journal homepage: www.elsevier.com/locate/jag

Multi-phenology WorldView-2 imagery improves remote sensing of savannah tree species

Sabelo Madonsela[a,b,*], Moses Azong Cho[a,b], Renaud Mathieu[a,c], Onisimo Mutanga[b], Abel Ramoelo[a], Żaneta Kaszta[d], Ruben Van De Kerchove[e], Eléonore Wolff[d]

[a] Earth Observation Research Group, Natural Resources and Environment, Council for Scientific and Industrial Research (CSIR), Pretoria, South Africa
[b] School of Agric. Earth and Environmental Sciences, University of KwaZulu-Natal (UKZN), Pietermaritzburg, Sout
[c] Department of Geography, Geoinformatics and Meteorology, University of Pretoria, Pretoria, South Africa
[d] IGEAT, Université Libre de Bruxelles (ULB), Belgium
[e] Unit Remote Sensing and Earth Observation Processes, Flemish Institute for Technological Research (VITO), Mol .

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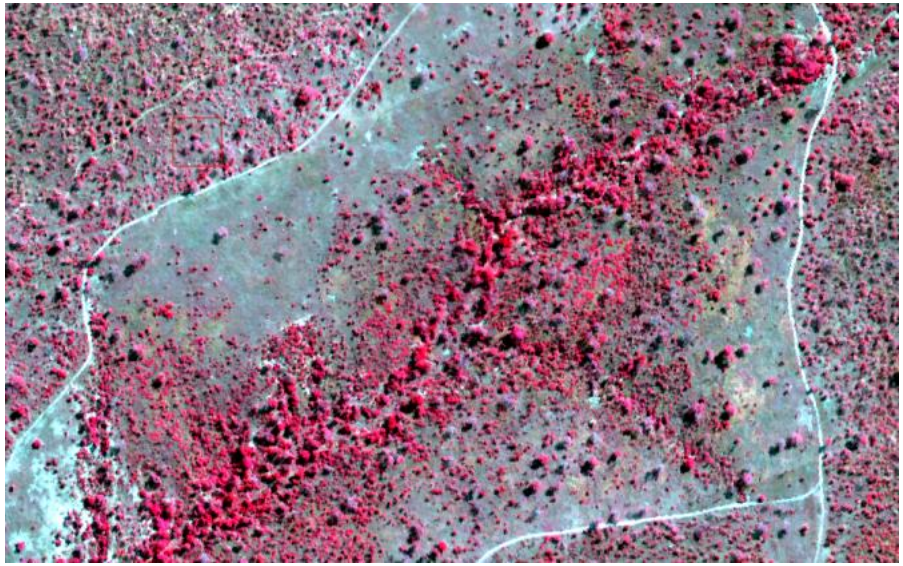
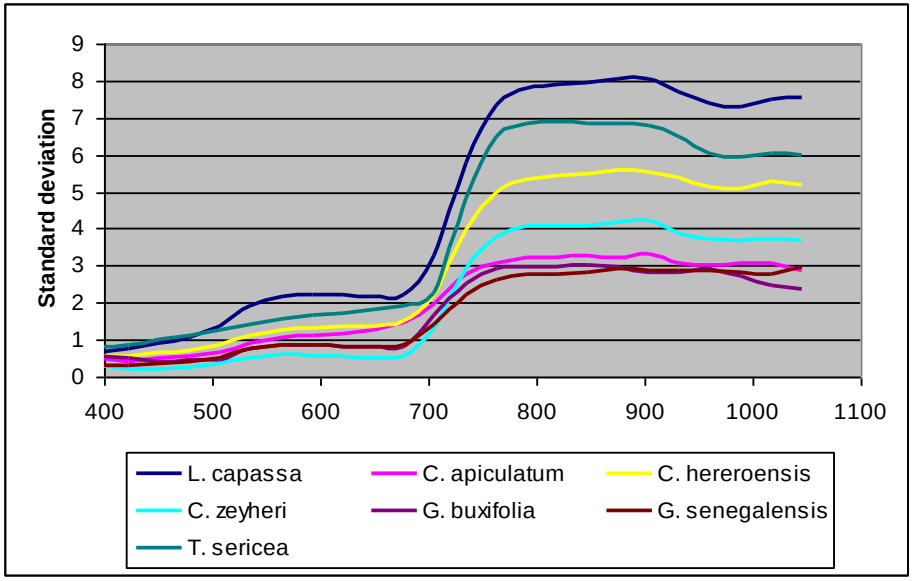
Tree Species Mapping





Source: CSIR

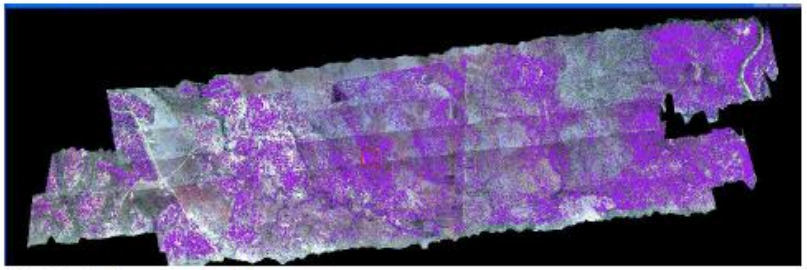


Fig 1. Sclerocarya birrea

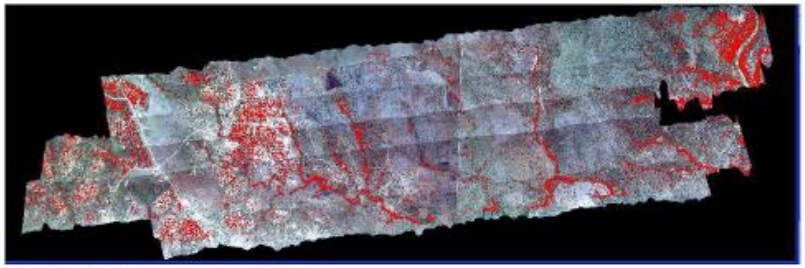


Fig 2. Spirostachys africanus

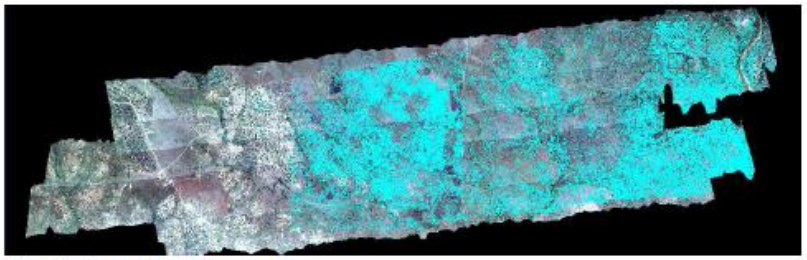


Fig 3. Acacia nigrescens

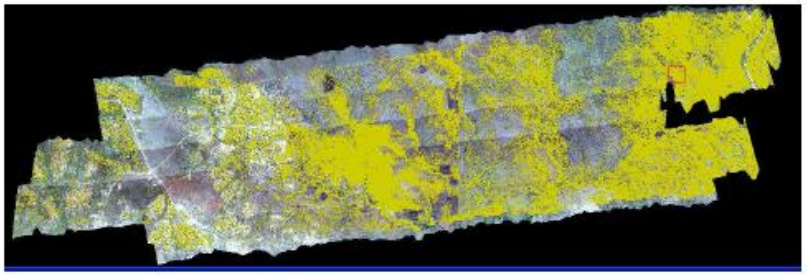
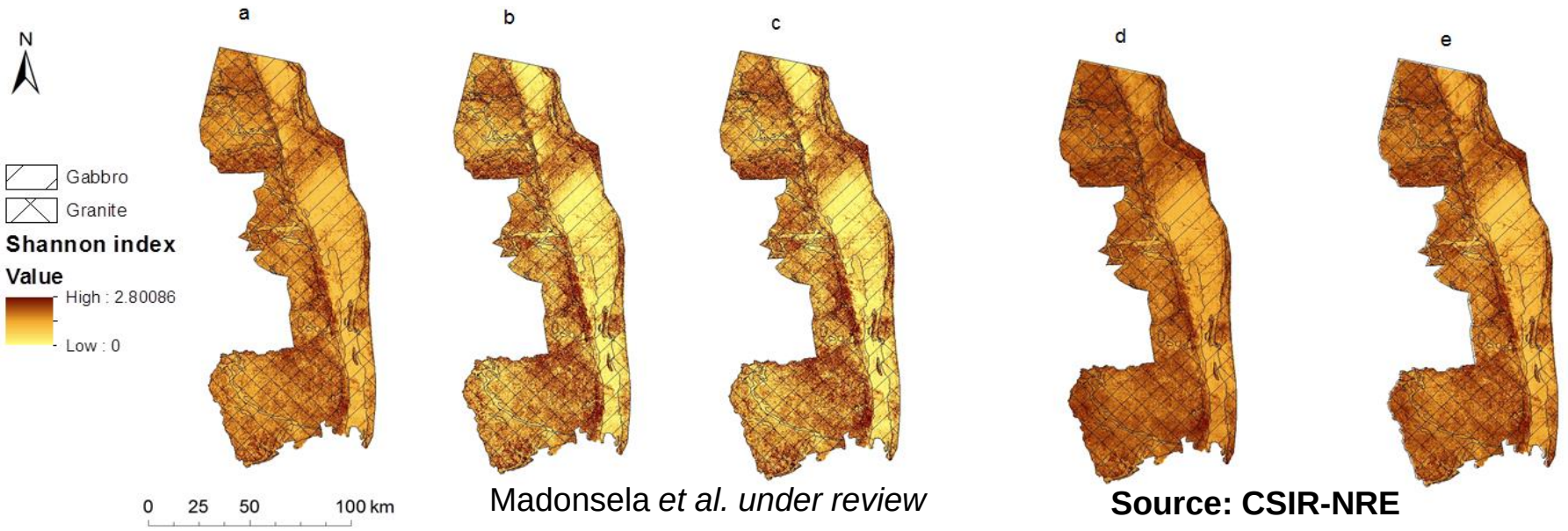


Fig. Combretum (dominated by apiculatum)

Towards development of tree species diversity monitoring



Madonsela *et al. under review*

Source: CSIR-NRE

Tree species diversity from the best (a) woody canopy cover (WCC) model, (b) factorial model involving NDVIMarch and WCC (c) factorial model involving NDVIApril and WCC (d) factorial model involving NDVIMay and WCC and (e) factorial model involving NDVIJuly and WCC

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Review | Open Access

Satellite remote sensing to monitor species diversity: potential and pitfalls

Duccio Rocchini, Doreen S. Boyd, Jean-Baptiste Féret, Giles M. Foody, Kate S. He, Angela Lausch, Harini Nagendra, Martin Wegmann, Nathalie Pettorelli

First published: 10 December 2015 | https://doi.org/10.1002/rse2.9 | Cited by: 26

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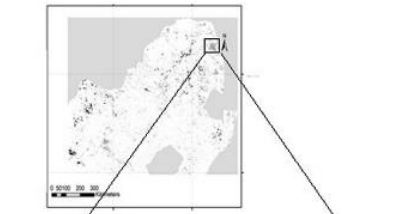
Mapping trends in tree cover: bush encroachment



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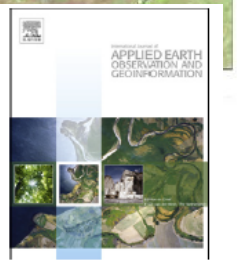
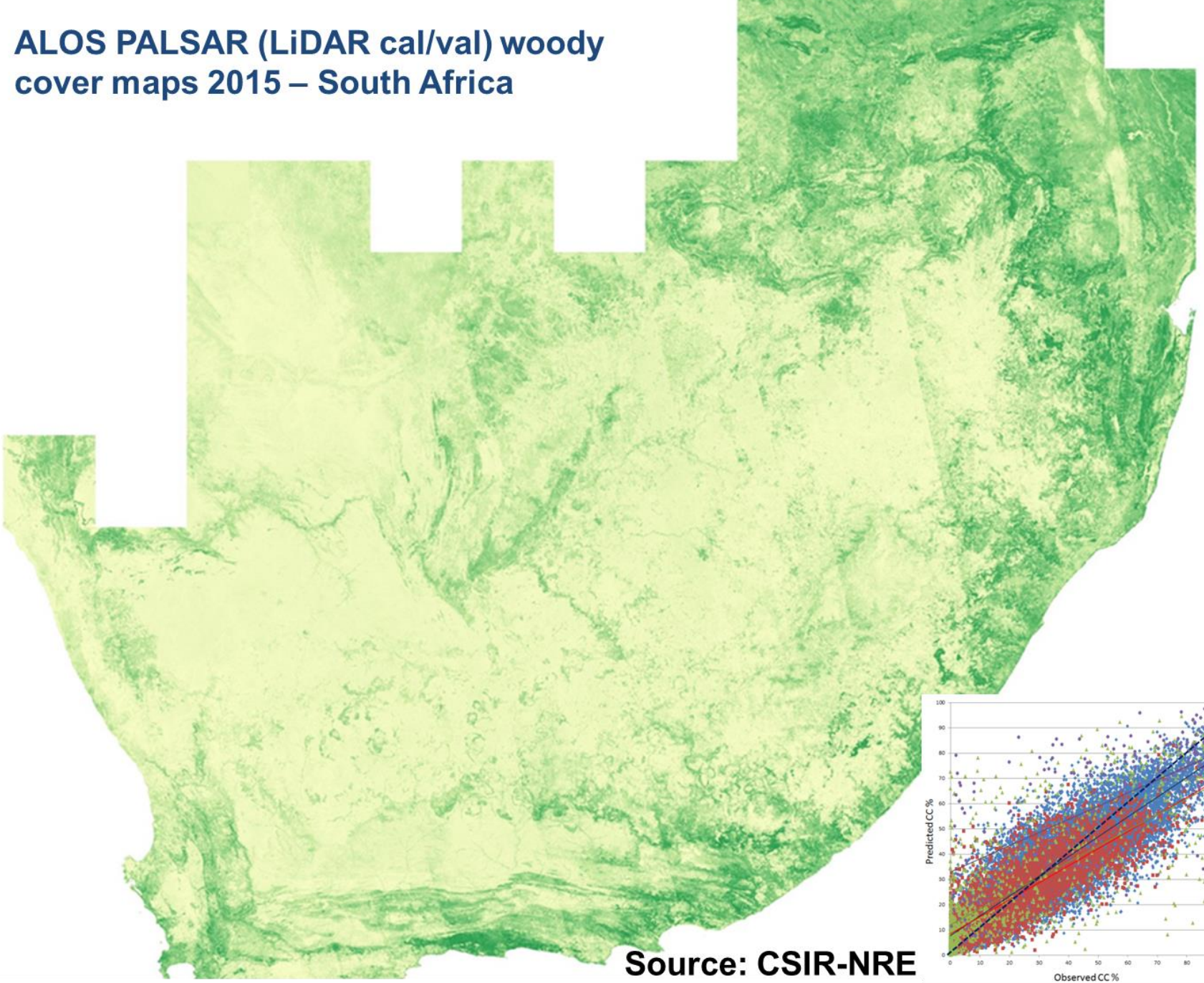


Optimal dates for assessing long-term changes in tree-cover in the semi-arid biomes of South Africa using MODIS NDVI time series (2001–2018)

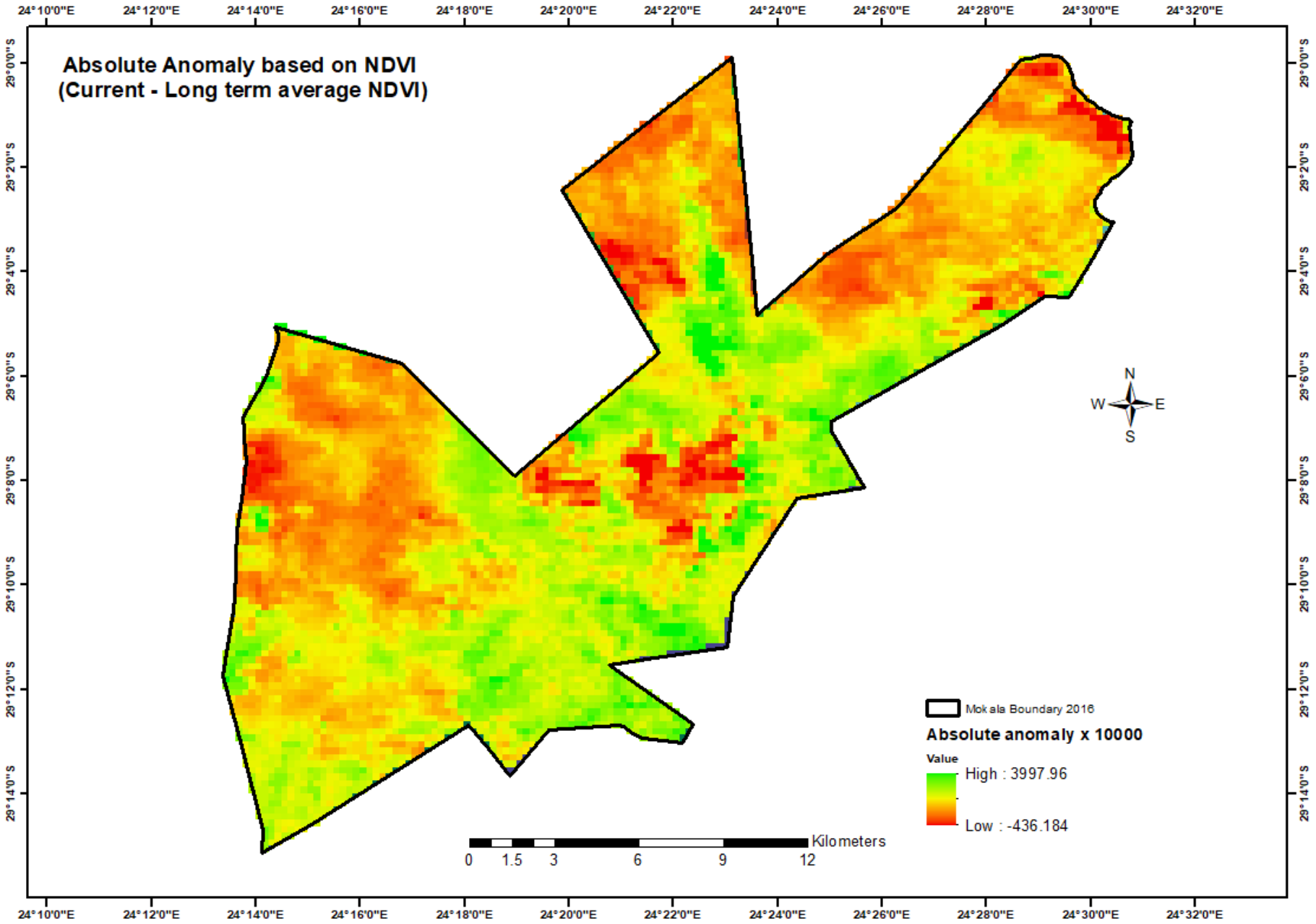
Moses Azong Cho[a,b,*], Abel Ramoelo[c,d]

ALOS PALSAR (LiDAR cal/val) woody cover maps 2015 – South Africa

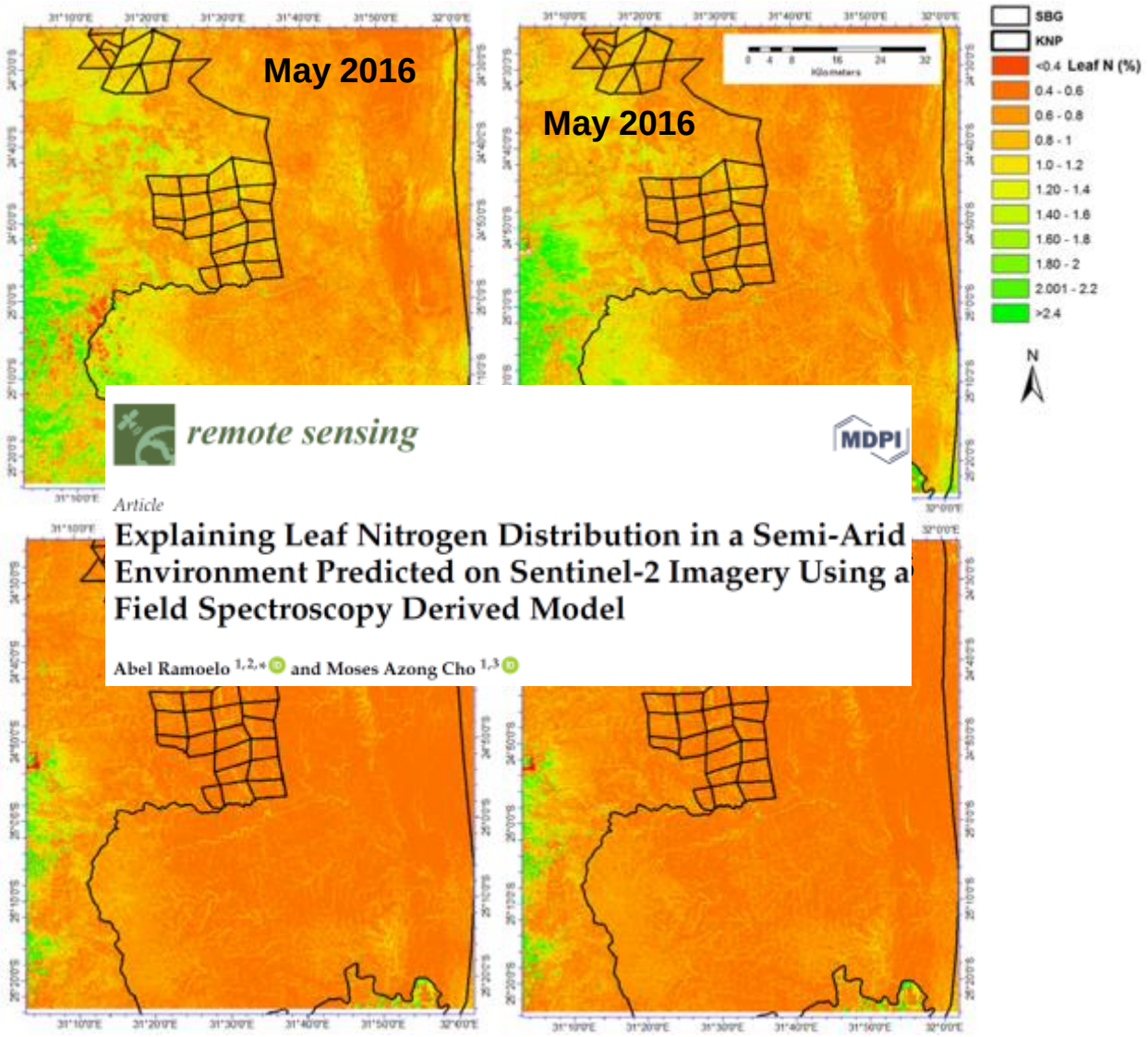


Source: CSIR-NRE

Vegetation condition assessment: Example of Mokala National Park



Empirical modelling of leaf N using simulated Sentinel-2 from Spectrometer data



remote sensing
MDPI
Article

Explaining Leaf Nitrogen Distribution in a Semi-Arid Environment Predicted on Sentinel-2 Imagery Using a Field Spectroscopy Derived Model

Abel Ramoelo [1,2,*] and Moses Azong Cho [1,3]

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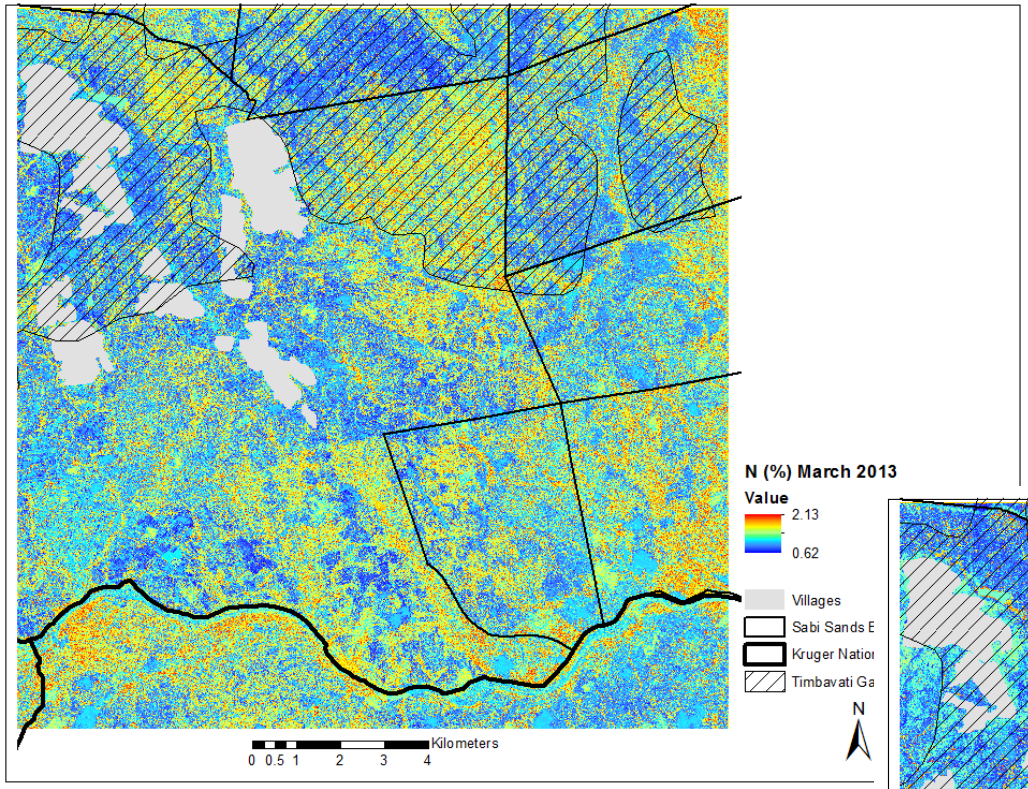
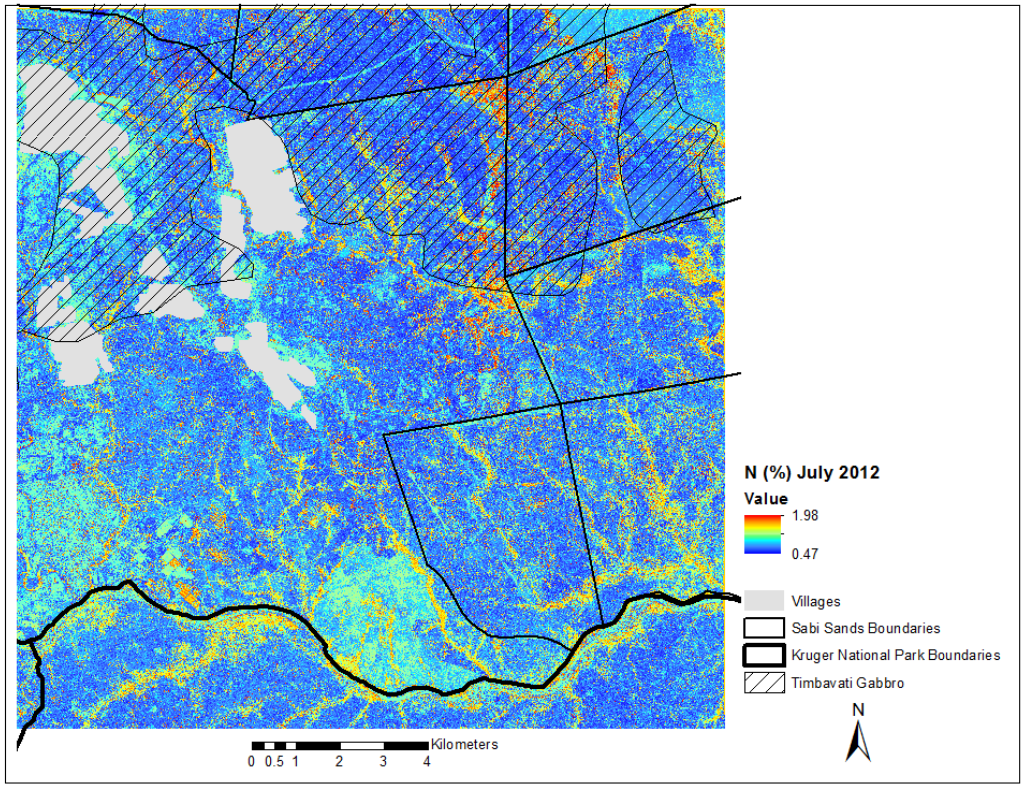
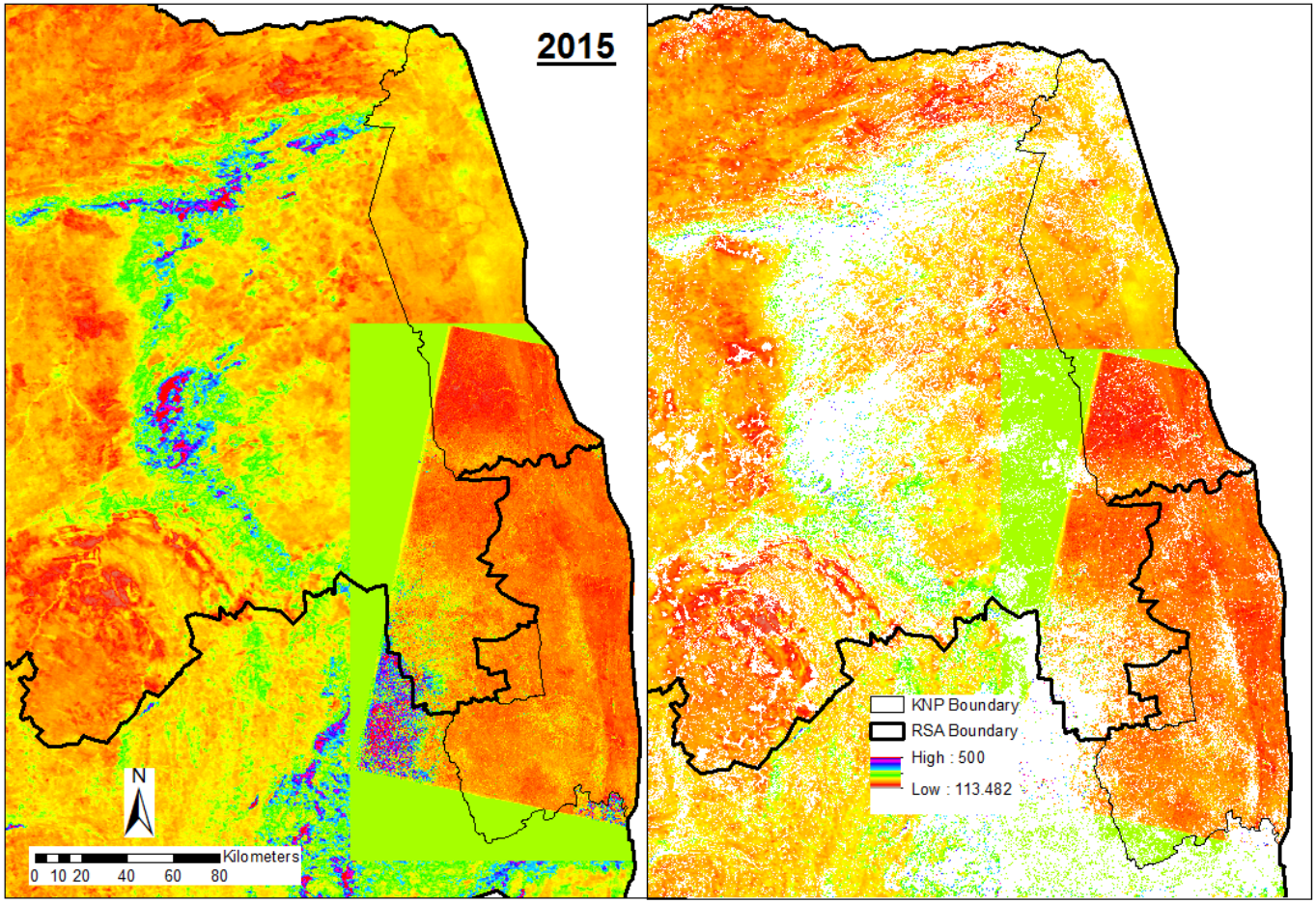
Leaf N –WorldView-2 (Red Edge Band)





Ramoelo *et al*. 2015. *JAG*

Mean Annual Biomass Maps (g/m²) from 2001 to 2015



Stolter, C., Ramoelo A., Kesch, K., , Madibela, O.R., Cho, M.A., Joubert, D., 2018. Forage Quality and Availability for Large Herbivores, In: Climate change and adaptive land management in southern Africa – assessments, changes, challenges and solutions (ed. By Revermann, R., Krewenka, K.M., Schmiedel, U., Olwoch J.M., Hlmschrot, J.,& Jurgens, N.), pp; 170 - 176. Biodiversity and Ecology, 6, Klaus Hess Publishers, Gottingen and Windhoek.

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EBVs provide potential for monitoring, but there are few questions.

- What are key environmental issues beyond each PAs?
- Uniqueness and representativeness of the PAs according to the EBVs?
- Who is working towards developing such variables, local, regional and international? Synergies?
- How can institutions be mobilized to contribute those EBVs for the management of the protected areas?
- How can we co-develop or co-produce these with various stakeholders?
- How can these data be collated, stored and further analysed for trends, etc? GEE? ARD?
- Monitoring, assessment and early warning tools
- At what scale, temporal, spectral and spatial?

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Acknowledgements

- SANParks
- CSIR
- ECOPOTENTIAL Project (http://www.ecopotential-project.eu/)
- GEOBON – Group on Earth Observation Biodiversity Observation Network

Thank you

Abel.Ramoelo@sanparks.org