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BIOSCAPE
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BIOSCAPE

Biodiversity Survey of the Cape

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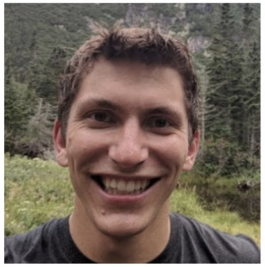


Phil Brodrick

Data PI

NASA Jet Propulsion Lab

BIOSCAPE: Biodiversity Survey of the Cape

1. WE COLLECT DATA: REMOTE & IN-FIELD

REMOTE: landsat, sentinel, EMIT, ECOSTRESS

IN-FIELD: Phytoplankton functional types

IN-FIELD: Plant functional traits & species composition

IN-FIELD: Leaf & canopy spectra

IN-FIELD: Animal counts

IN-FIELD: DNA & eDNA samples

REMOTE: Imaging spectometry (UVSWIR & thermal) and laser altimeter

2. TO STUDY BIODIVERSITY

FUNCTIONAL DIVERSITY

TAXONOMIC DIVERSITY

PHYLOGENETIC DIVERSITY

SPECTRAL DIVERSITY

3. TO BETTER CONSERVE NATURE & ITS CONTRIBUTIONS TO PEOPLE

SHIFTING COMMUNITY COMPOSITION

ECOSYSTEM DISTURBANCE, RESILIENCE & RECOVERY

ECOSYSTEM FUNCTION & CONTRIBUTION TO PEOPLE

Field data - mostly coincident with airborne acquisitions

Vegetation surveys across environmental gradients

Freshwater and marine phytoplankton communities

Environmental DNA and plant DNA

“Soundscapes” from autonomous recorders

3 Imaging Spectrometers + 2 LiDAR on 3 Aircraft

NRF National Research Foundation | SAEON South African Environmental Observation Network

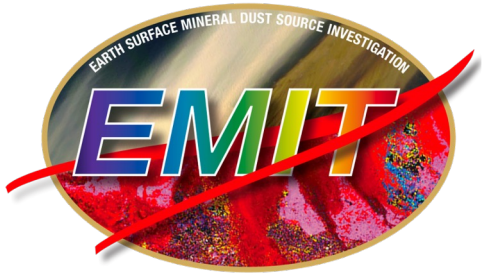
Airborne Visible / Infrared Imaging Spectrometer
AVIRIS NEXT GENERATION

PORTABLE REMOTE IMAGING SPECTROMETER
PRISM
JET PROPULSION LABORATORY • NASA

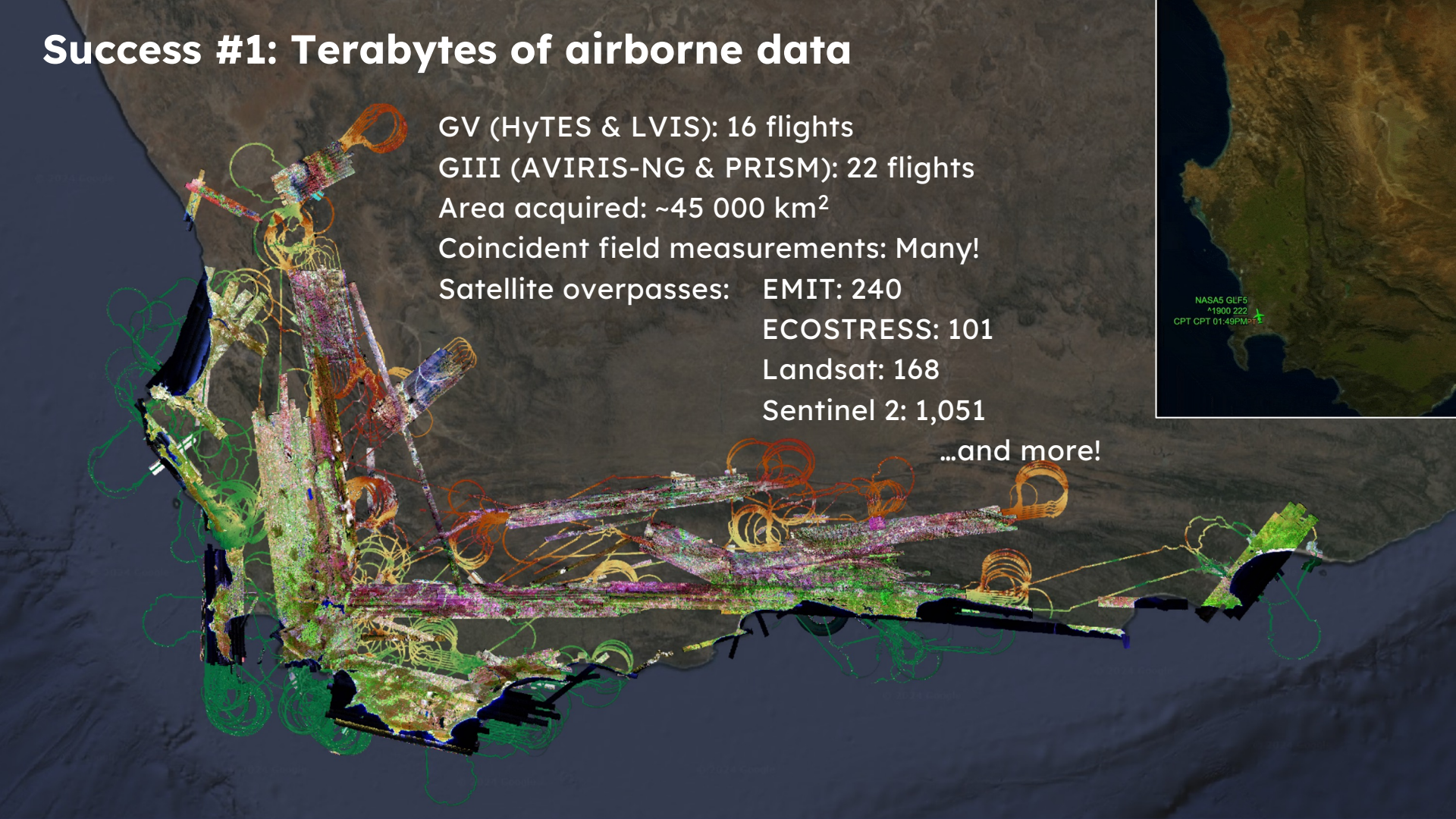
HYPERSPECTRAL THERMAL EMISSION SPECTROMETER
HyTES
NASA • JET PROPULSION LABORATORY

Goddard Space Flight Center
LVIS
Land, Vegetation, & Ice Sensor

BioSCape is Preparing Us for the Future of Remote Sensing

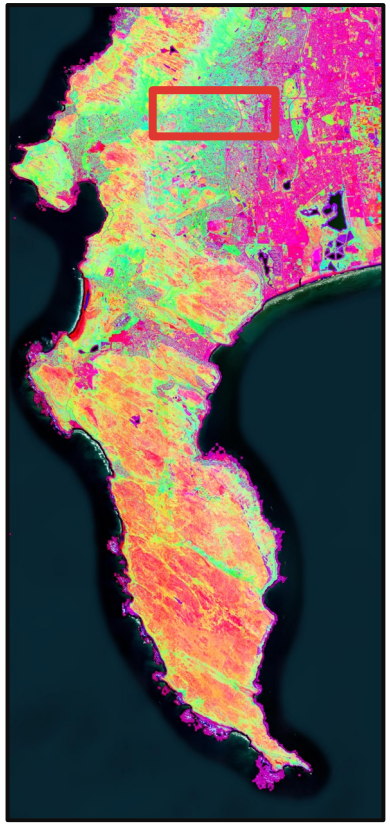


Success #1: Terabytes of airborne data

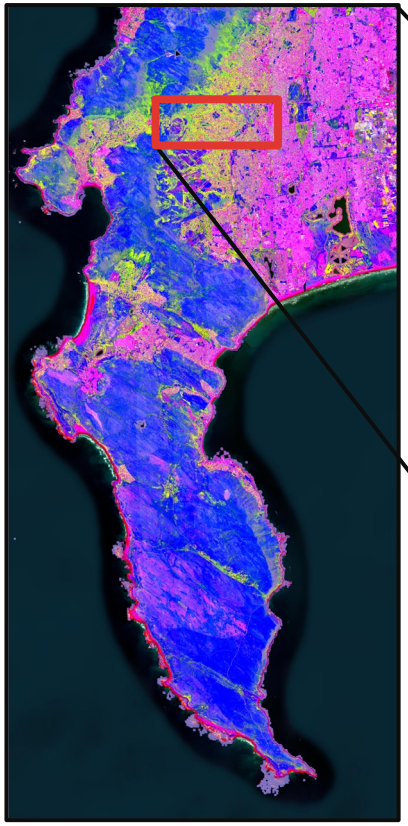


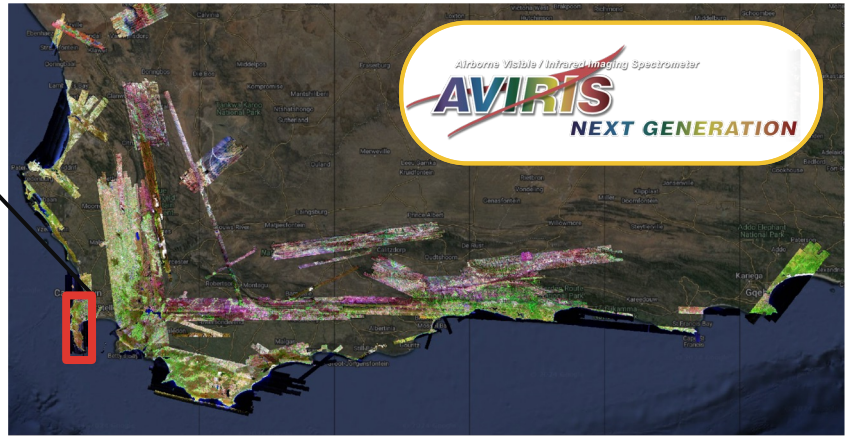
GV (HyTES & LVIS): 16 flights
GIII (AVIRIS-NG & PRISM): 22 flights
Area acquired: ~45 000 km^2
Coincident field measurements: Many!
Satellite overpasses: EMIT: 240
ECOSTRESS: 101
Landsat: 168
Sentinel 2: 1,051
...and more!

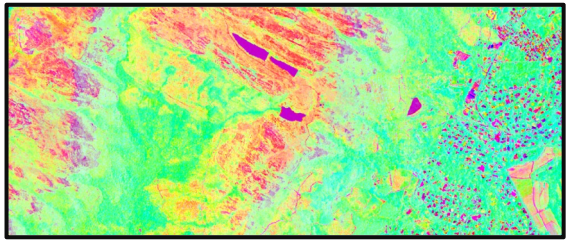
Vegetation Principal Components (7,10,3)

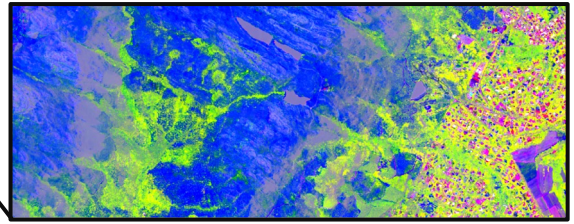


Vegetation Principal Components (5,6,7)









Analysis: Phil Brodrick

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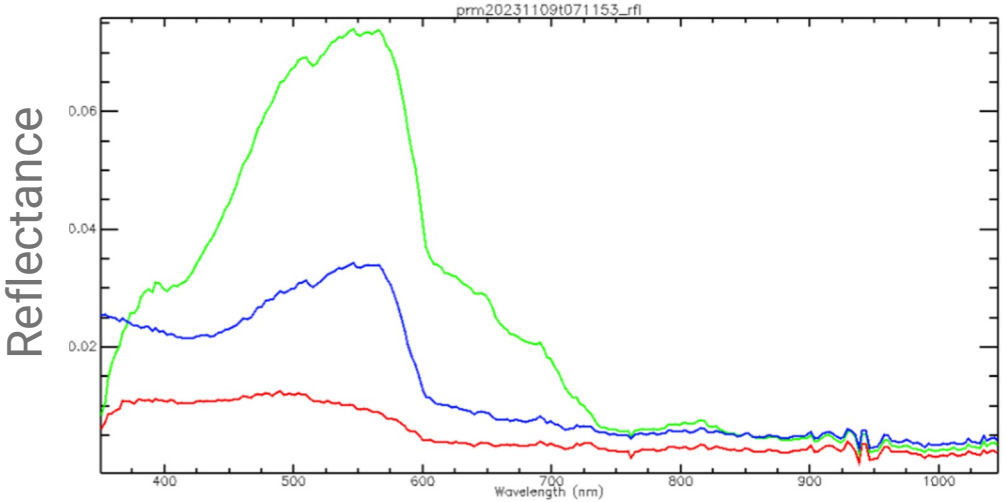
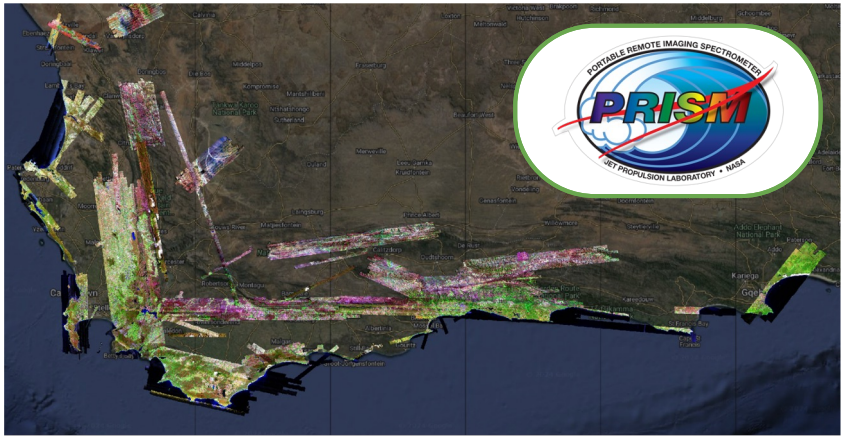


Wavelength (nm)



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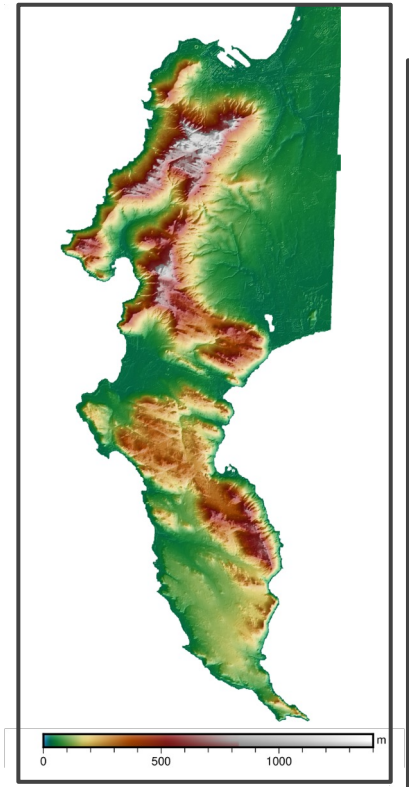
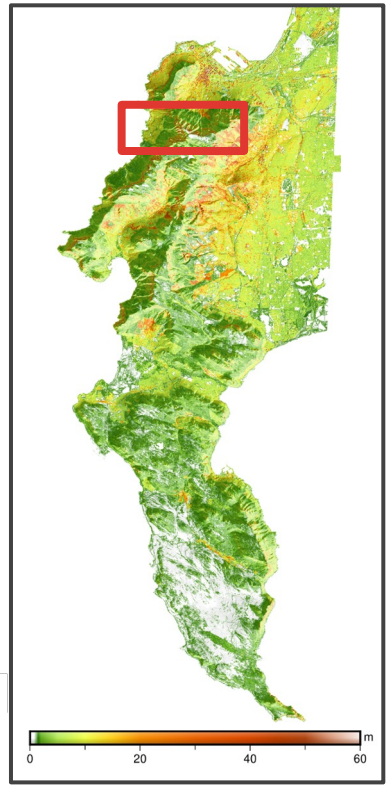
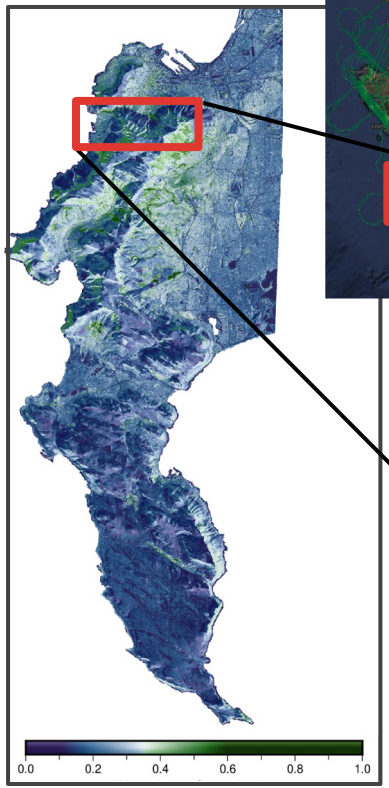


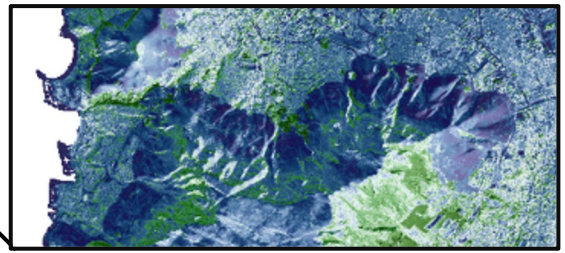
Elevation

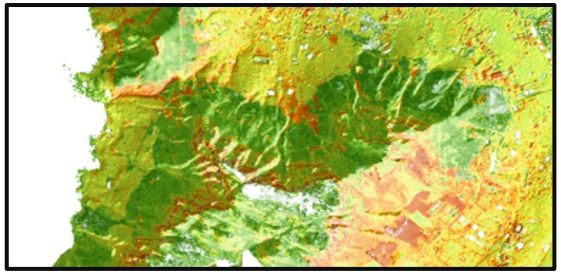


RH95
Vertical Extent



Waveform
Complexity





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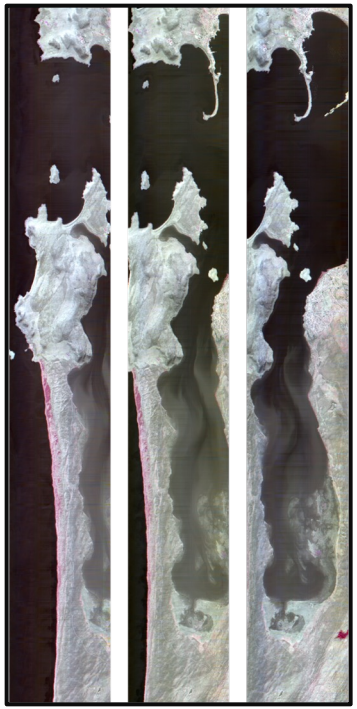
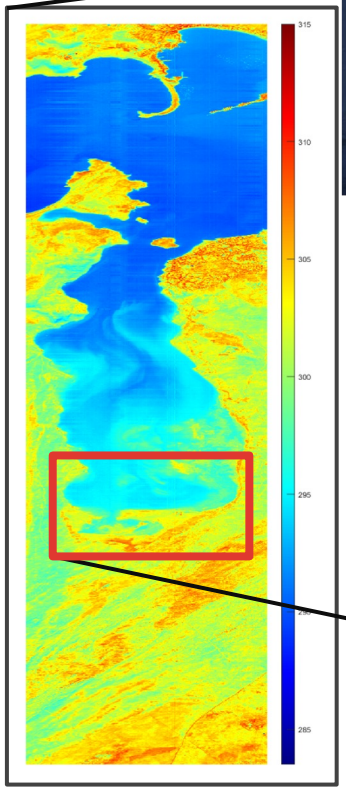
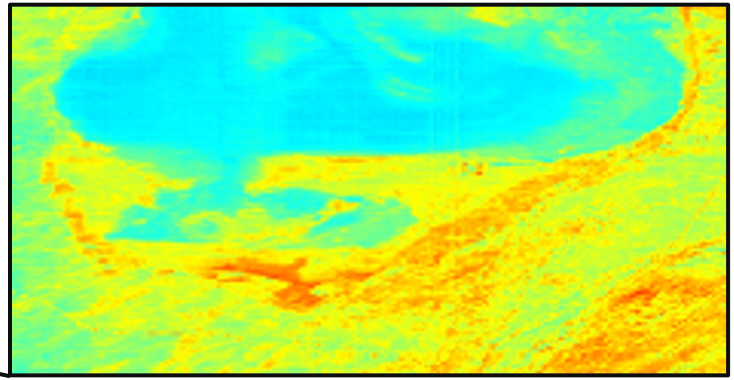
False Color
10.07, 9.25, 8.21 μm

10.07μm 8.86μm 8.20μm



Single Band
used for BT 179
(10.58μm)





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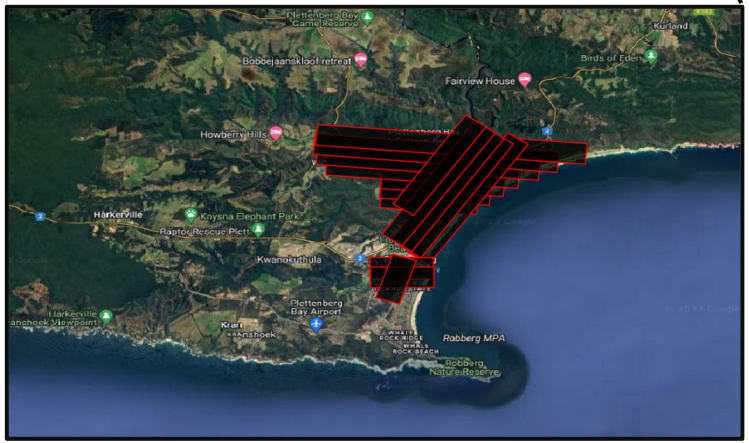
Discrete Return LiDAR &
High Resolution RGB



- Klein Estuary
- Bot Estuary
- Onrus Estuary
- Grootbos Nature Reserve
- Palmiet Estuary
- Keurbooms & Piesang Estuaries

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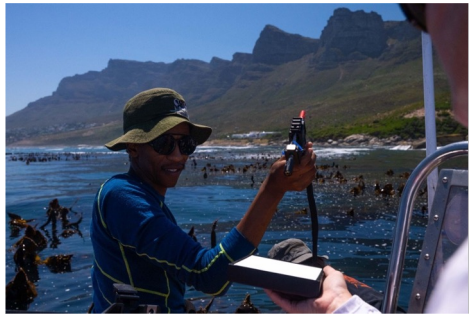
Success #2: Lots of diverse of field data





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Success #3: Prioritizing data accessibility

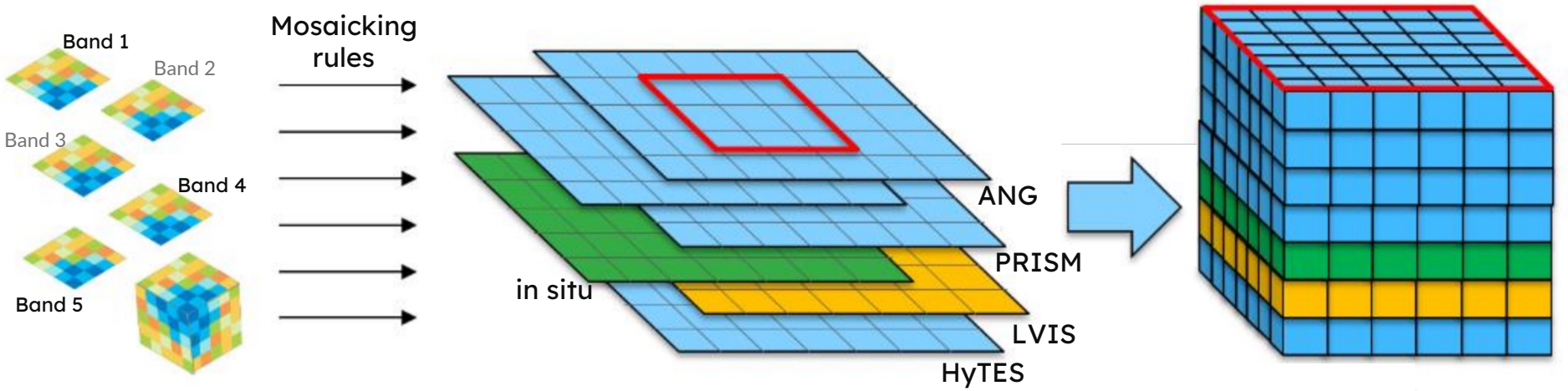


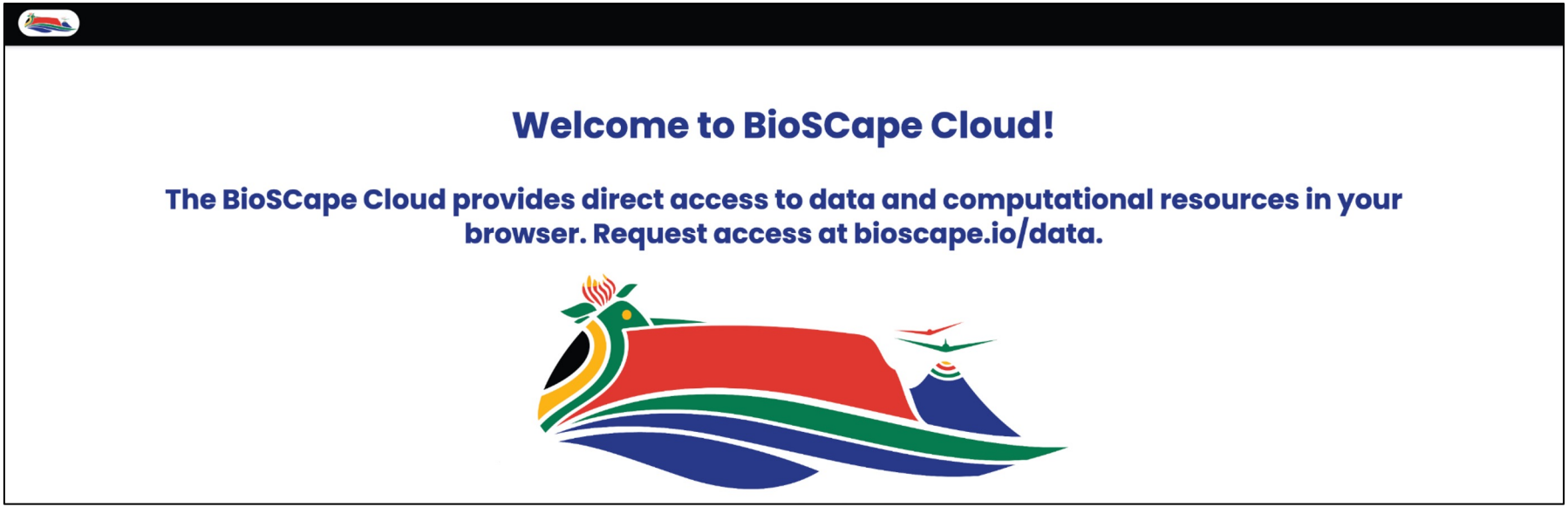
Image files from each instrument

Mosaics from each instrument, co-registered to a common grid

Pixel aligned image cube

Based on: Kopp et al., 2019

Success #3: Prioritizing data accessibility



Success #4: 500+ people engaged, focus on capacity building

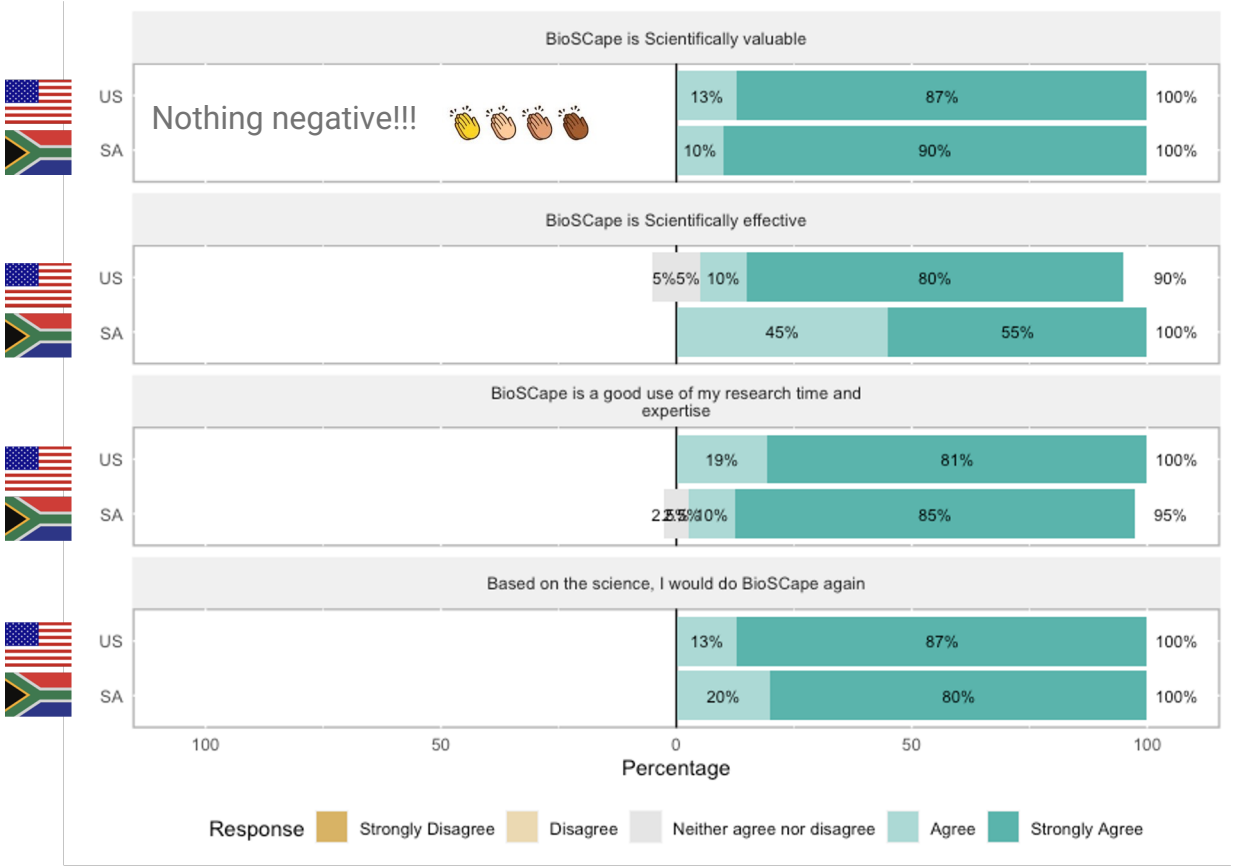
Success #5: Excellent team dynamic (and no reported incidents)





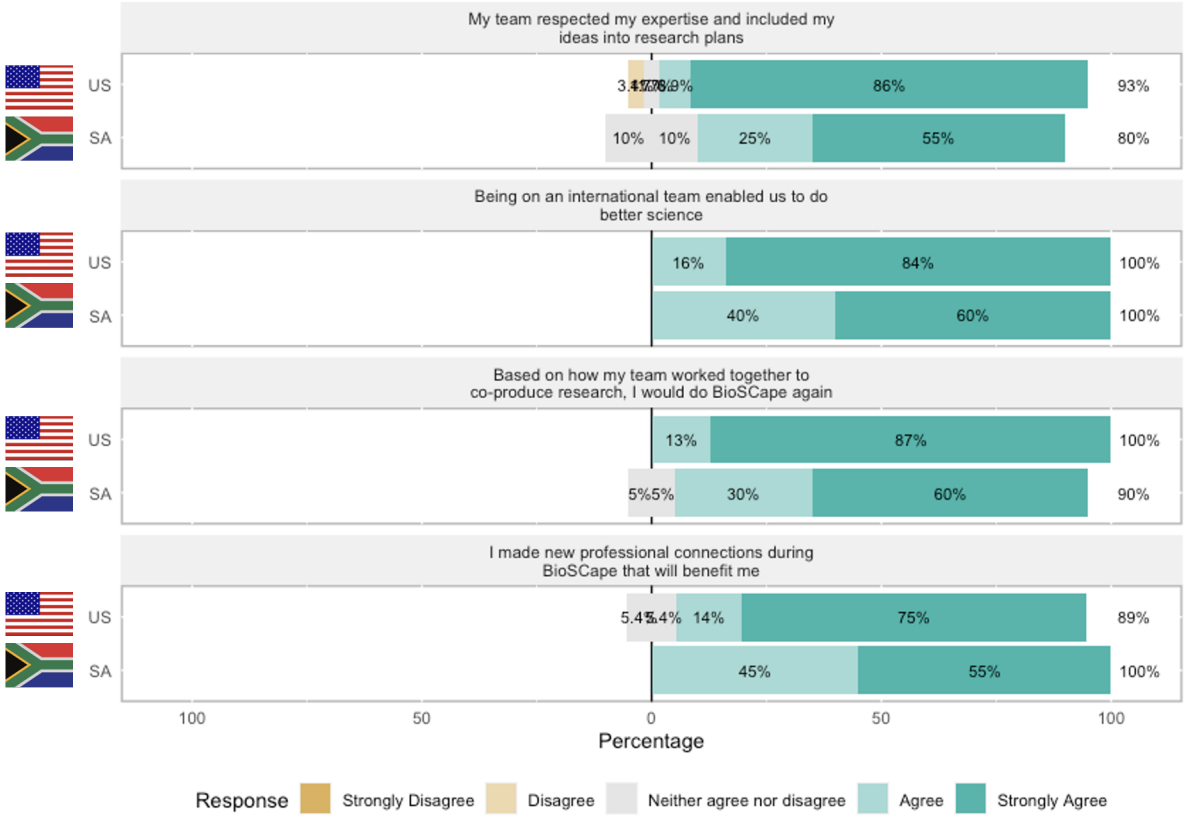

Team Feedback: Perception of the Science

n=52



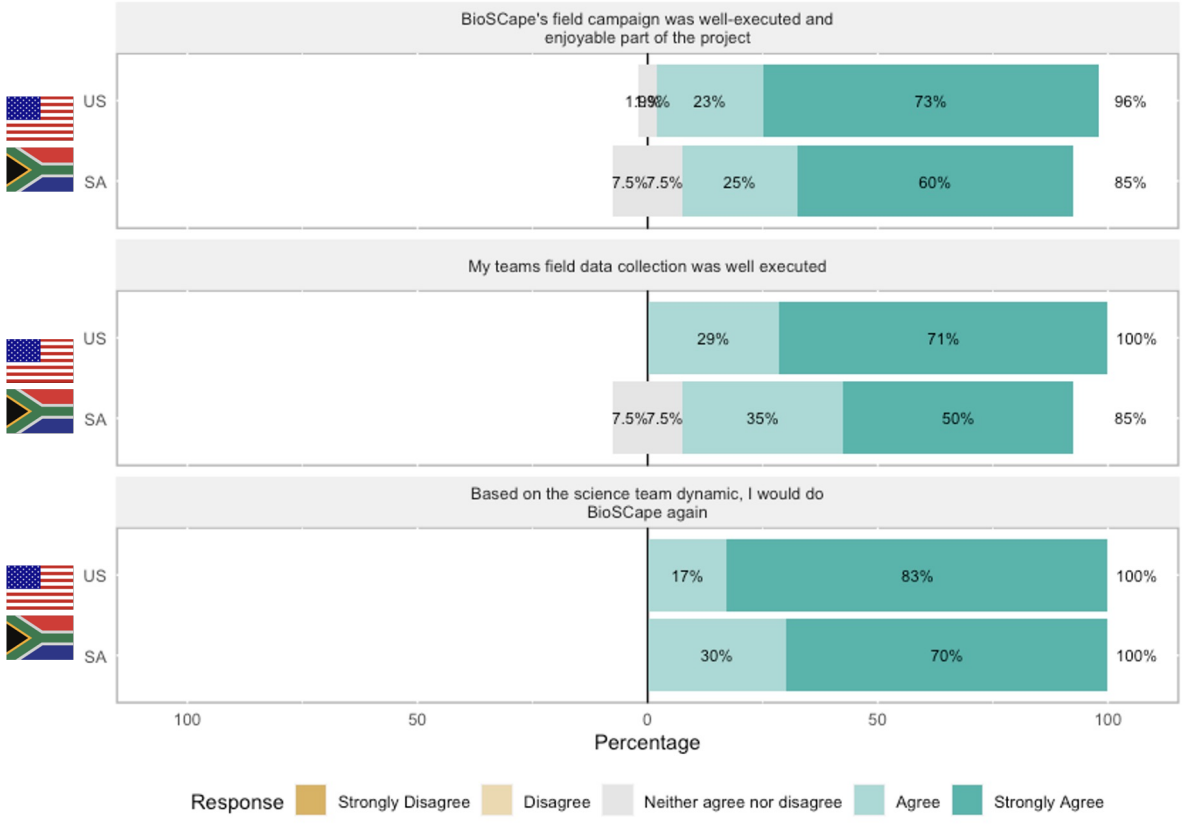
Team Feedback: Perception of International Collaboration

n=52



Team Feedback: Perception of Project Execution

n=52



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Team Feedback: What did you love about BioSCape? n=42

- **Collaboration and Inclusivity (55%)**
  - "I loved the full integration between South African and US scientists."
- **Enjoyment and Positive Experiences (36%)**
  - "The amazing support that we got from our South Africa collaborators."
- **Productive Science (26%)**
  - "It makes me feel like I am applying my research in real world application and conservation efforts."
- **Effective Organization and Planning (19%)**
  - "Extremely well organised despite complexity of the programme."

Team Feedback: What did you hate about BioSCape? n=38

- **No Negative Feedback (26%)**
  - "There really wasn't much to dislike about BioSCape. It went way beyond my expectations."

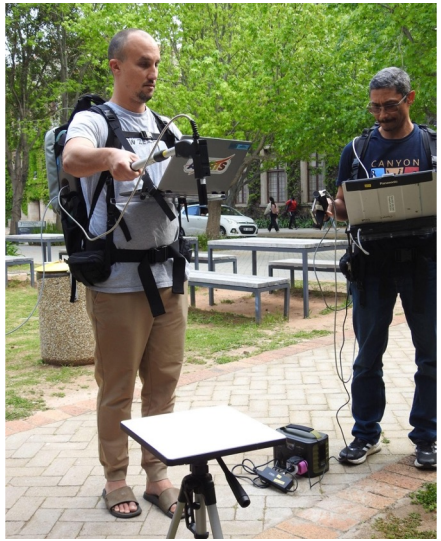
- **Funding Concerns (17%)**
  - "Not being able to compensate South African partners with research dollars."

- **Logistics (16%)**
  - "It was unfortunate that the aircraft did not arrive on the dates originally planned."

- **Data Delays (8%)**
  - "Waiting for data while we burn personnel budget."

- **Diversity and Inclusion (5%)**
  - "I wish we could have included more individuals of diverse backgrounds."

Looking Forward



ARSET/ORNL DAAC/Traits Workshop:
7-11 October 2024 in Cape Town

Conference Workshops:
ESA & AGU

SCIENCE TEAM MEETING (virtual): 3 October 2024

BioSCape Film:
In theatres worldwide late 2024

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Thank you to everyone who made this possible

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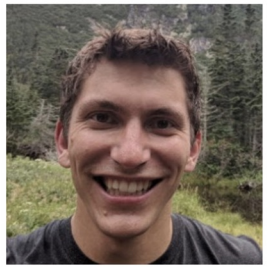
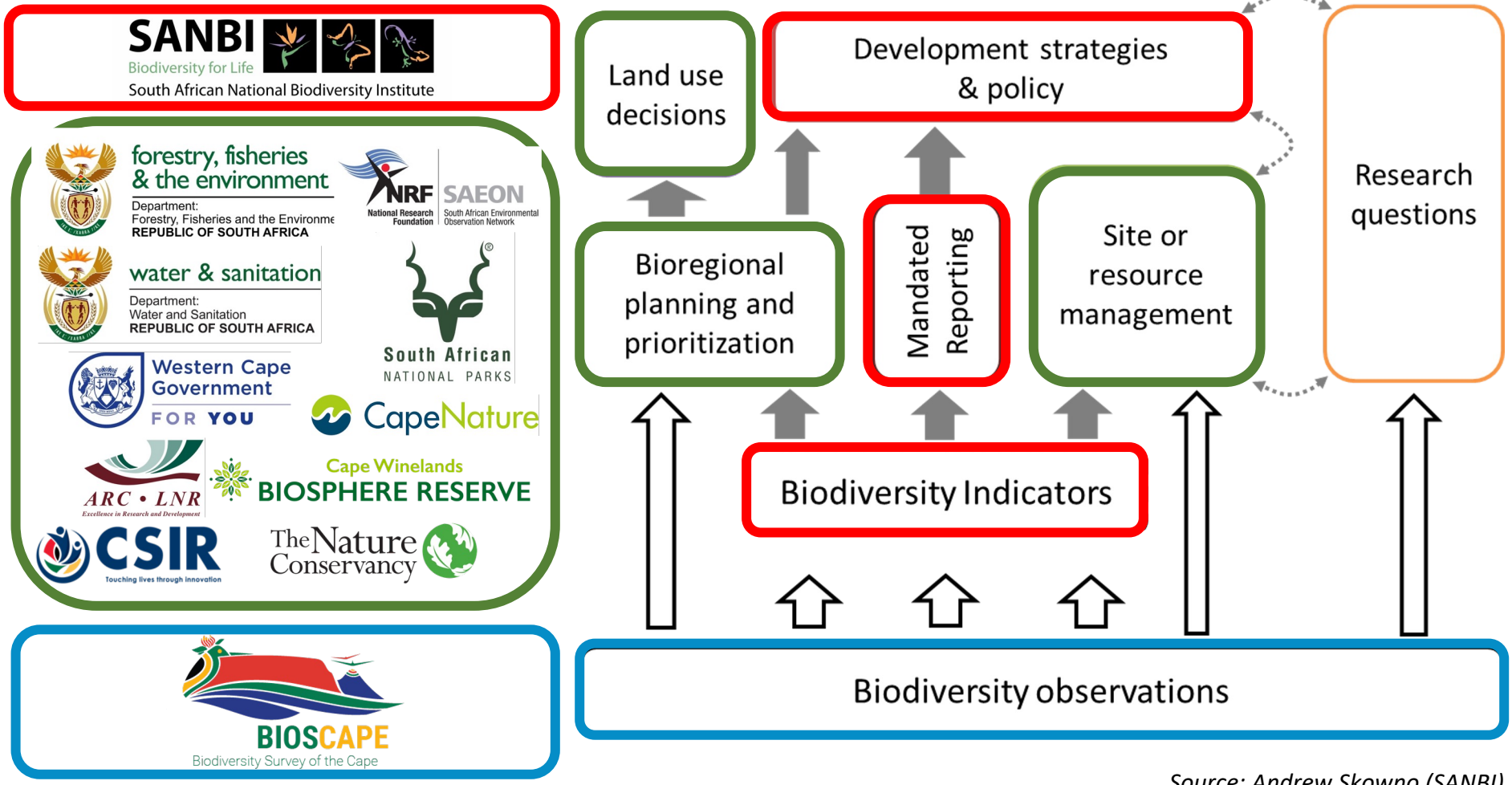


Phil Brodrick

Data PI

NASA Jet Propulsion Lab

1. Context: Why BioSCape Applications?



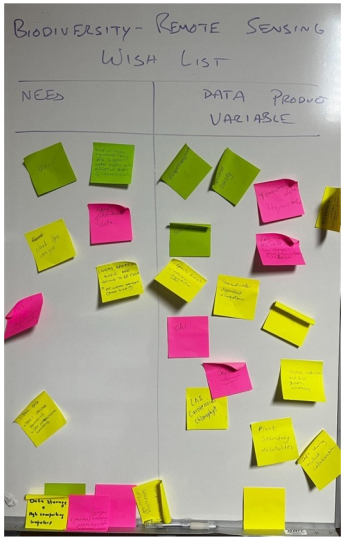
Source: Andrew Skowno (SANBI)

2. Stakeholder engagement: BioSCape Applications Workshop (22-26 May 2023)

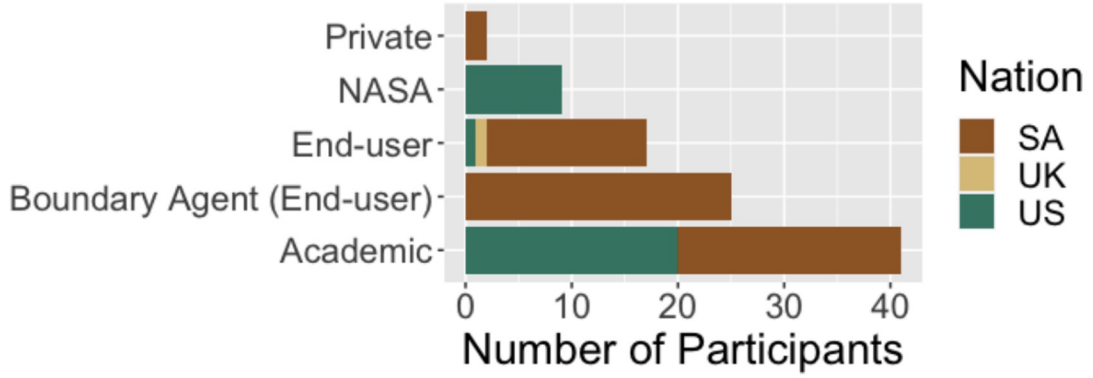
5-day workshop for the BioSCape Science Team + practitioners (end-user and boundary agency organisations); 94 knowledge holders

2.1. Remote Sensing of biodiversity **"Wishlist"**: What are your applied research needs and desired data products/variables?

Managing expectations and creating space to share our **hopes and dreams**! BioSCape as a **springboard** for the future (funding, collaborations, etc.)... thus exciting **cross-project collaborations** have emerged - Alien Tree Mapping working group + Water Quality collaboration.



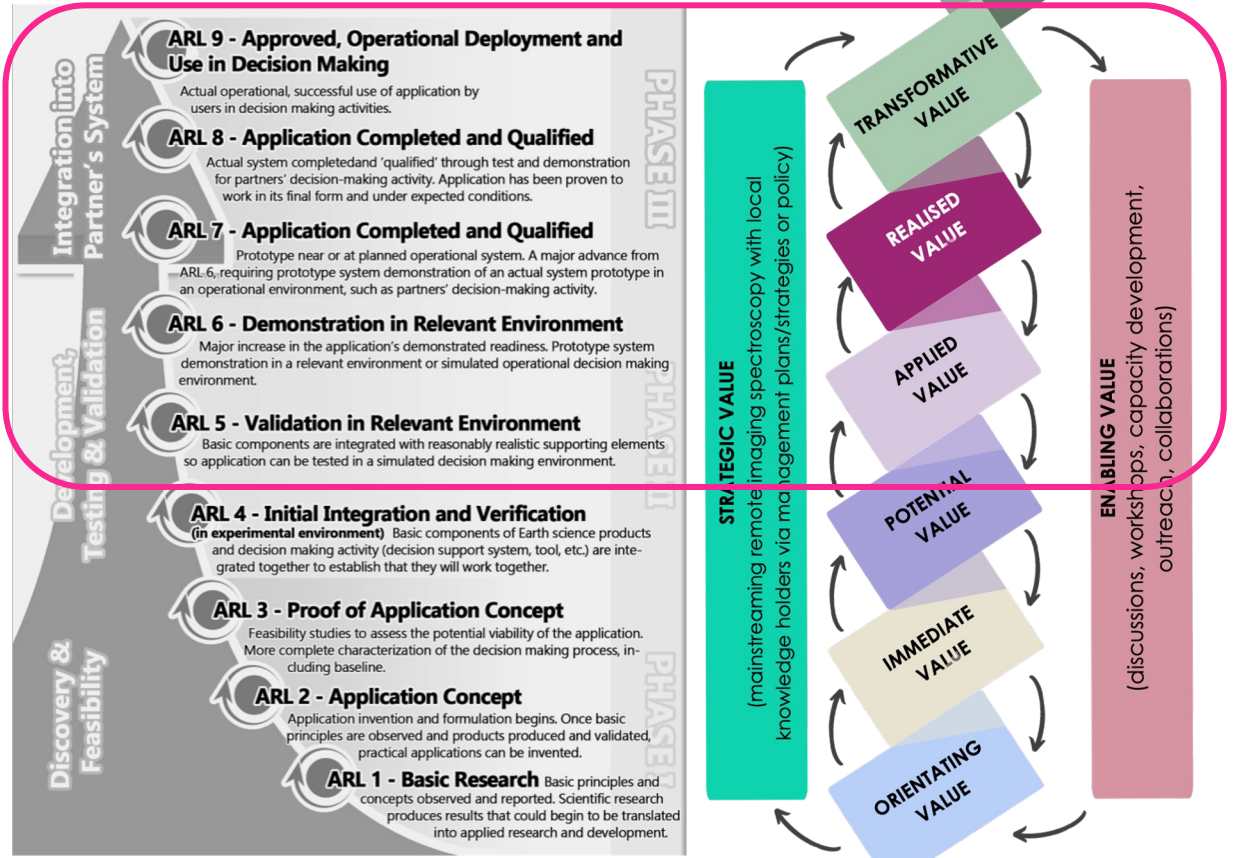
2.2. Stakeholder engagement: Value Creation Framework (VCF) session



Dedicated time to reflect on the **"value" (importance, worth, or usefulness)** of RS data in relation to their application needs. 90+min, 10 survey questions, 10 focus groups: Agriculture & Food Security, IAPs, Vegetation Monitoring & Disturbance, Land Use, Water Quality, Wetlands & Watersheds, Oceans, Climate Change, Botany & Plant Ecology, Birds & Amphibians

2.3. Stakeholder engagement: Using Value Creation Framework (VCF) to document possible BioSCape applications - **a "baseline assessment" prior to use of BioSCape data products**

Application Readiness Levels (ARLs)

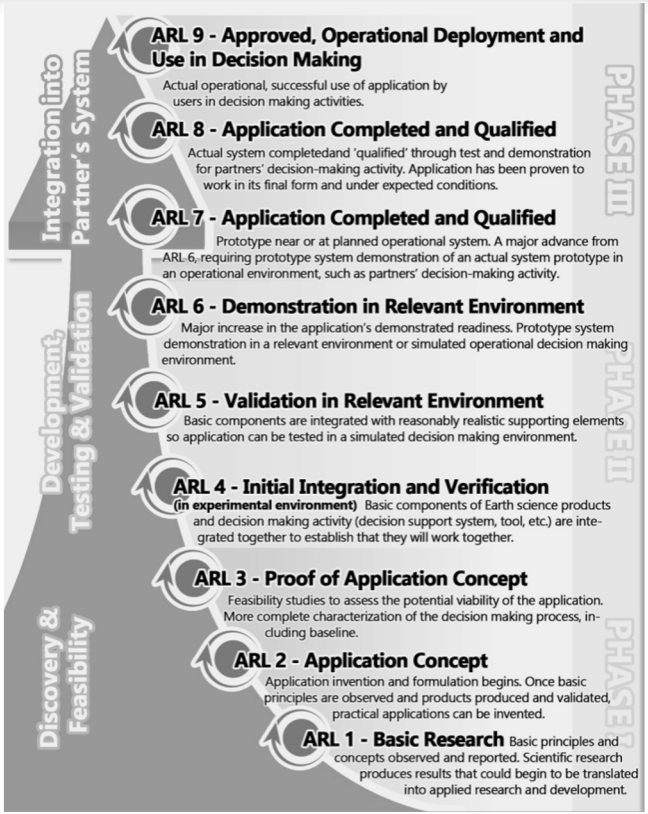


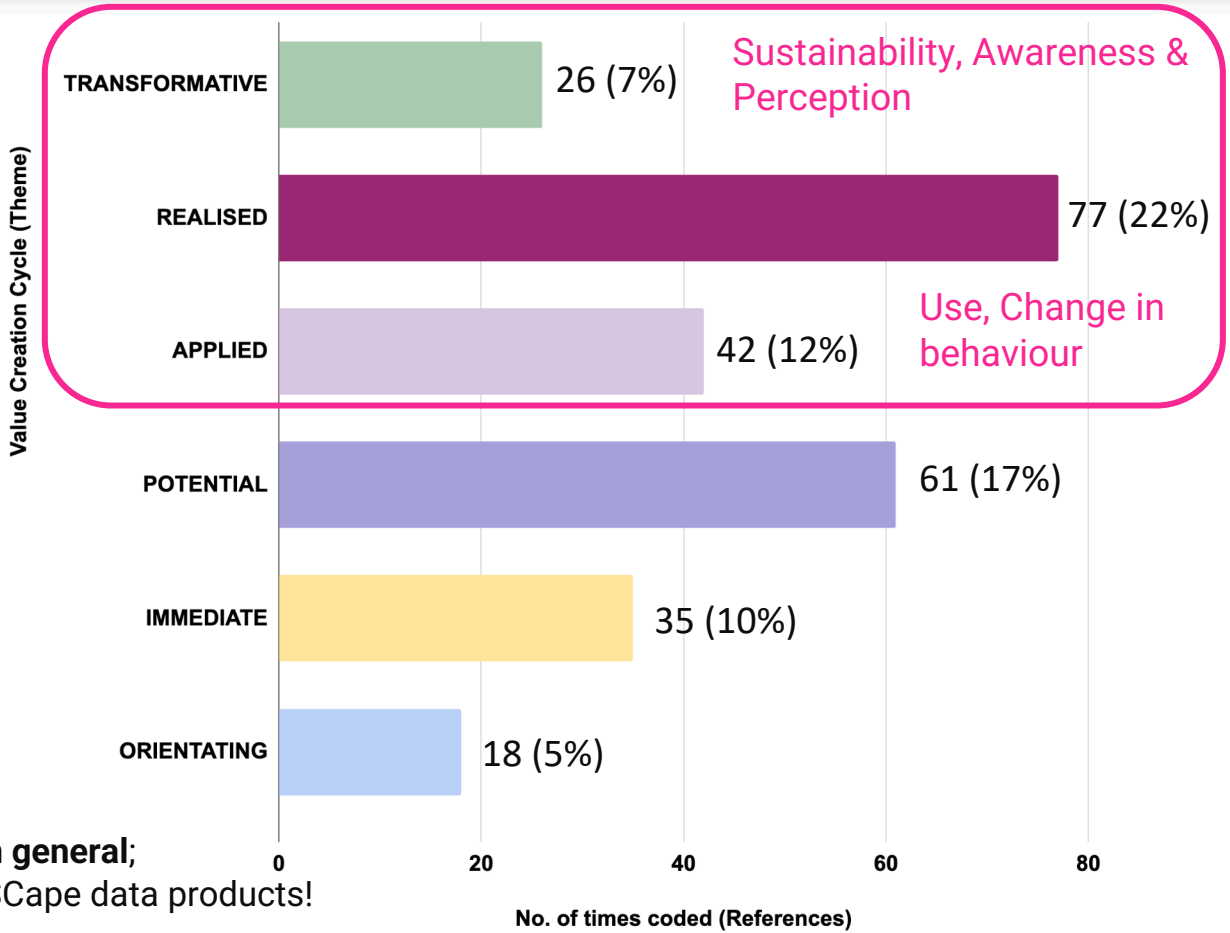
(Wenger-Trayner et al., 2019)

= **integration, operationalization and sustained use** of BioSCape applications-relevant data products.

The power of VCF =
(1) **open-ended** reflexive questions, no preconceived ideas, practitioners define what is valuable to them; (2) Map out value cycles in relation to the ARLs; identify leverage points or **"indicators of impact"** as practitioners apply RS data in decision-making.

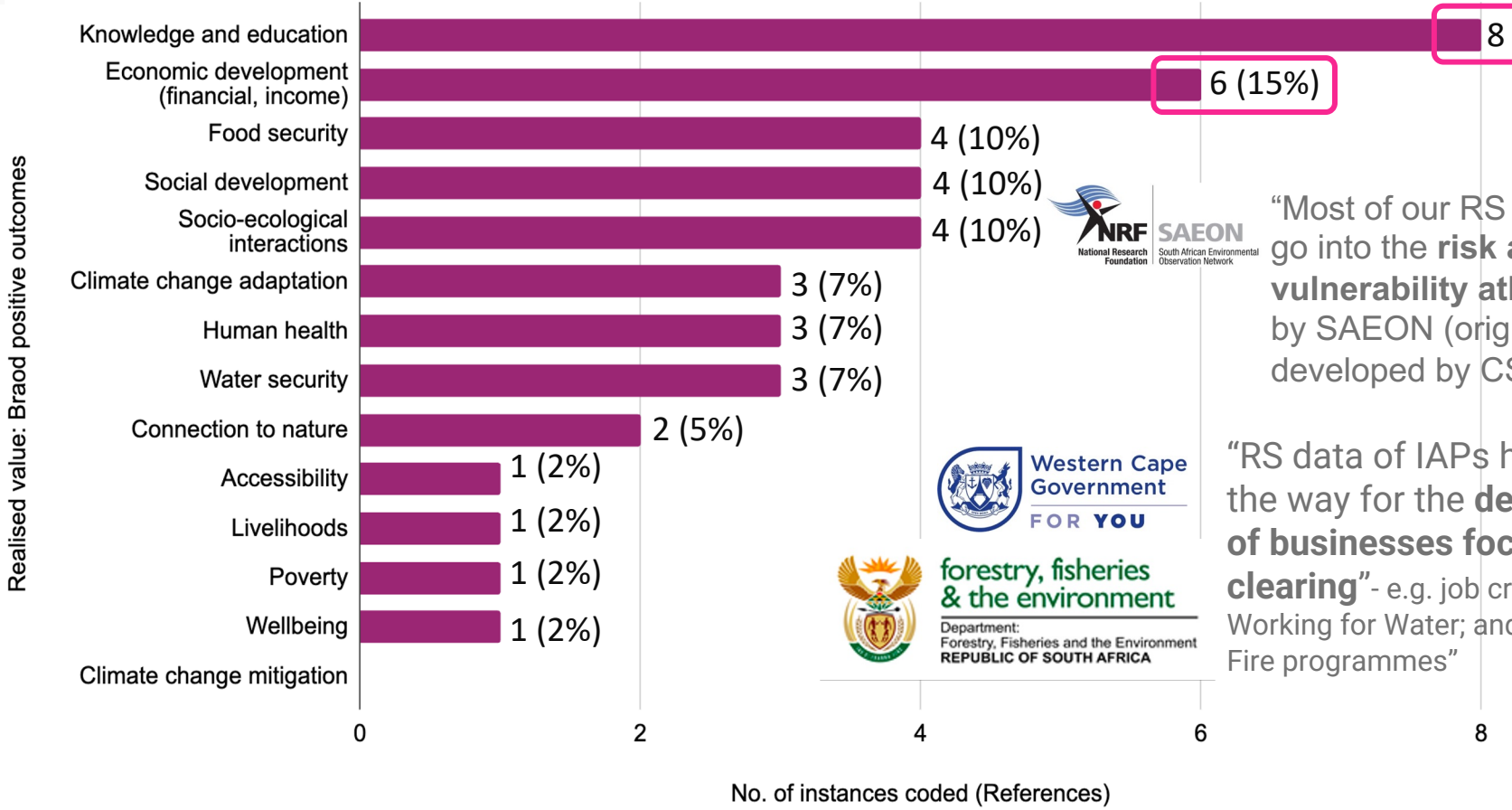
2.4. Value of RS data as perceived by SA practitioners (end-users and boundary agencies)





NOTE: VCF results on the use of **RS data in general**; **"baseline assessment"** prior to use of BioSCape data products!

2.5. Realised value: Positive outcomes of utilizing biodiversity remote sensing and GIS data



NRF National Research Foundation | SAEON South African Environmental Observation Network

"Most of our RS data will soon go into the **risk and vulnerability atlas** managed by SAEON (originally developed by CSIR)."

Western Cape Government FOR YOU

forestry, fisheries & the environment
Department: Forestry, Fisheries and the Environment
REPUBLIC OF SOUTH AFRICA

"RS data of IAPs has paved the way for the **development of businesses focused on clearing**"- e.g. job creation in Working for Water; and Working on Fire programmes"

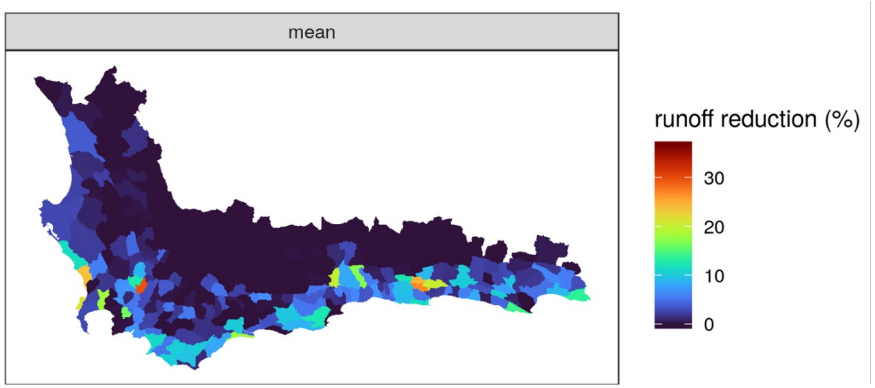
3.1. End-user needs related to (a) Invasive Alien Plants (IAPs) management

APPLICATIONS

PROBLEM

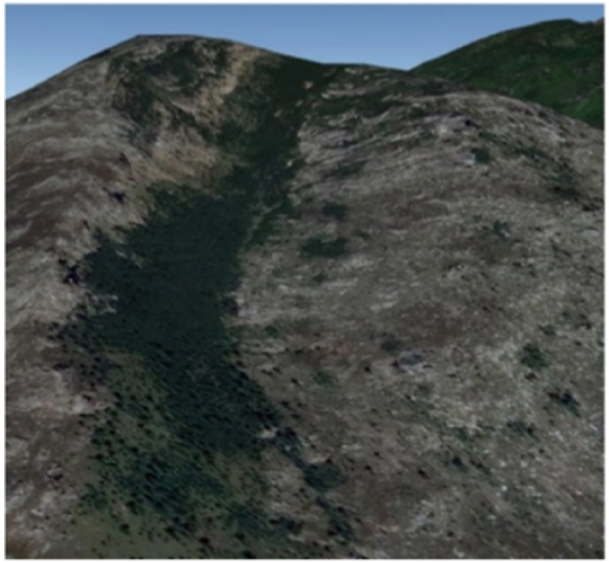
Invasive alien plants (IAPs) outcompete local flora, alter fire regimes and reduce runoff impacting on water provision, thus posing threats to biodiversity conservation and nature's contributions to people.

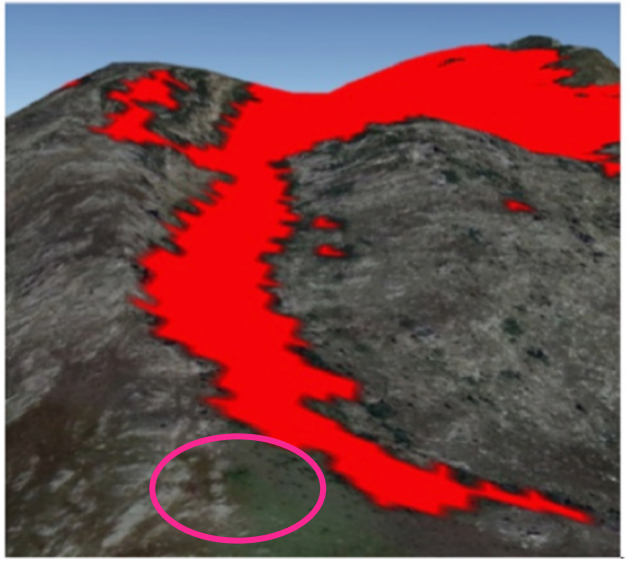
A wildfire on the Garden Route fuelled by invasive alien trees. File photo



BIOSCAPE'S VALUE-ADD: Once-off data products but a 'proof-of-concept' that helps distinguish between IAPs (genera specific, e.g. Acacia, Eucalyptus and Pinus) and detect subtle changes at a broad scale that can help manage cleared sites from reverting to their original state or worsen without follow-up clearing and restoration.

See Adler et al. project + Alien Tree Mapping WG (representatives from six BioSCape PI-led projects)





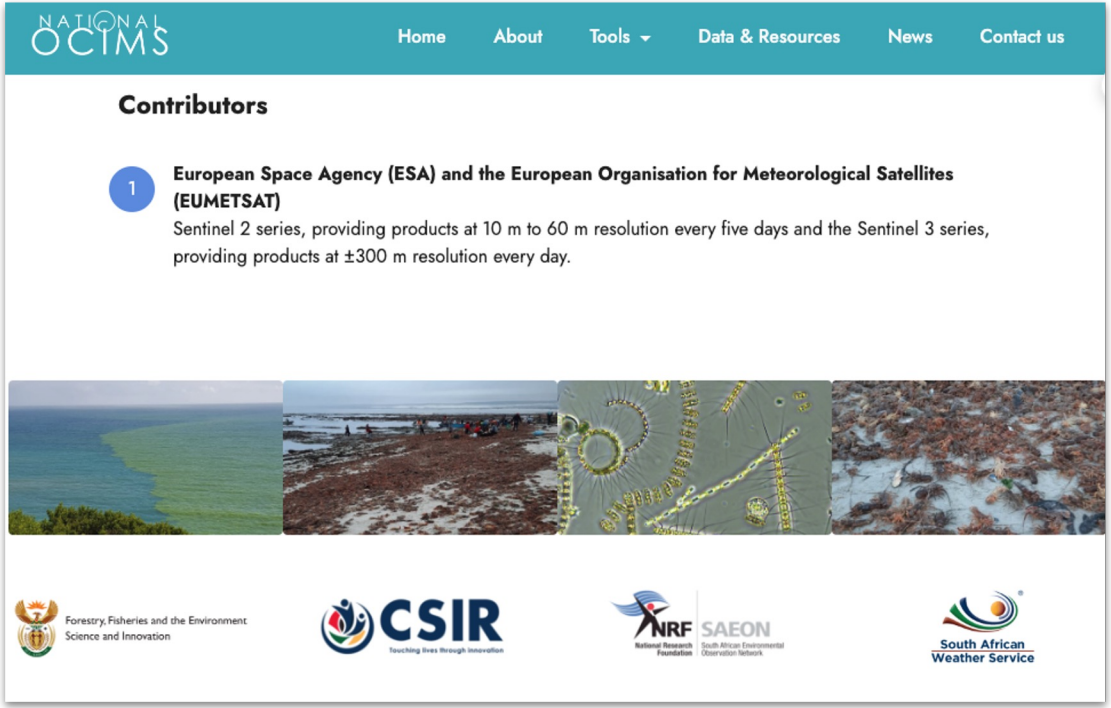
Current state of play: Land cover classification at 10m (Sentinel data)
from Holden, Rebelo et al. 2021. *RSASE* https://doi.org/10.1016/j.rsase.2020.100448.

What about the scattered pines?

3.2. End-user needs related to (b) Water Quality monitoring for improving risk assessments

APPLICATIONS PROBLEM

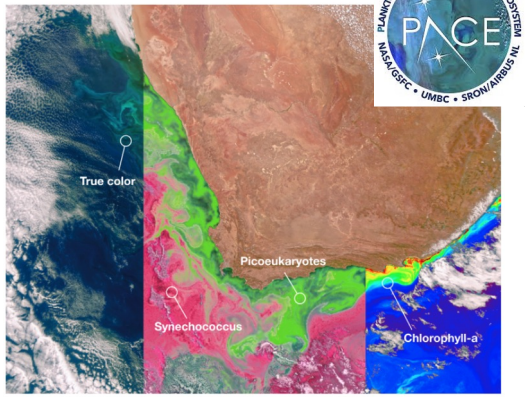
Nutrient enrichment of both inland freshwater dams and marine ecosystems trigger algal blooms, killing aquatic biodiversity and affecting amenity value (drinking water, irrigation water for agriculture and fisheries, and shellfish industries).



National Oceans and Coastal Information Management System (OCIMS) project

BIOSCAPE'S VALUE-ADD: More bio-optical data with improved algorithms + DWS in-situ database = **more accurate maps** (chl a concentration, "good" vs "bad" phytoplankton, rainfall, temperature, seasonal trends, and turbidity) **to develop a eutrophication index** (e.g. Theewaterskloof Dam)**.** Generally assist with scaling up (e.g. EMIT and PACE), repeatable monitoring inform an **early warning system** to help end-users. ***See Guild et al. (freshwater) + Wu et al. (marine) projects.***

NASA's PACE Data on Ocean, Atmosphere, Climate Now Available

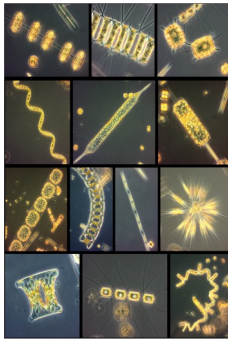


13% capacity - CT's 2018 "Day Zero" water crisis

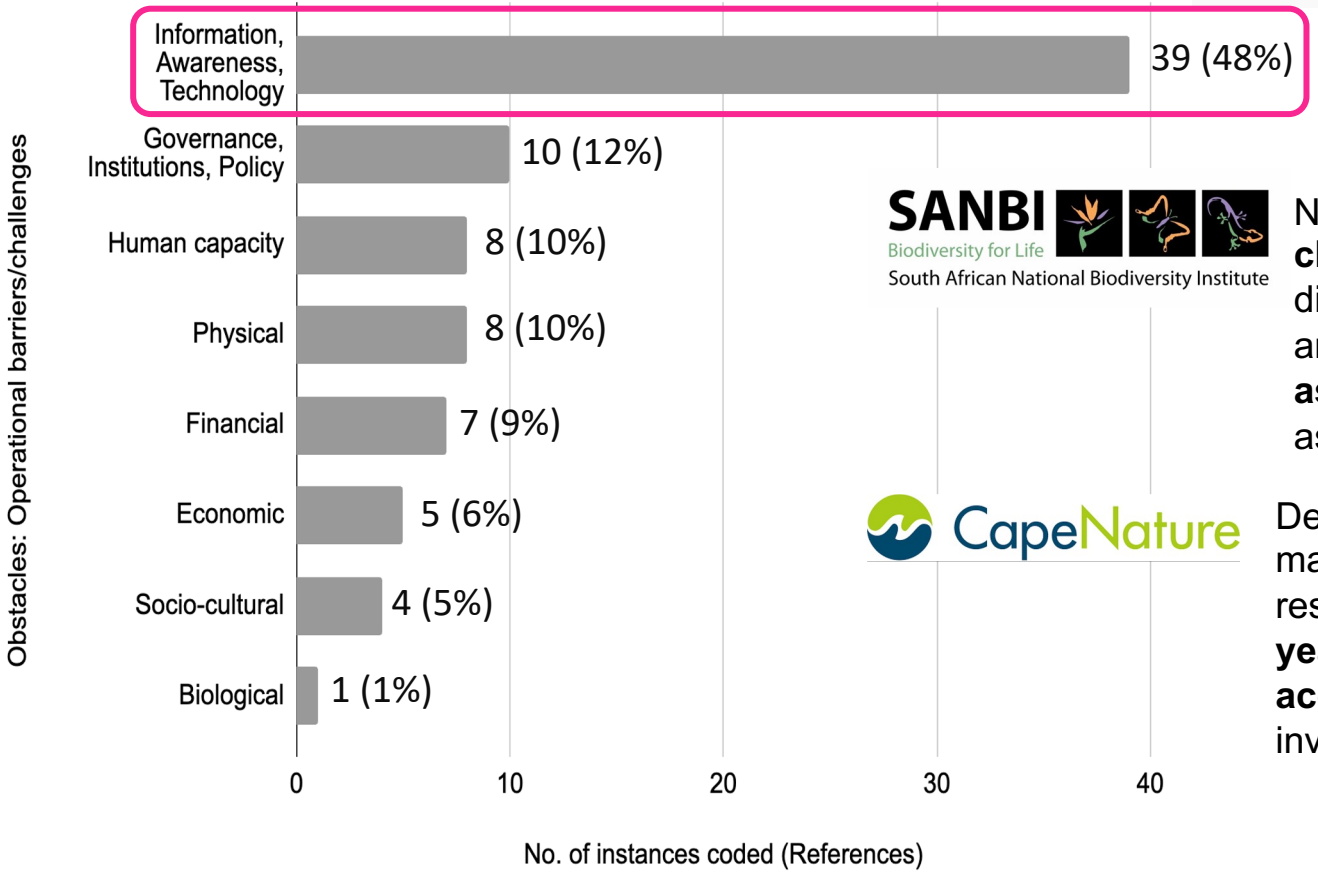
water & sanitation
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

BioSCape deployed first hyperspectral radiometric buoy in Africa.

EMIT



3.3. Obstacles: Operationalizing RS data sustainably is difficult; need to make sure it is not only a one-time product for a specific application



SANBI
Biodiversity for Life
South African National Biodiversity Institute

National mandated **monitoring channels** for vegetation, distribution, and ecosystem trends are **not meeting end-user assessment goals** due to poor assessment of change.

CapeNature

Despite implementing a method for mapping IAPs since 2010, the resulting data is **only gridded on a yearly basis**, making it **difficult to accurately assess changes** in invasive species over time.

4.1. Concluding remarks: SA end-user “readiness” for increased impact

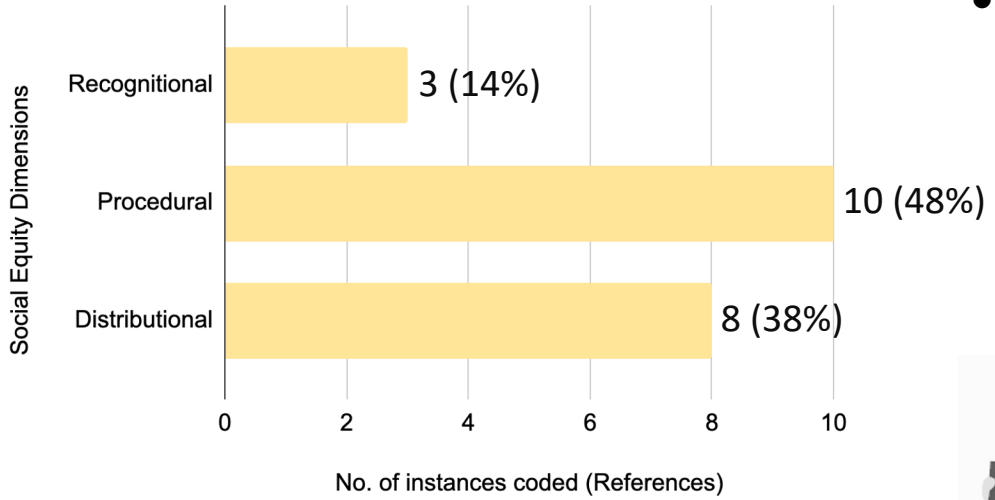
BIOSCAPE’S VALUE-ADD:

High resolution maps of IAPs and water quality parameters that add to efforts in developing a strategic **spatially explicit, web-based, accessible information** management system for the strategic water source areas (SWSAs) of the Western Cape Water Supply System - i.e. **Boland-Groot Winterhoek SWSA Collective**.

WWF | Western Cape Government FOR YOU

4.2. Concluding remarks: SA end-user “readiness” for increased impact

We cannot have BioSCape Applications without diversity, equity & inclusion!



- **Awareness-raising**
  - Western Cape Government’s ‘BioSCape Applications Showcase’ for government officials (date TBC). **DEA&DP’s GIS viewer with BioSCape portal** (biodiversity spatial plan, riparian & water quality maps, etc.)
- **Capacity development**
  - CSIR’s ‘Earth Observation in support of Water Monitoring Training and Capacity Building Course’ for DWS government officials (25-26 June 2024)
  - ARSET and ORNL DAAC’s workshop for end-users and SA researchers (7-11 Oct 2024)

Western Cape Government FOR YOU

water & sanitation
Department: Water and Sanitation
REPUBLIC OF SOUTH AFRICA

CSIR
Touching lives through innovation

APPLIED REMOTE SENSING TRAINING PROGRAM
TRAIN - EMPOWER - ADVANCE

ORNL DAAC

Transition to BioSCape project talks