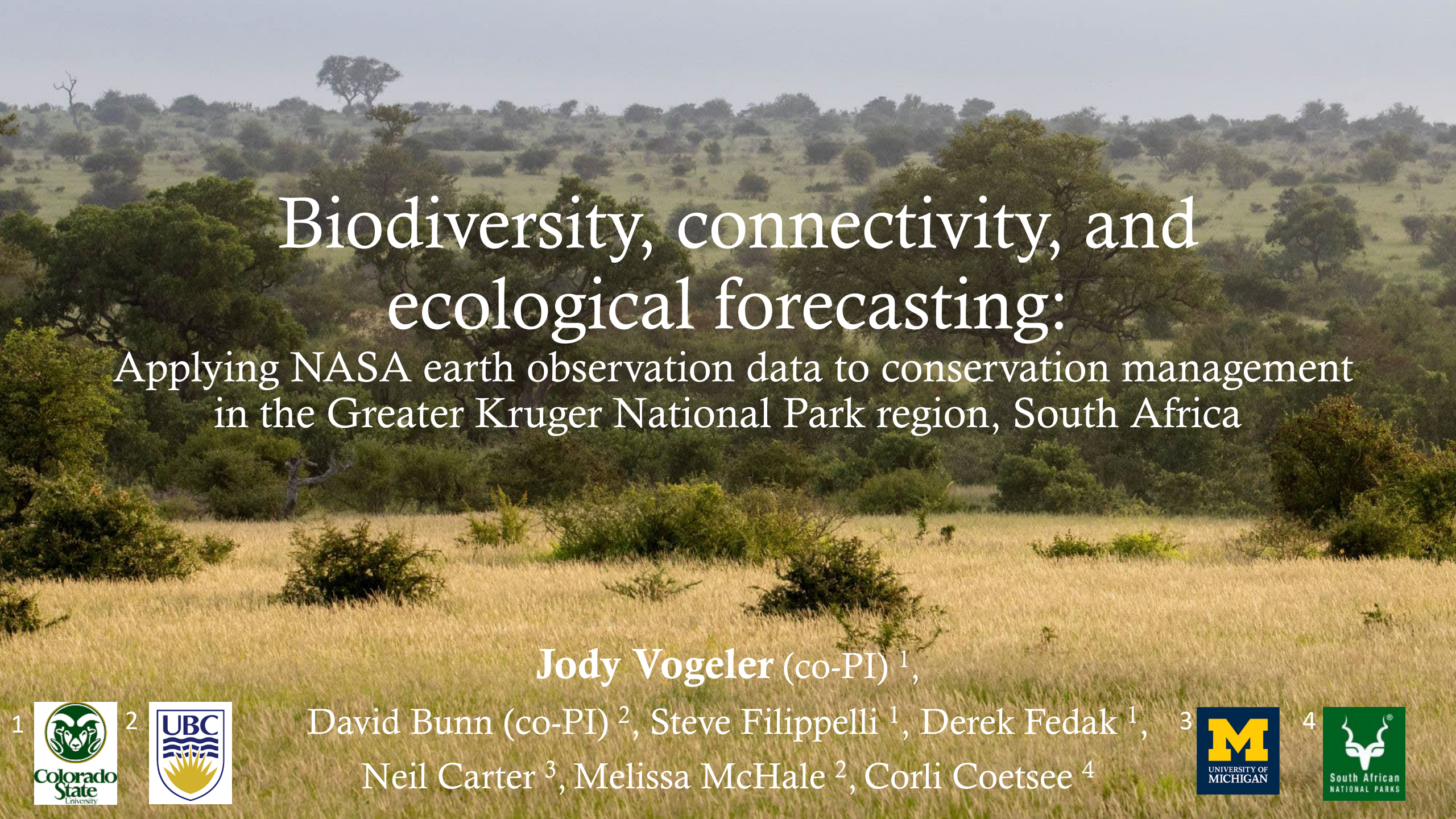


Biodiversity, connectivity, and ecological forecasting:

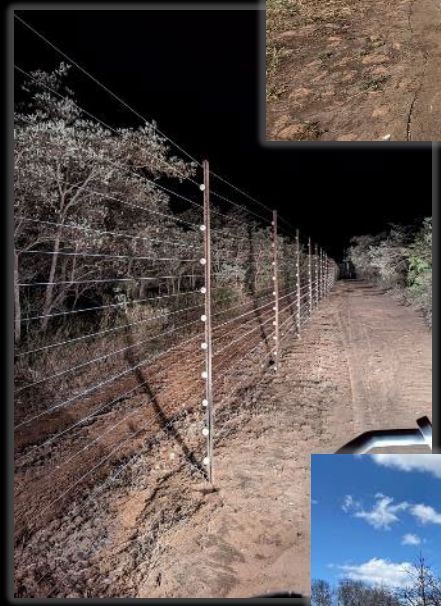
Applying NASA earth observation data to conservation management in the Greater Kruger National Park region, South Africa

Jody Vogeler (co-PI) [1],

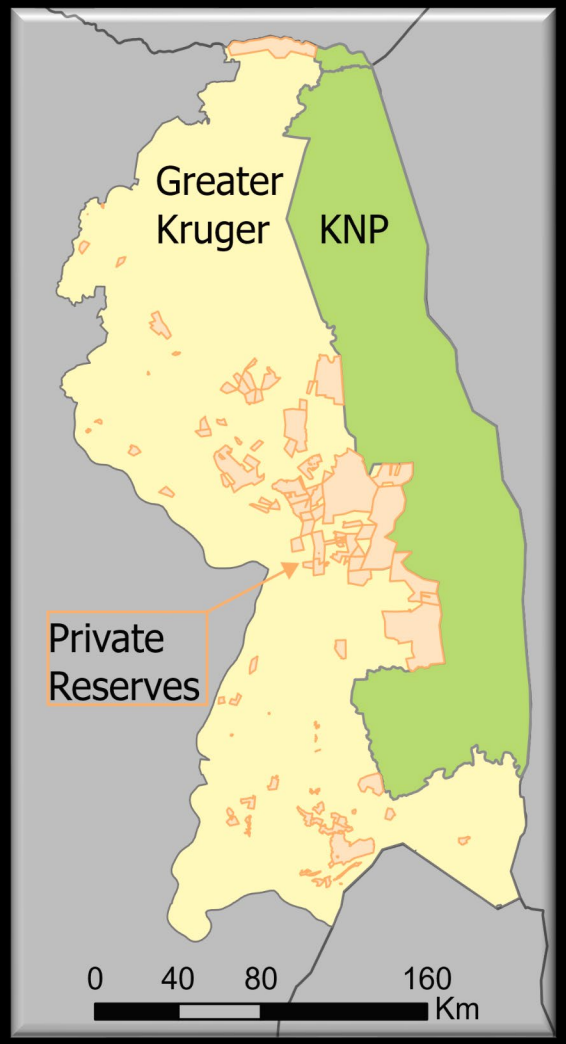
David Bunn (co-PI) [2], Steve Filippelli [1], Derek Fedak [1], Neil Carter [3], Melissa McHale [2], Corli Coetsee [4]

1 Colorado State University 2 UBC 3 University of Michigan 4 South African National Parks

Conservation Planning across the Greater Kruger National Park Region



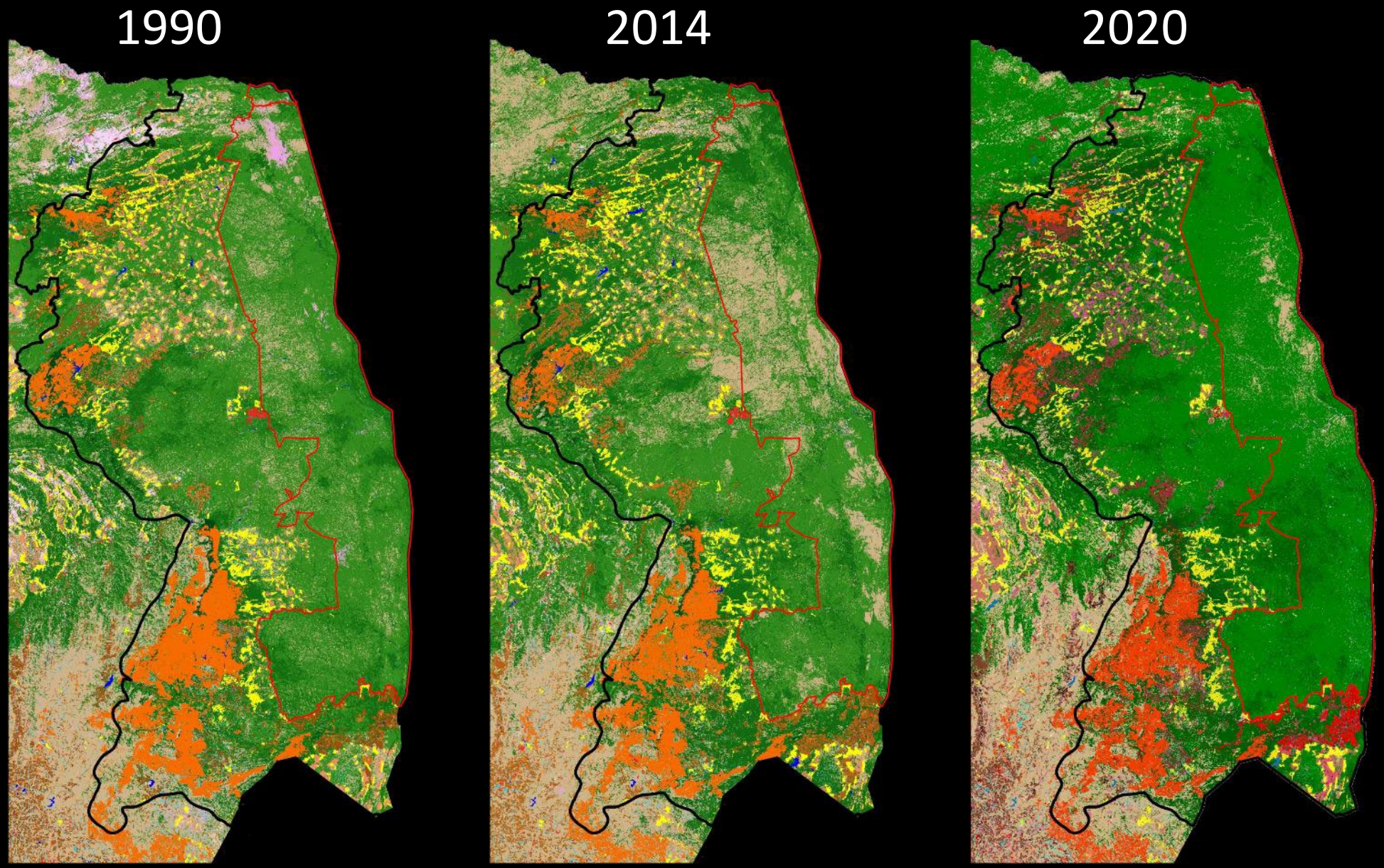
Rewilding & Adaptive Management Strategies

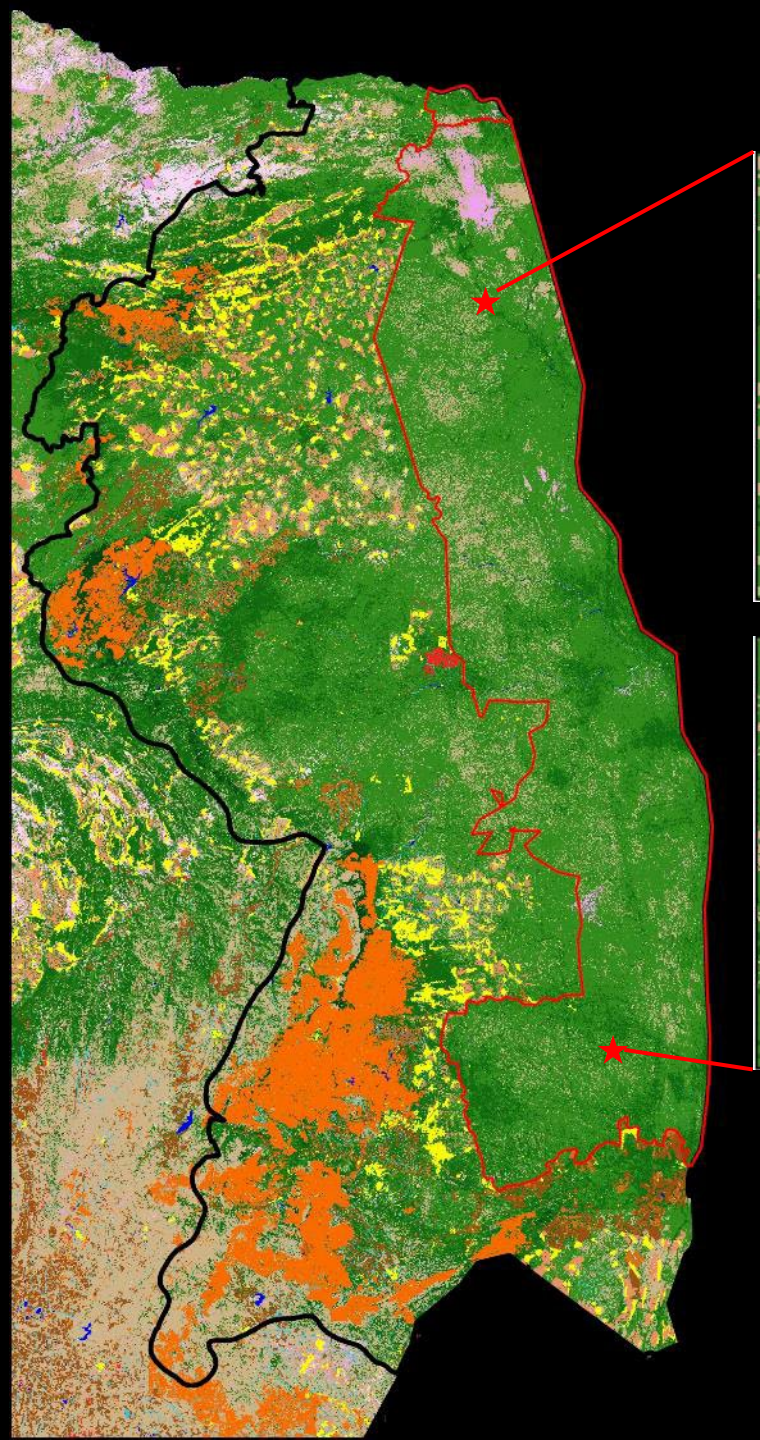


Patterns & drivers of tree mortality

Increasing urbanization pressures along protected area borders

South Africa Land Cover Land Use Mapping Program

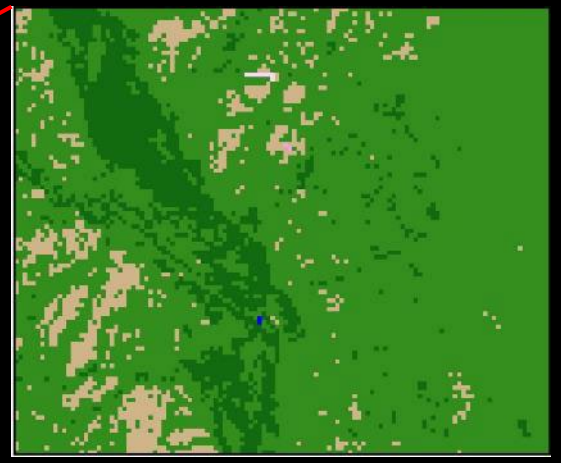


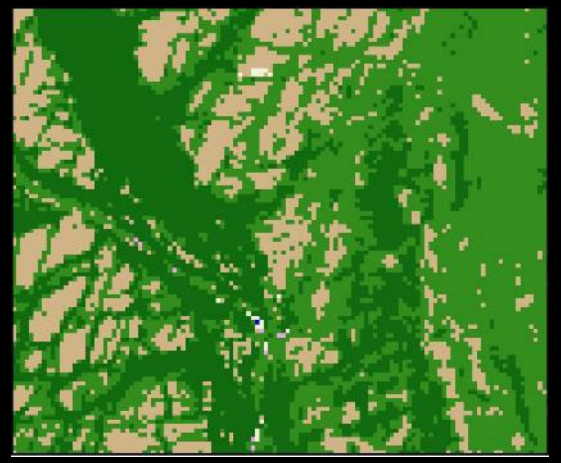


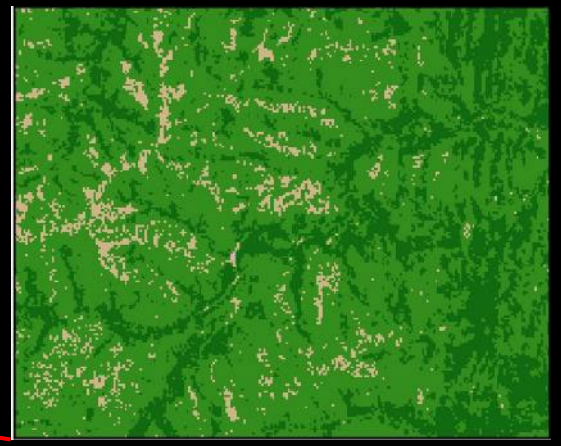
1990

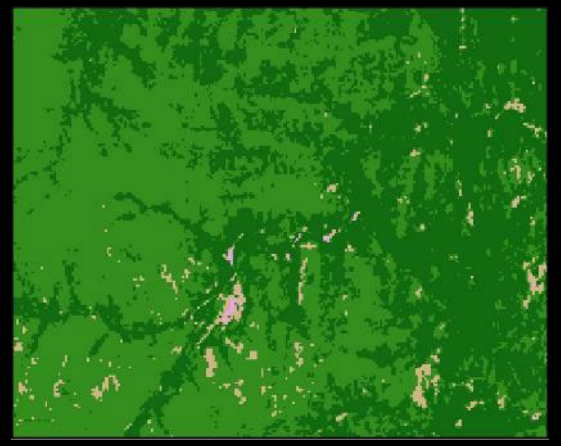
2014

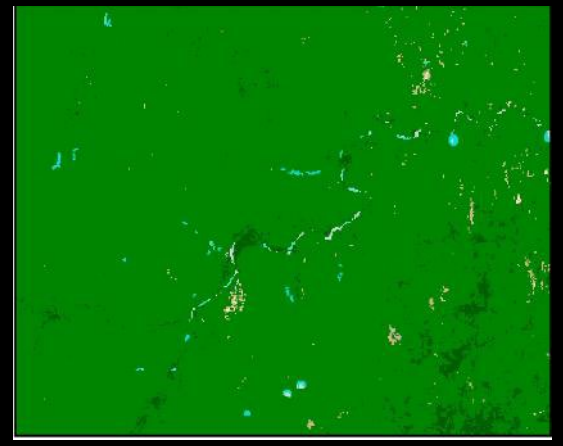
2020











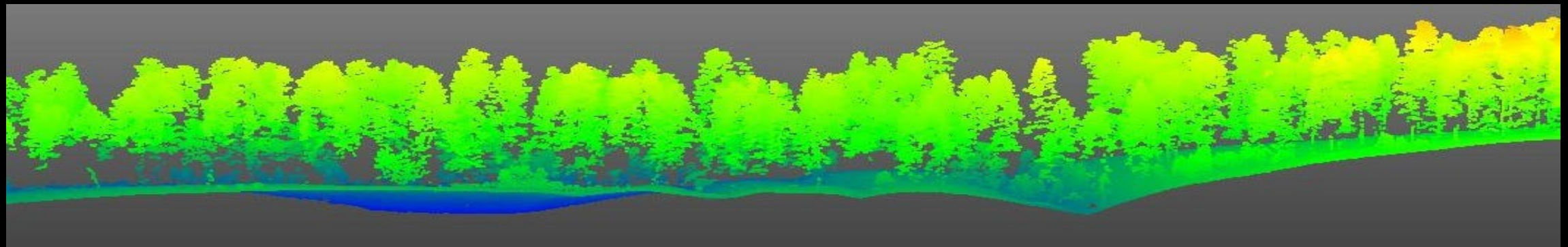
Trading vegetation detail for spatial and temporal extents

Inset Legend

- Thicket /Dense bush
- Woodlan/Open bush
- Low shrubland
- Grasslands
- Waterbodies
- Wetlands

Active Remote Sensing of GKNP Savannas

- Previous lidar and SAR based studies in region show the value of these data for characterizing savanna structures
- BUT all limited in spatial and temporal extents based on strips of lidar data (which are also not publicly available for most part),
- OR scaled up to park or reserve extents with SAR data, but not region, and calibrated on the spatially limited lidar strips




Our Project Goal:
How can we continue to advance spatial tools for conservation planning across GKNP?

Remote Sensing for Informing GKNP Conservation

End-User Engagement

Identify Critical Data Gaps for Planning/Monitoring Programs

Consider Available Remote Sensing Data to Meet Needs

Uncertainty Assessments

Consider Data/Tool Accessibility

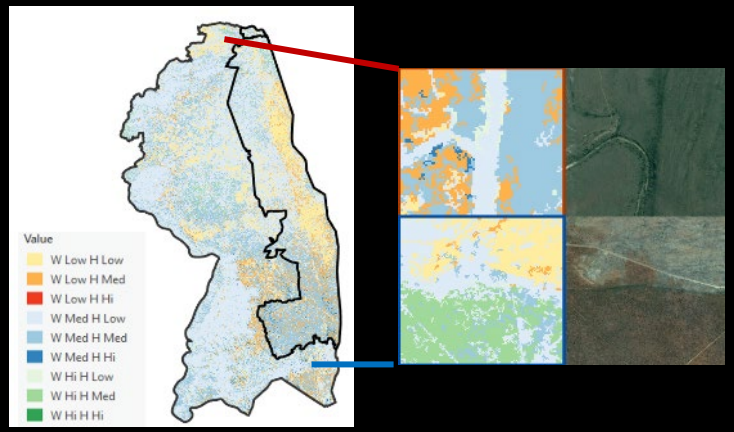
Training and Hand-Off Support for End-User Integration

Project Goals & Outputs

Vegetation Structure & Change Products

Woody Vegetation Structure

Herbaceous Biomass & Patch Classes



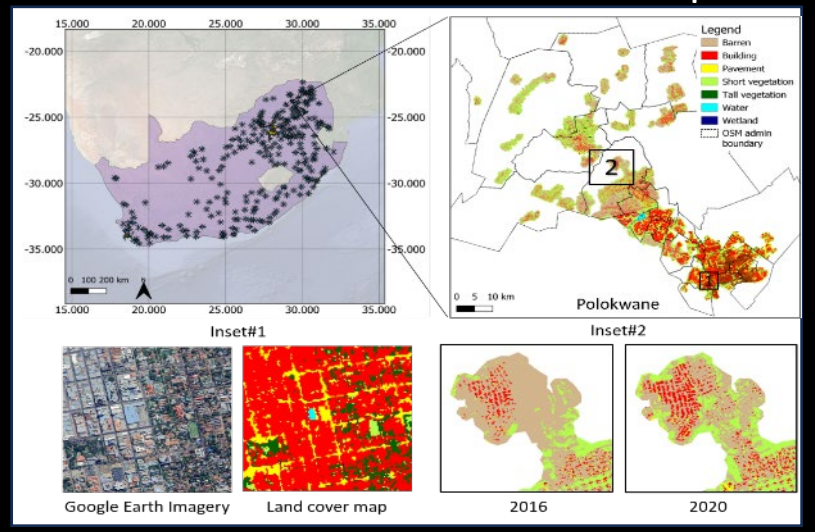
Project Goals & Outputs

Vegetation Structure & Change Products

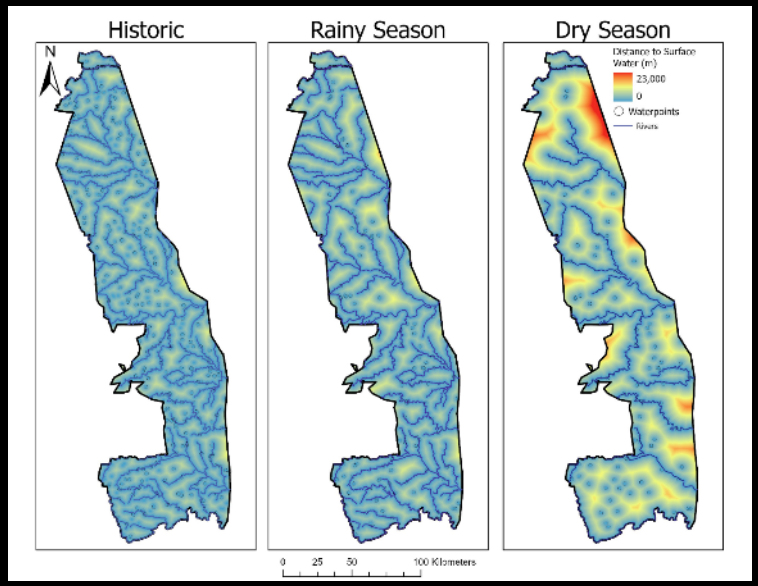
Project Goals & Outputs

Additional Landscape Pattern Products

Urbanization Patterns & Landscapes



Updated Waterhole Distributions & Status Information



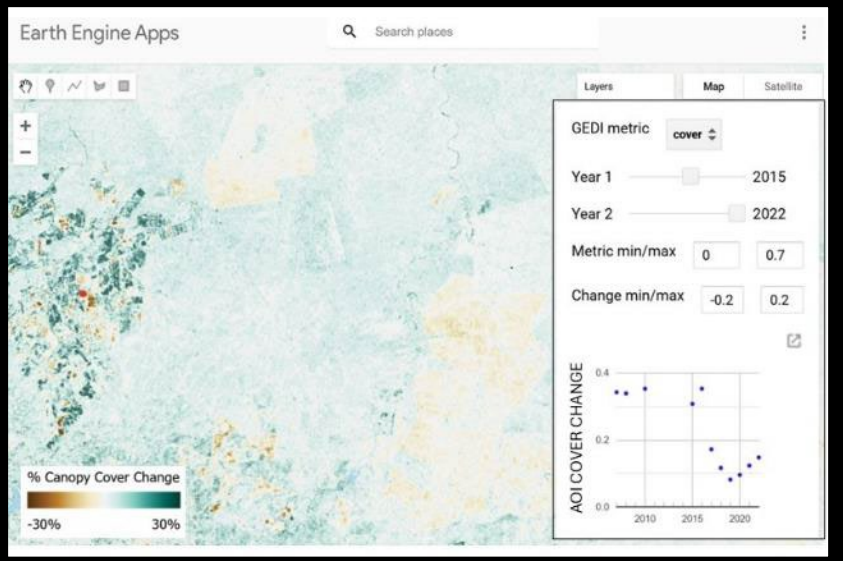
Vegetation Structure & Change Products

Monitoring & Conservation Planning Tools

Project Goals & Outputs

Additional Landscape Pattern Products

Cloud-based tools,
Educational Resources, Tutorials

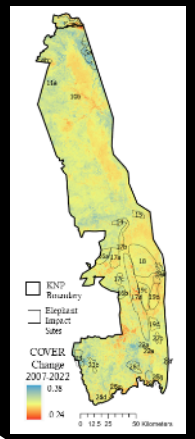


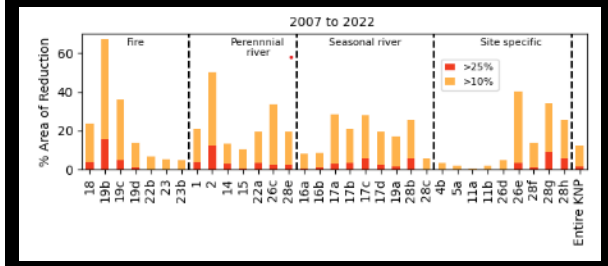
Vegetation Structure & Change Products

Monitoring & Conservation Planning Tools

Project Goals & Outputs

End-User Defined Monitoring & Analyses

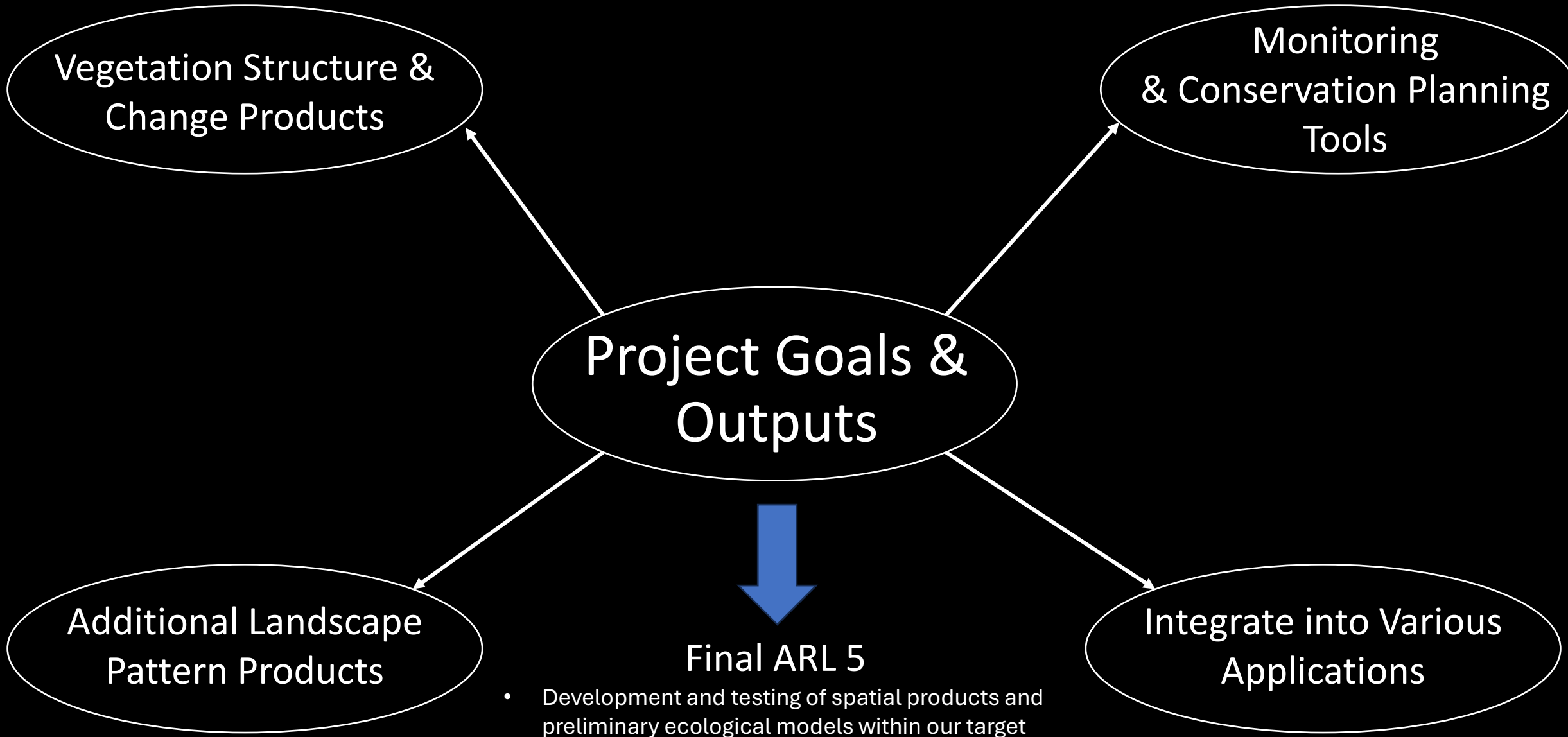




Additional Landscape Pattern Products

Wildlife Occupancy & Connectivity

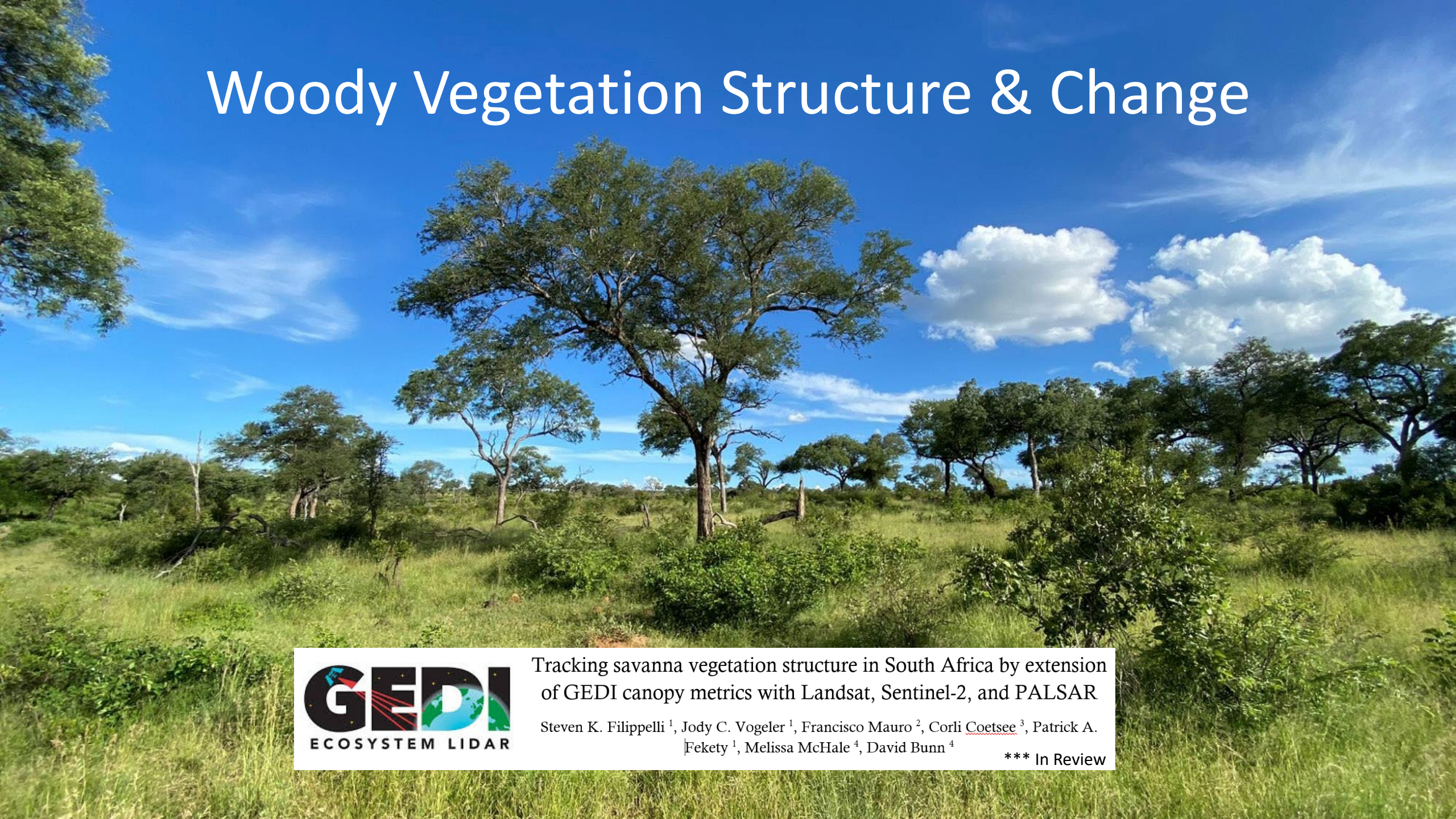
Integrate into Various Applications



Final ARL 5

- Development and testing of spatial products and preliminary ecological models within our target environment.
- Initial integration into monitoring activities by our partners and decision-making frameworks to establish the value within end-user partner programs.

Woody Vegetation Structure & Change



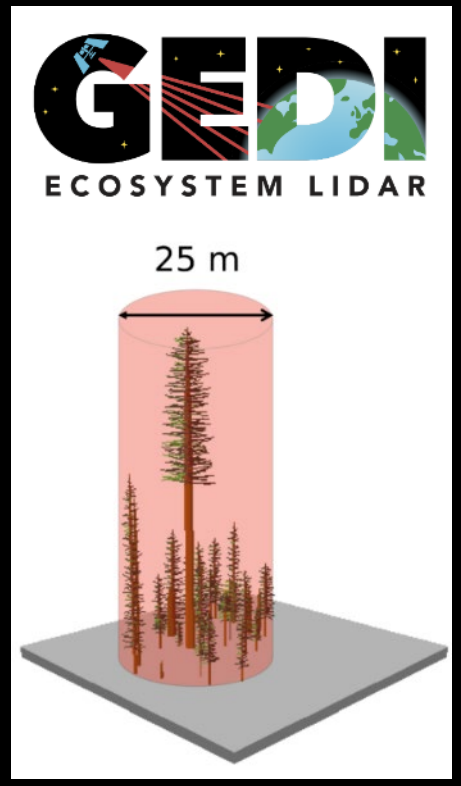
GEDI ECOSYSTEM LIDAR

Tracking savanna vegetation structure in South Africa by extension of GEDI canopy metrics with Landsat, Sentinel-2, and PALSAR

Steven K. Filippelli [1], Jody C. Vogeler [1], Francisco Mauro [2], Corli Coetsee [3], Patrick A. Fekety [1], Melissa McHale [4], David Bunn [4]

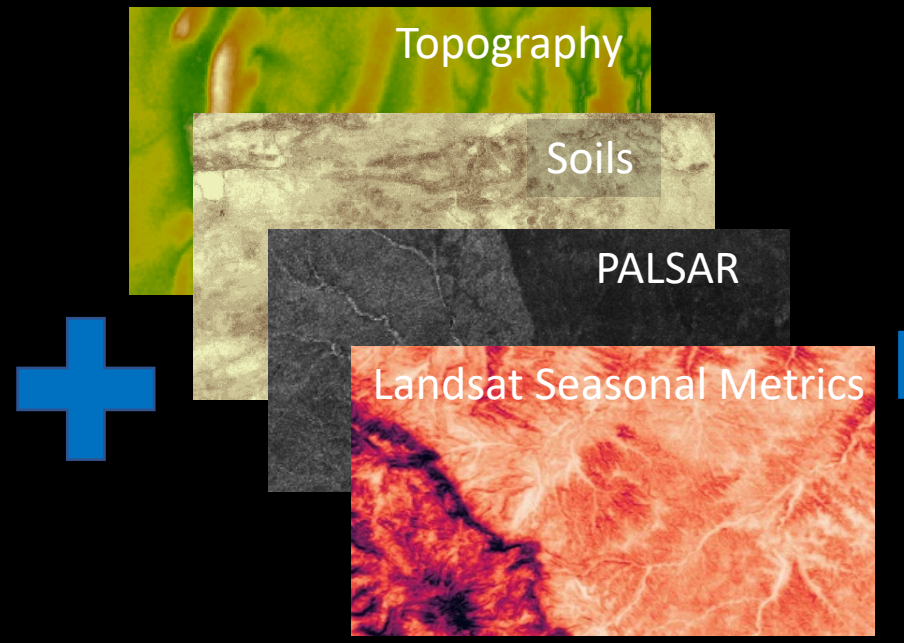
*** In Review

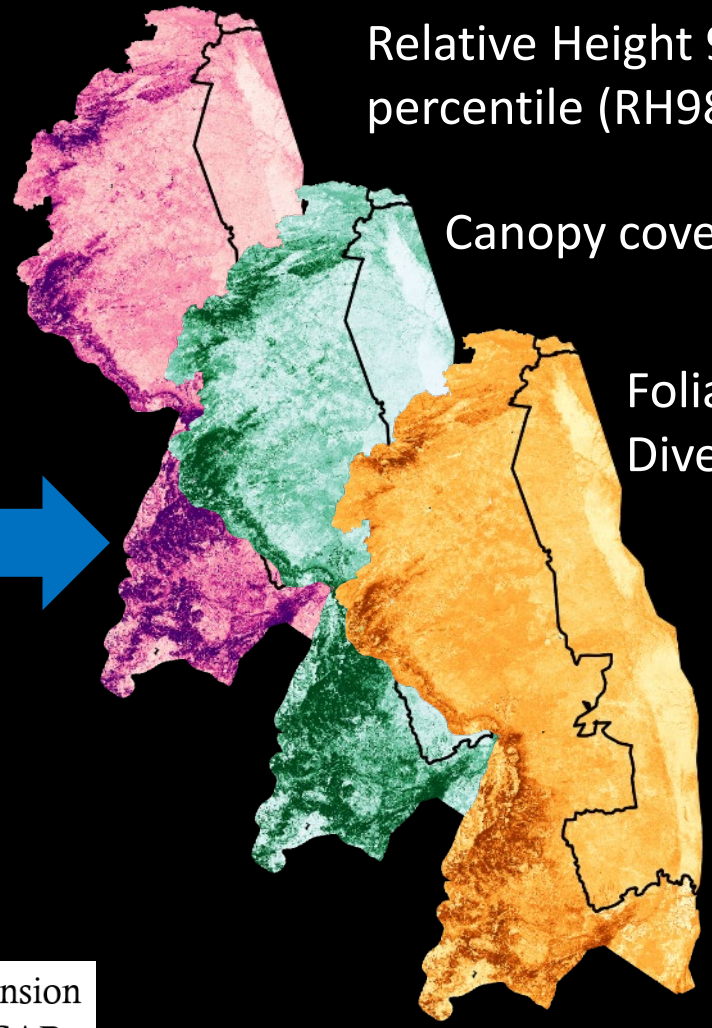
Random Forest Modeling Framework



High Quality Leaf-on Footprints Only

Sample sampling of footprints





Relative Height 98th percentile (RH98)

Canopy cover (COVER)

Foliage Height Diversity (FHD)

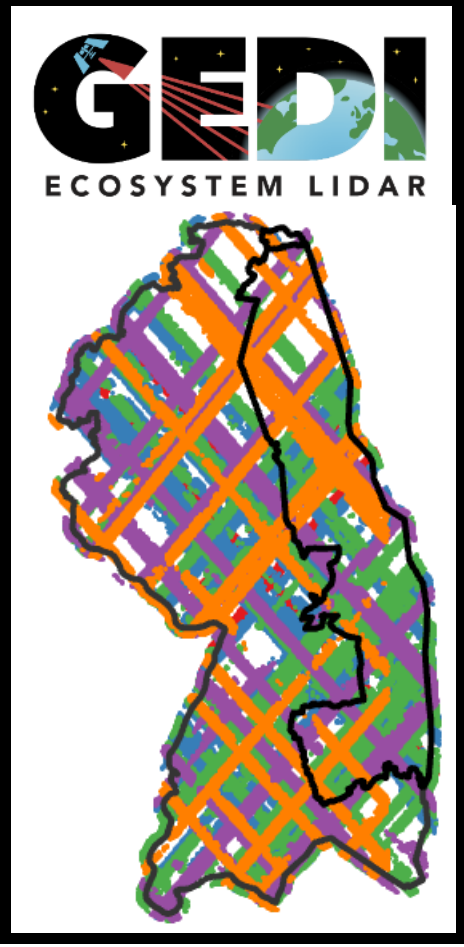
30 m resolutions

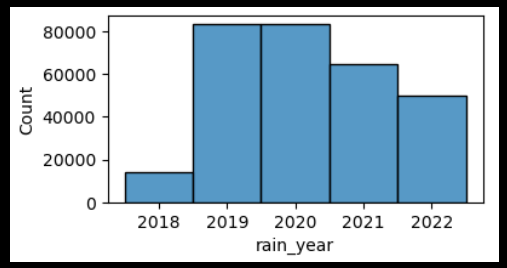
Tracking savanna vegetation structure in South Africa by extension of GEDI canopy metrics with Landsat, Sentinel-2, and PALSAR

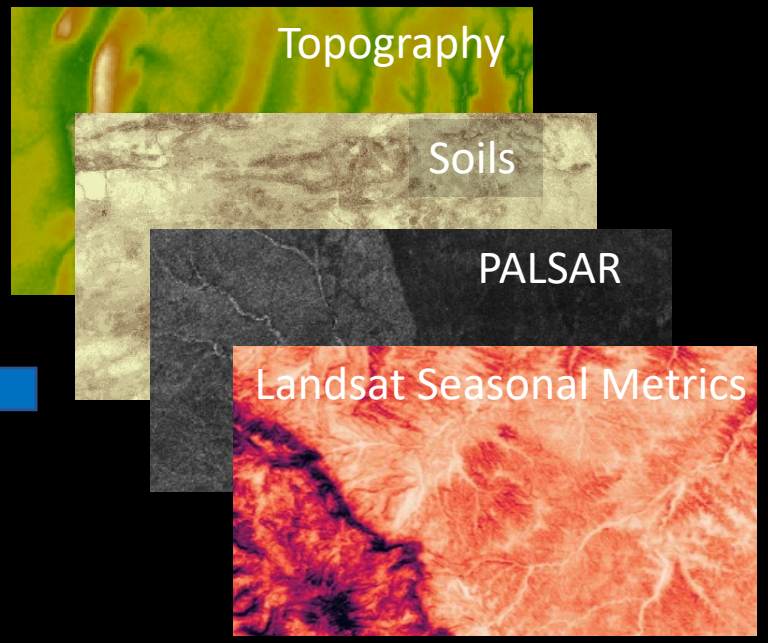
Steven K. Filippelli [1], Jody C. Vogeler [1], Francisco Mauro [2], Corli Coetsee [3], Patrick A. Fekety [1], Melissa McHale [4], David Bunn [4]

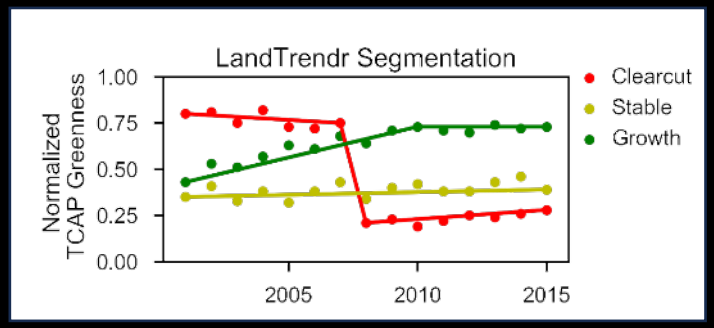
*** In Review

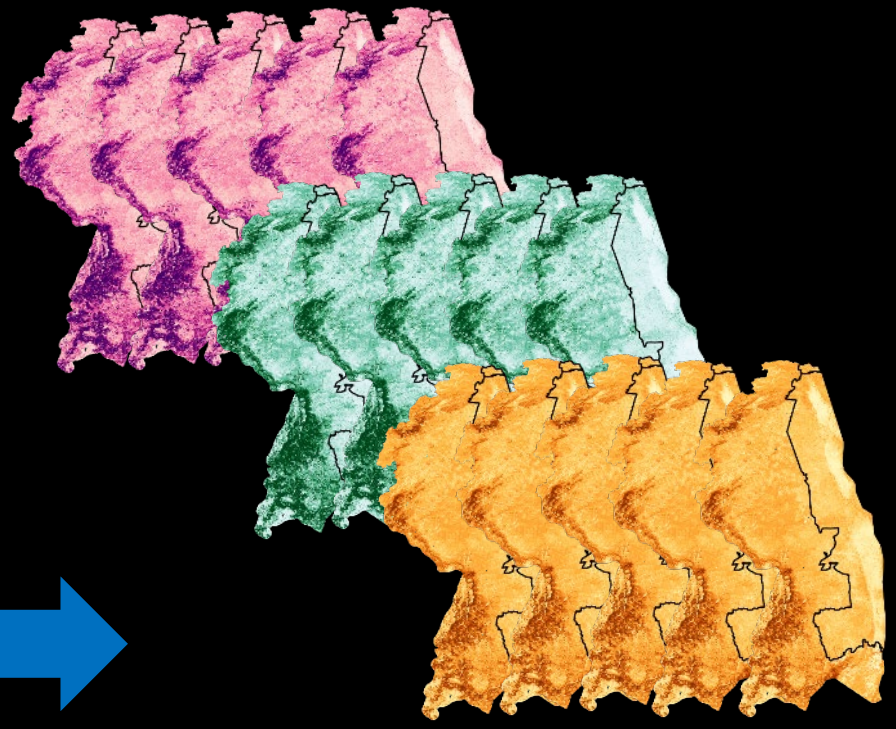
Random Forest Modeling Framework





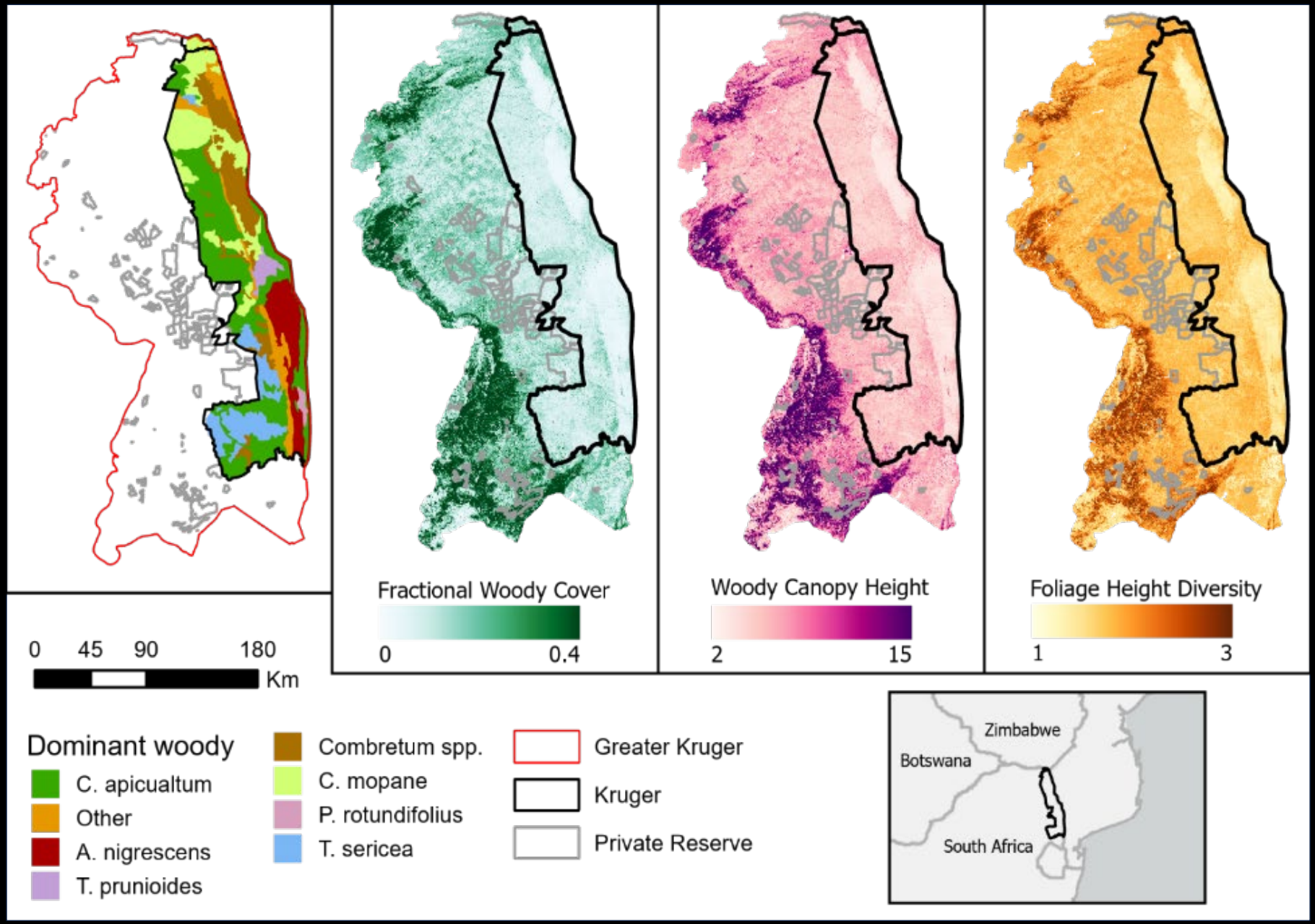


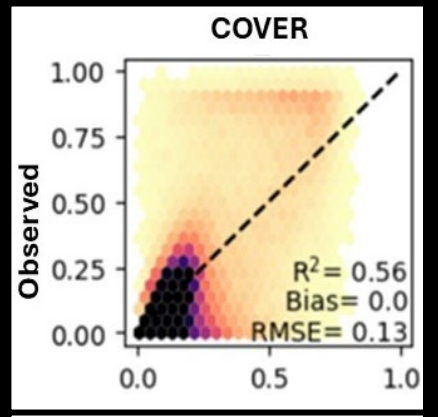


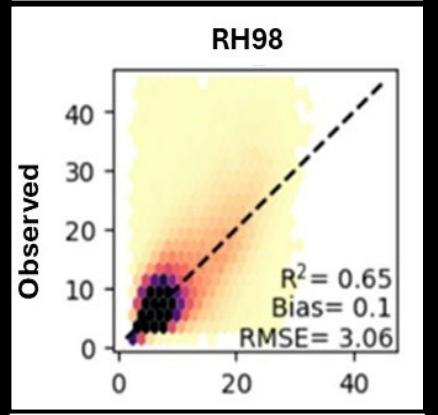


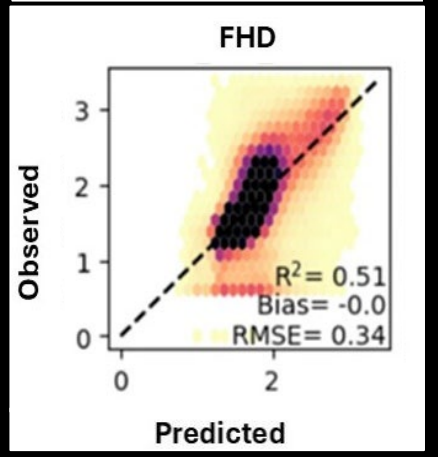
2007-2010, 2015-present

Annual structure map products to support monitoring change & better match timing of field-data collections through time

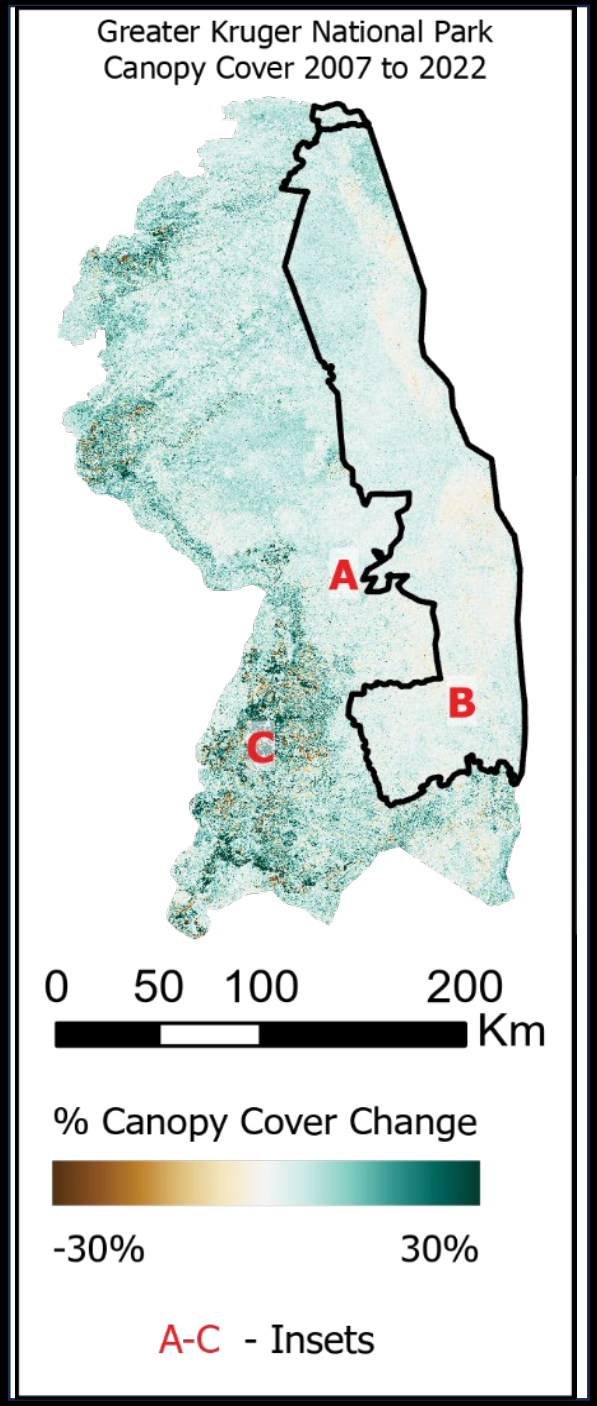


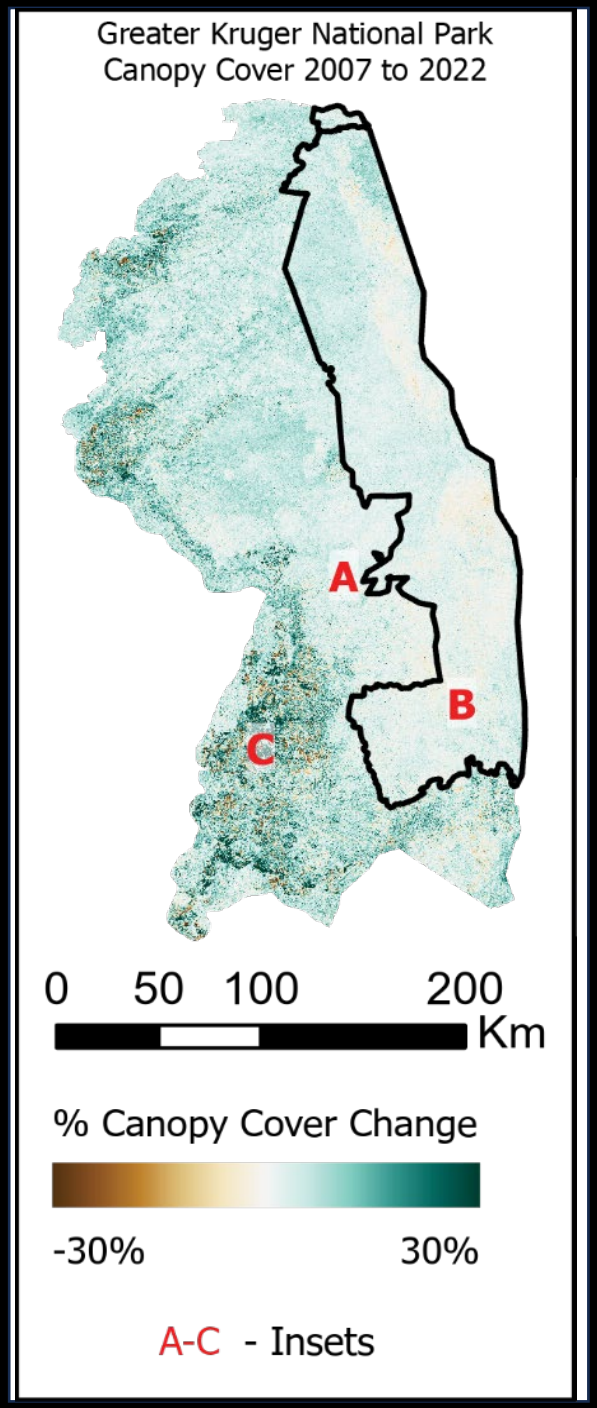




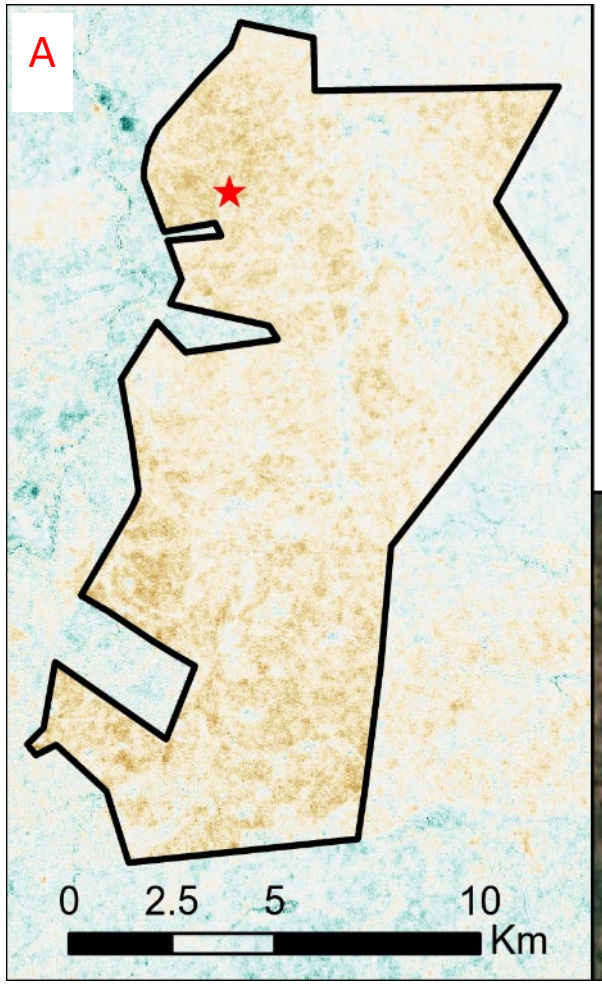


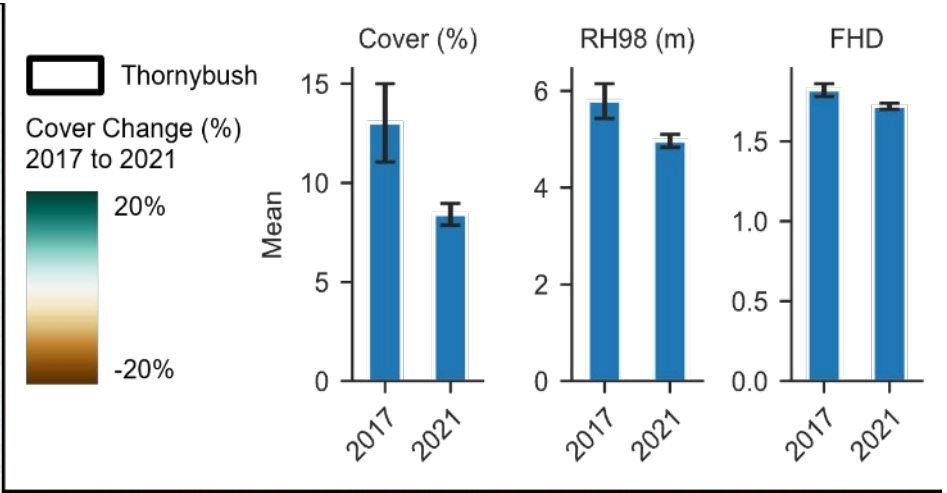
*** Publication currently in Review (and data pre-print on ORNL DAAC)

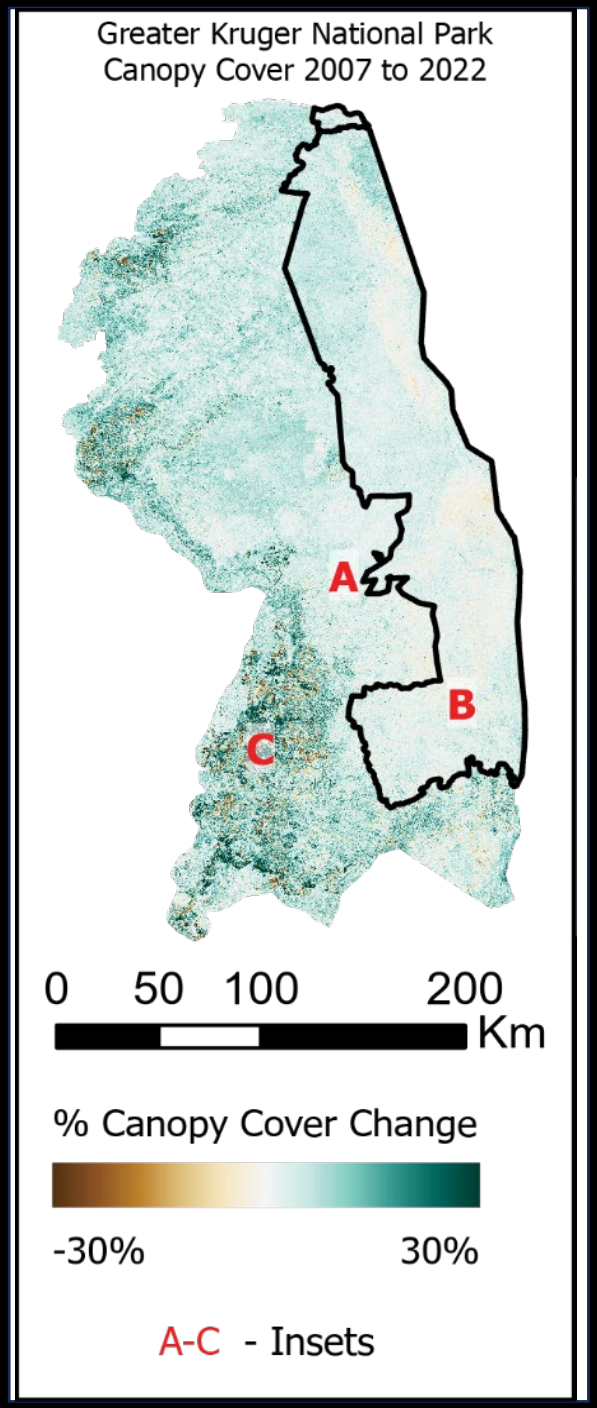

Greater Kruger National Park
Canopy Cover 2007 to 2022
A
B
C
0 50 100 200
Km
% Canopy Cover Change
-30%
30%
A-C - Insets



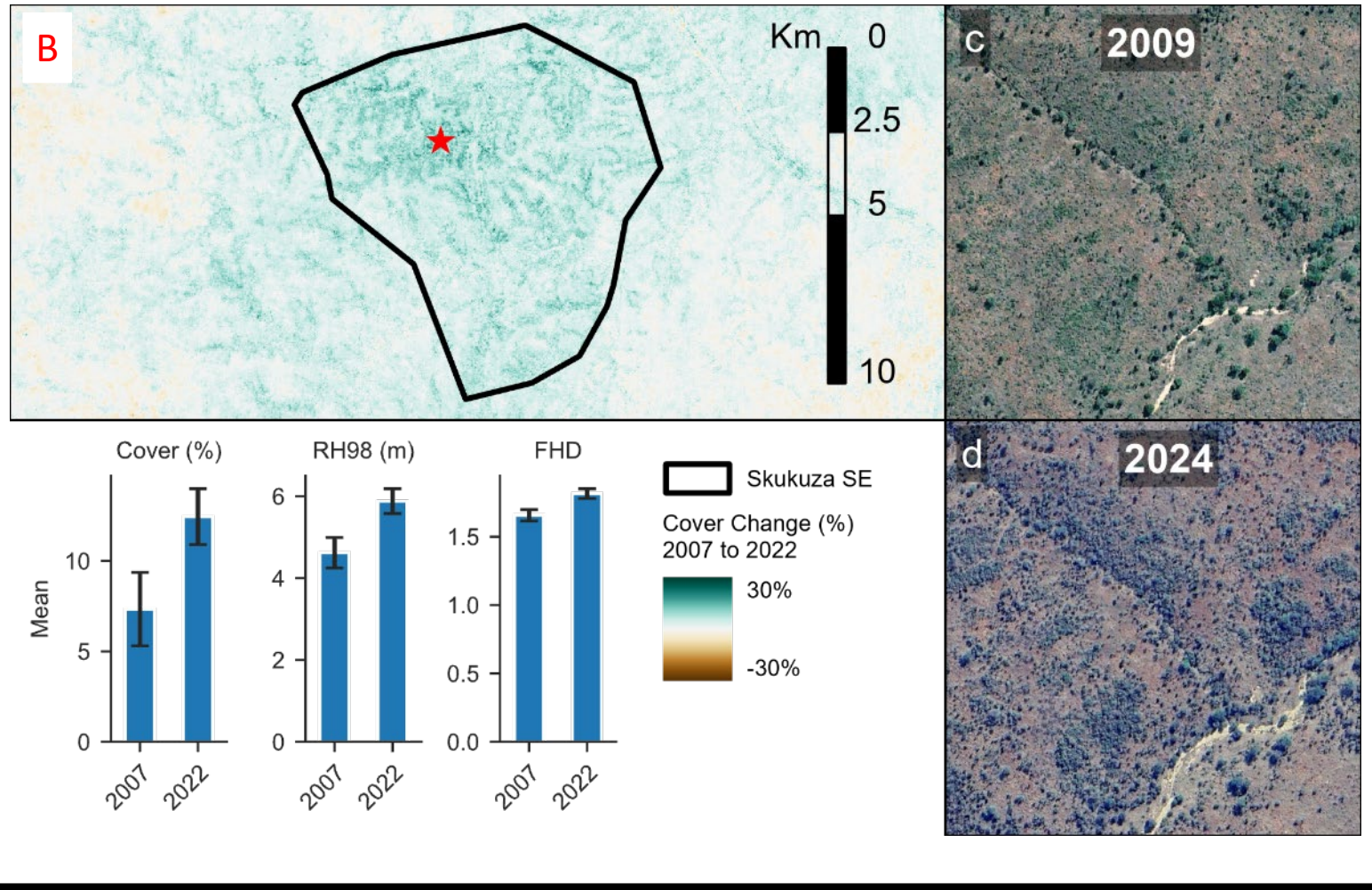
Elephant Impacts – Thornybush Nature Reserve

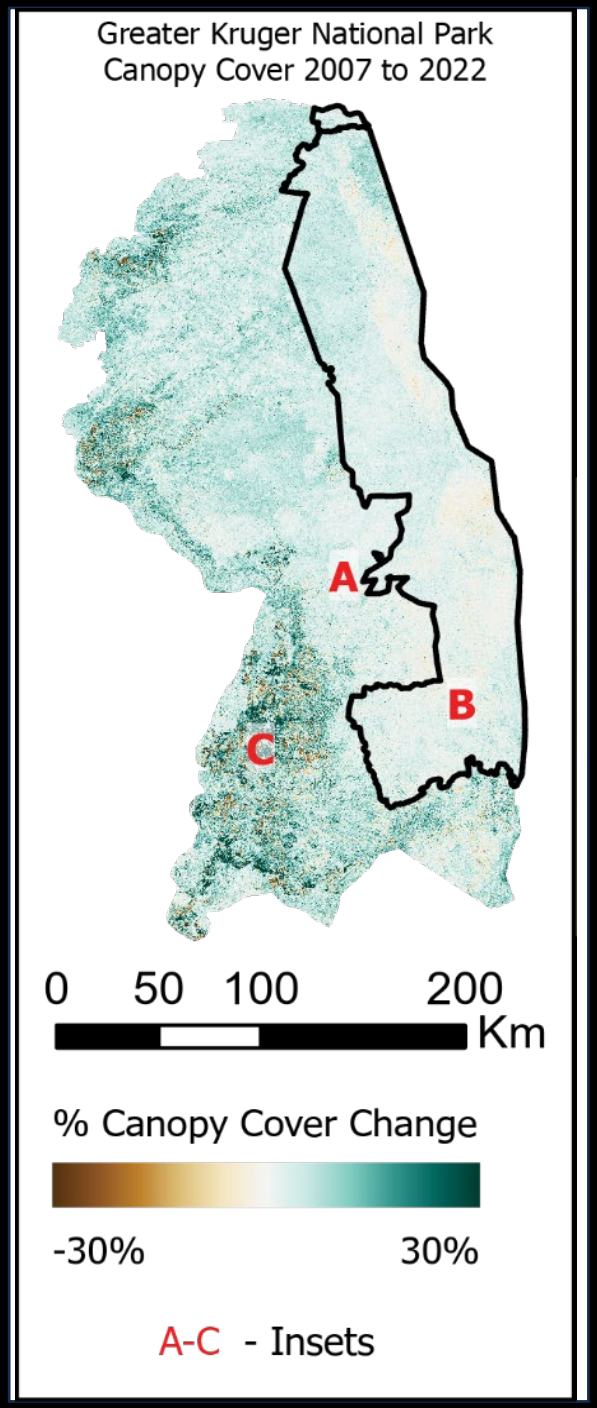




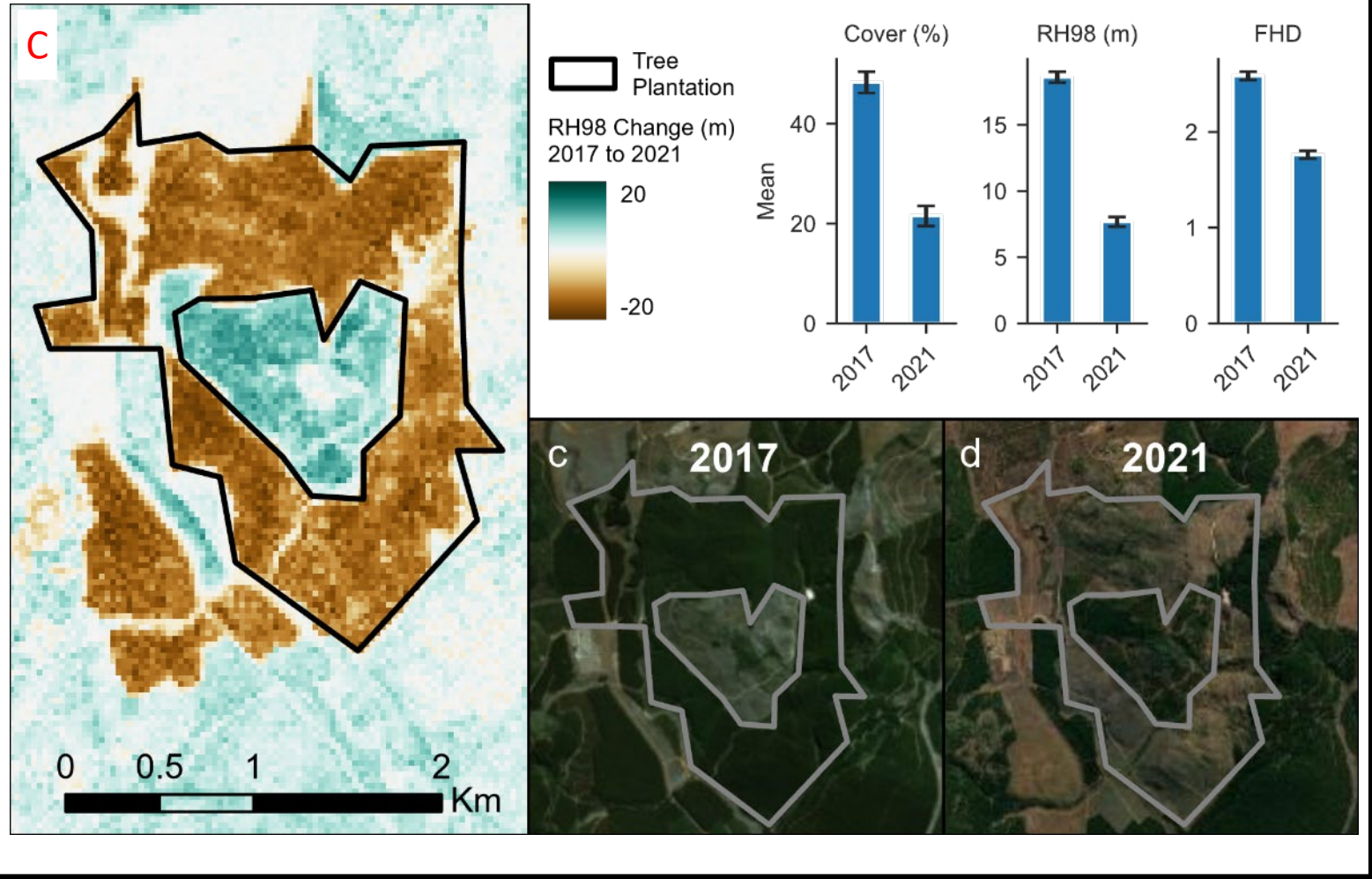


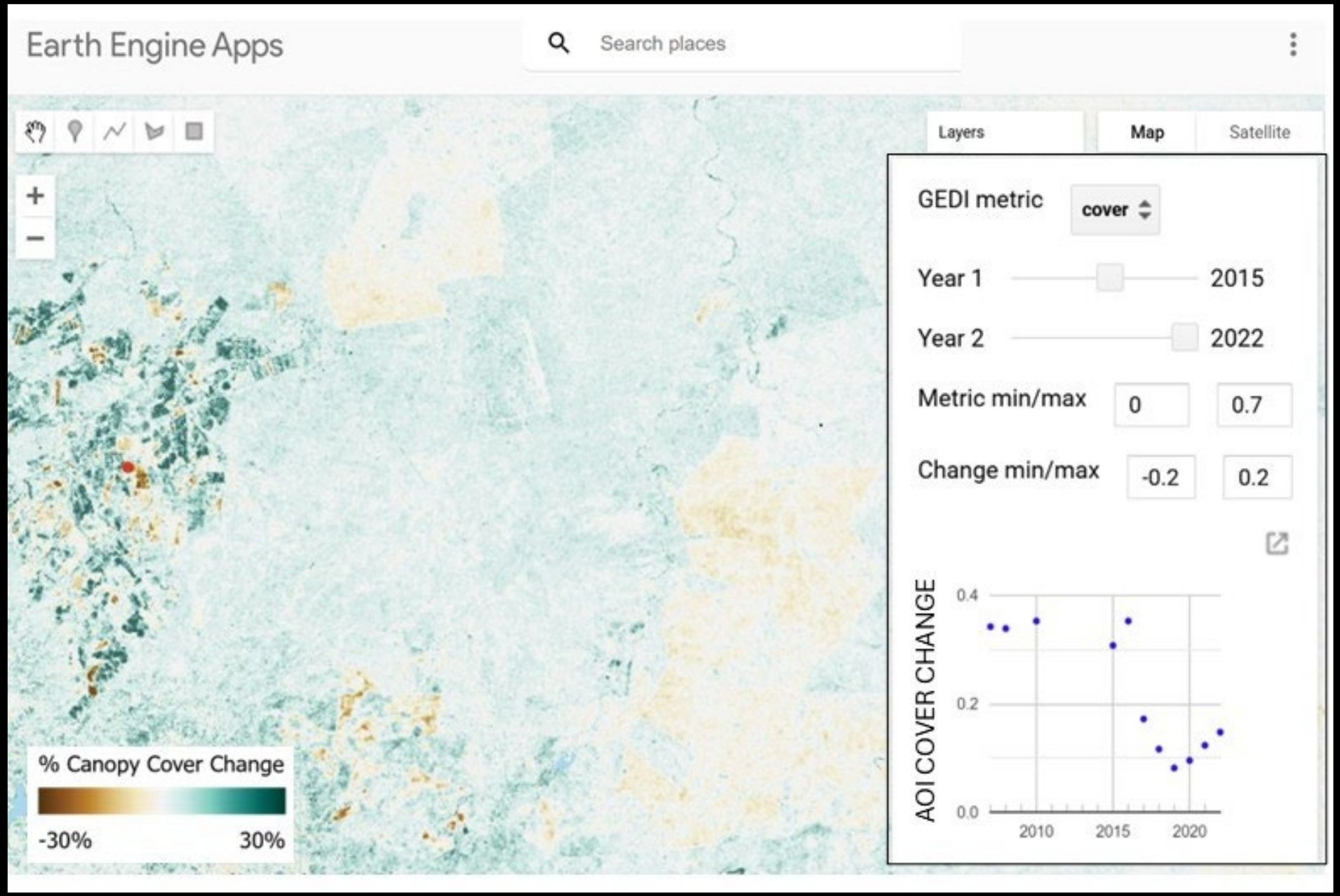
Skukuza – Woody Encroachment (Bush Thickening)





Tree Plantations – southwest GKNP region



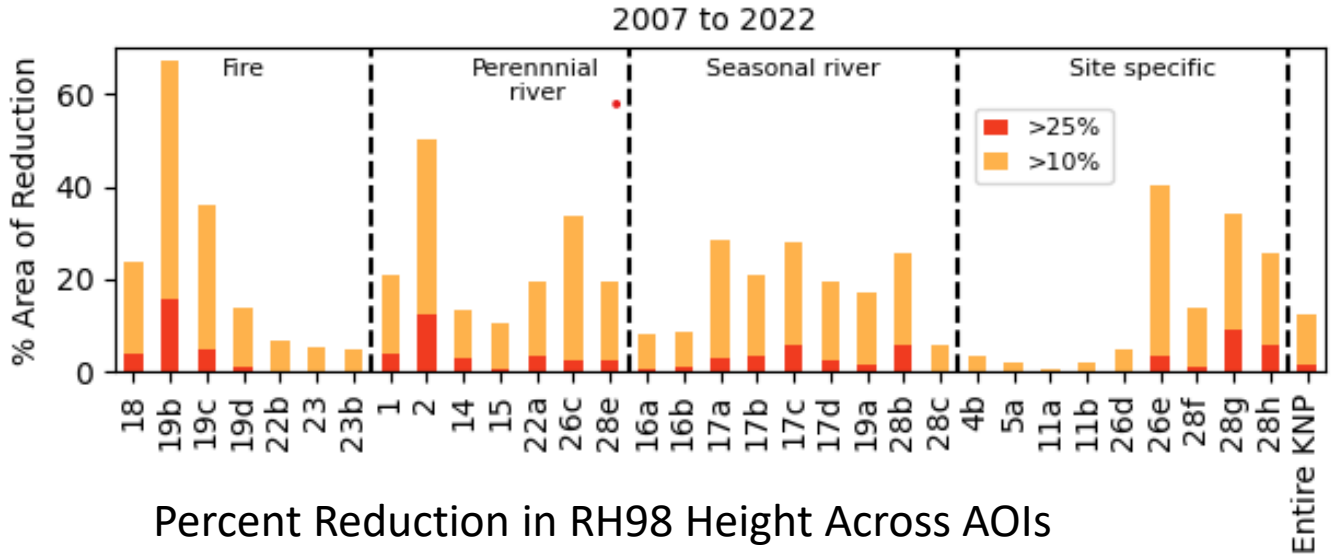

Earth Engine Apps
Search places
Layers
Map
Satellite
GEDI metric
cover
Year 1
2015
Year 2
2022
Metric min/max
0
0.7
Change min/max
-0.2
0.2
AOI COVER CHANGE
0.4
0.2
0.0
2010
2015
2020
% Canopy Cover Change
-30%
30%

End-User Driven Applications – Monitoring Elephant Impacts & Bush Encroachment

Longer-term vegetation change in elephant areas of concern in Kruger National Park, South Africa

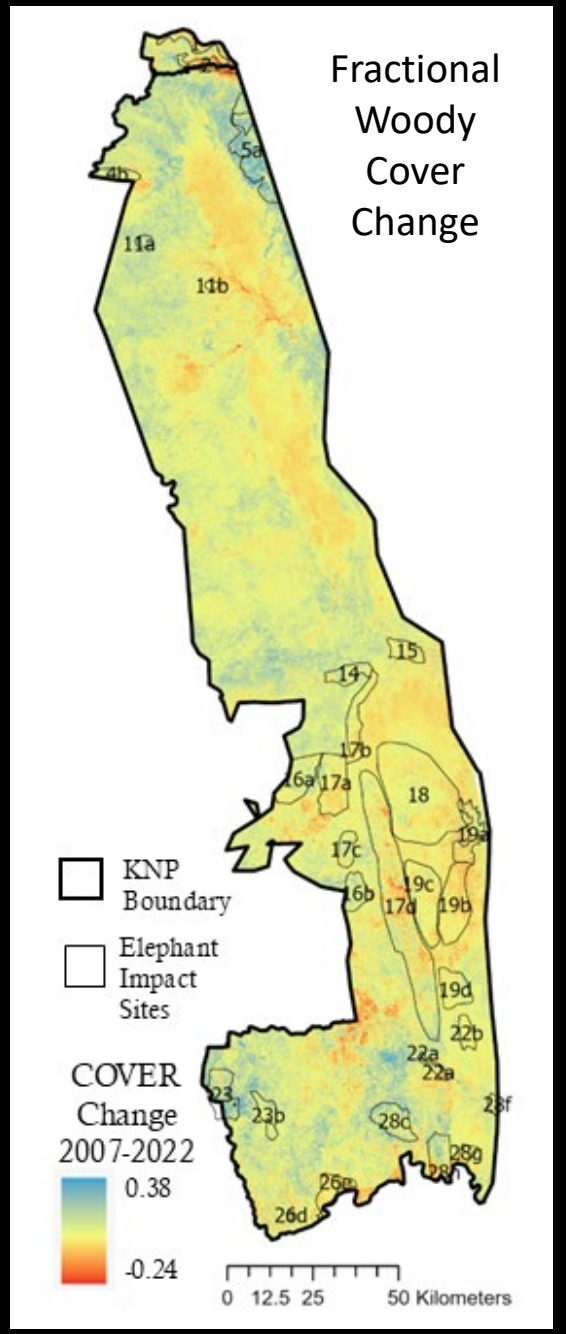
Corli Coetsee[1,2], Linda Kleyn[3], Jody C. Vogeler[4], Steven K. Filippelli[4], Liezl M. Vermeulen[5], Benjamin J. Wigley[6,2,1], Tinyiko Golele[7], and Sam Ferreira[1,8]

* Soon to be in Review (next month)



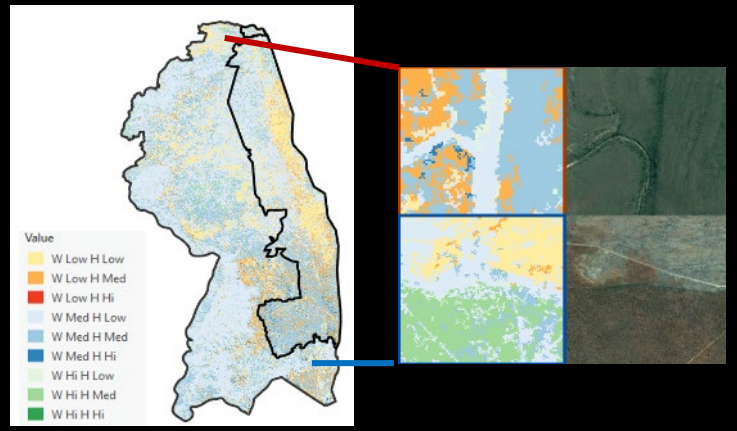
Percent Reduction in RH98 Height Across AOIs

Combining local "traditional ecological knowledge" (ranger defined areas of concern) with remote sensing change analyses for informing monitoring frameworks.



Vegetation Structure & Change Products

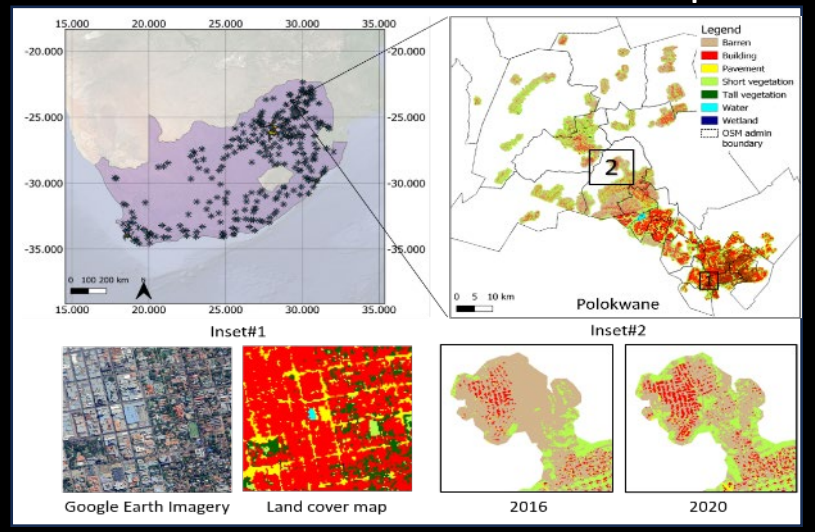
Herbaceous Biomass & Patch Classes



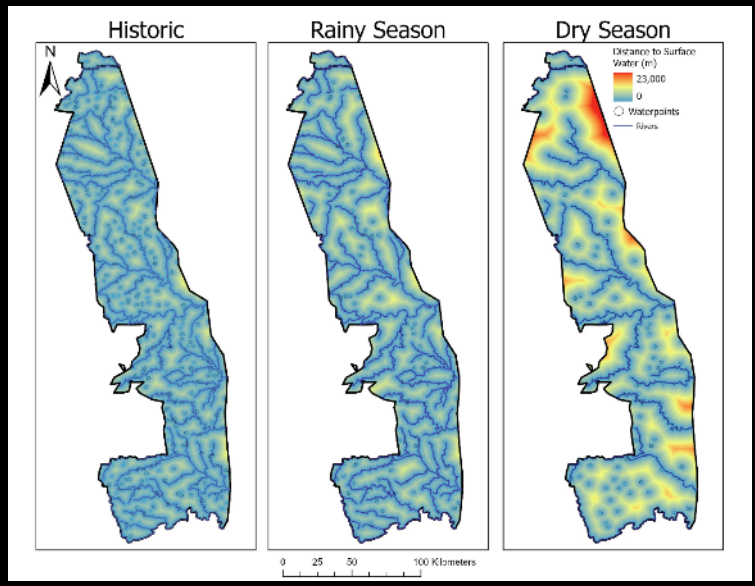
Project Goals & Outputs

Additional Landscape Pattern Products

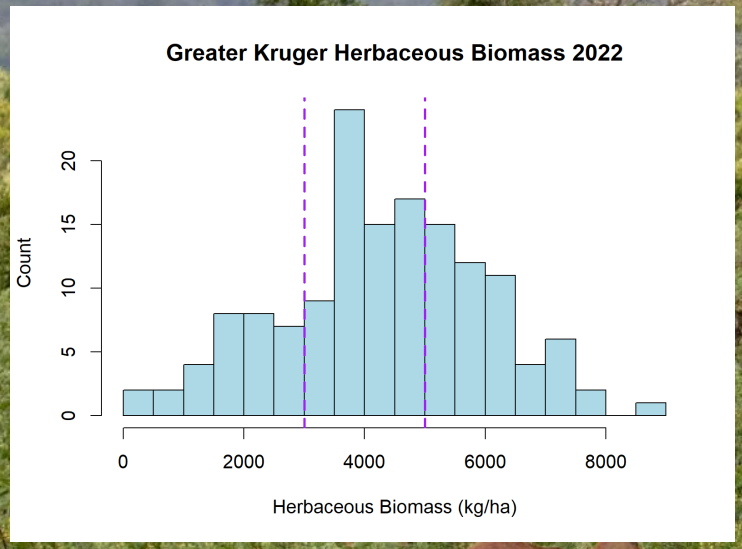
Urbanization Patterns & Landscapes



Updated Waterhole Distributions & Status Information

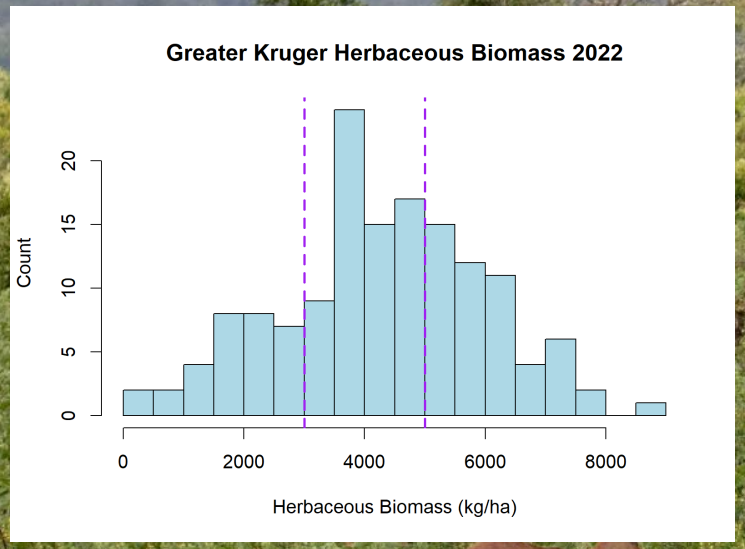


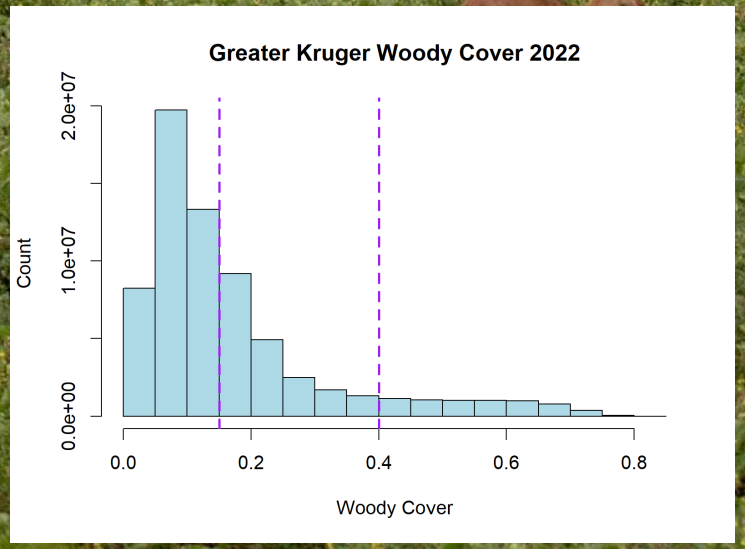
Vegetation Patch Classification

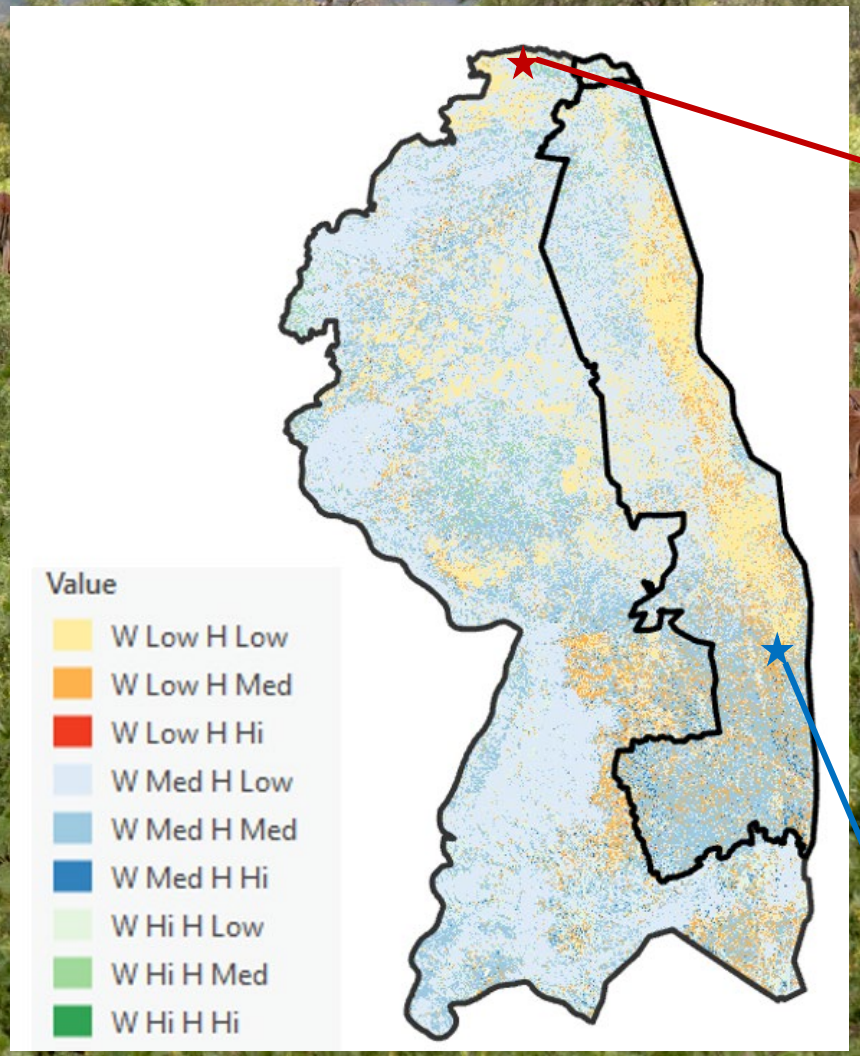


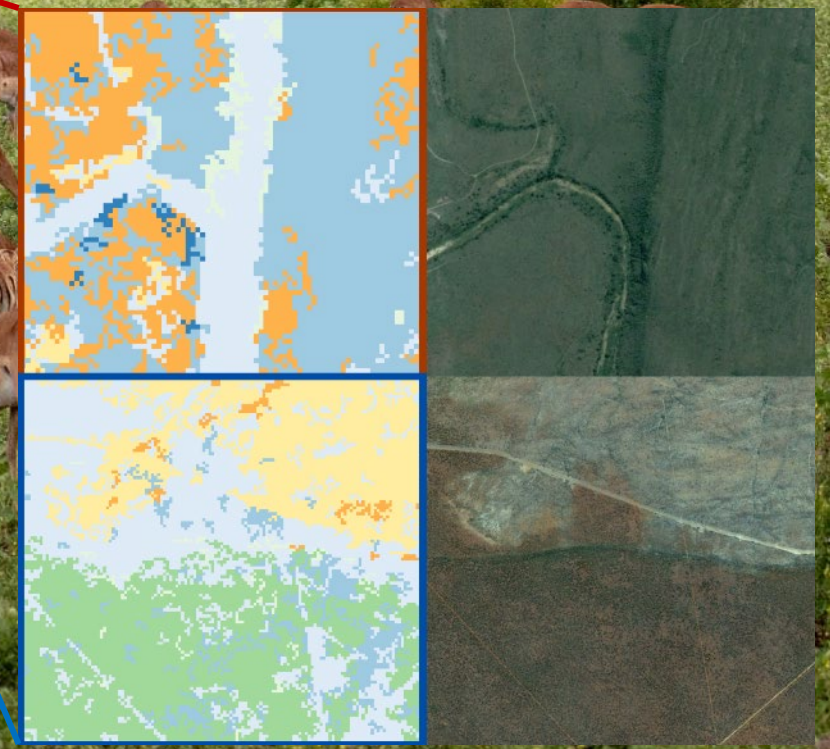
- Modeled herbaceous biomass based on park field data and Landsat
- Overall Accuracy = 60%
- Working to incorporate additional regional plots outside park

Vegetation Patch Classification

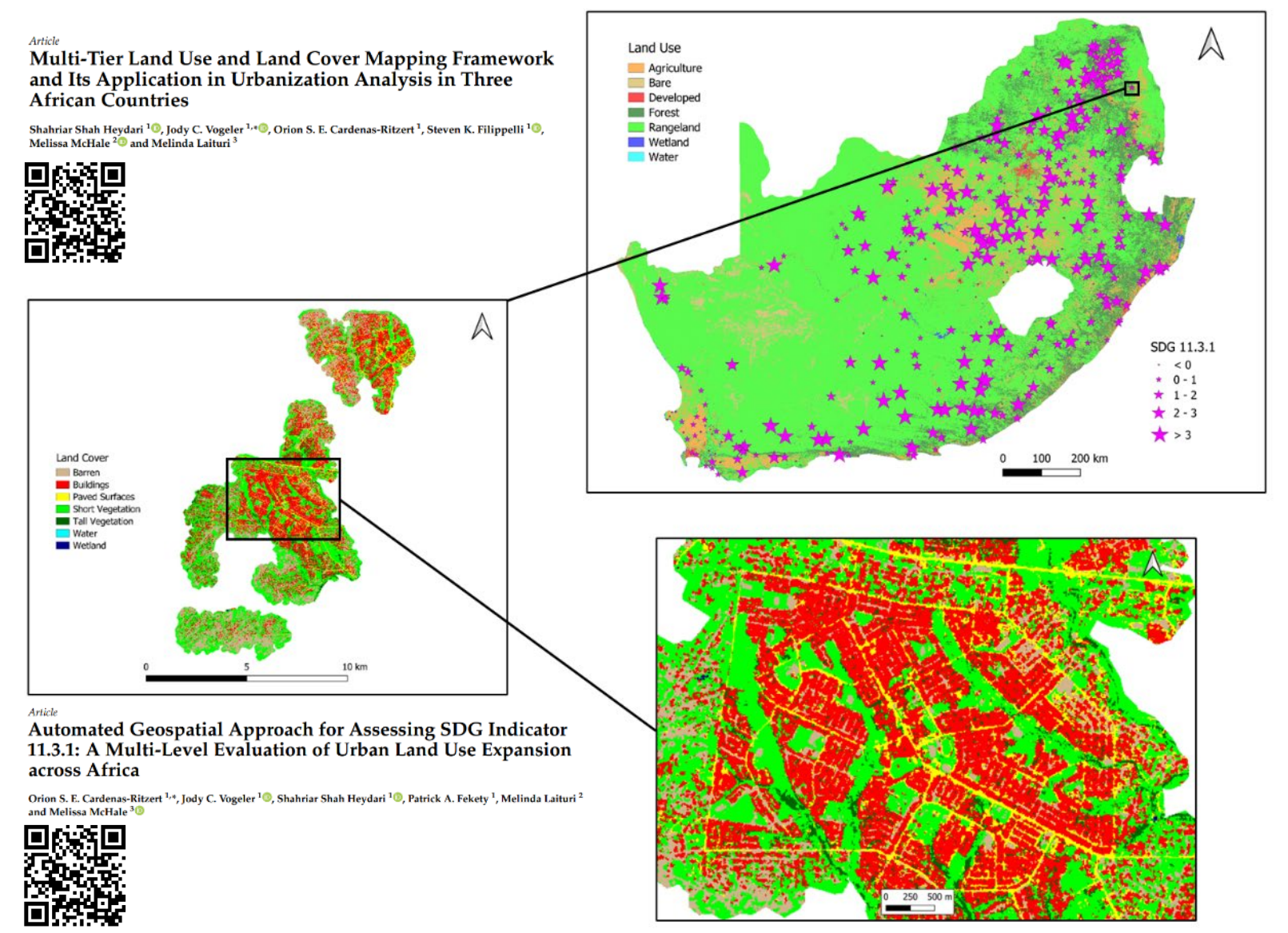








Urban Landscapes & change

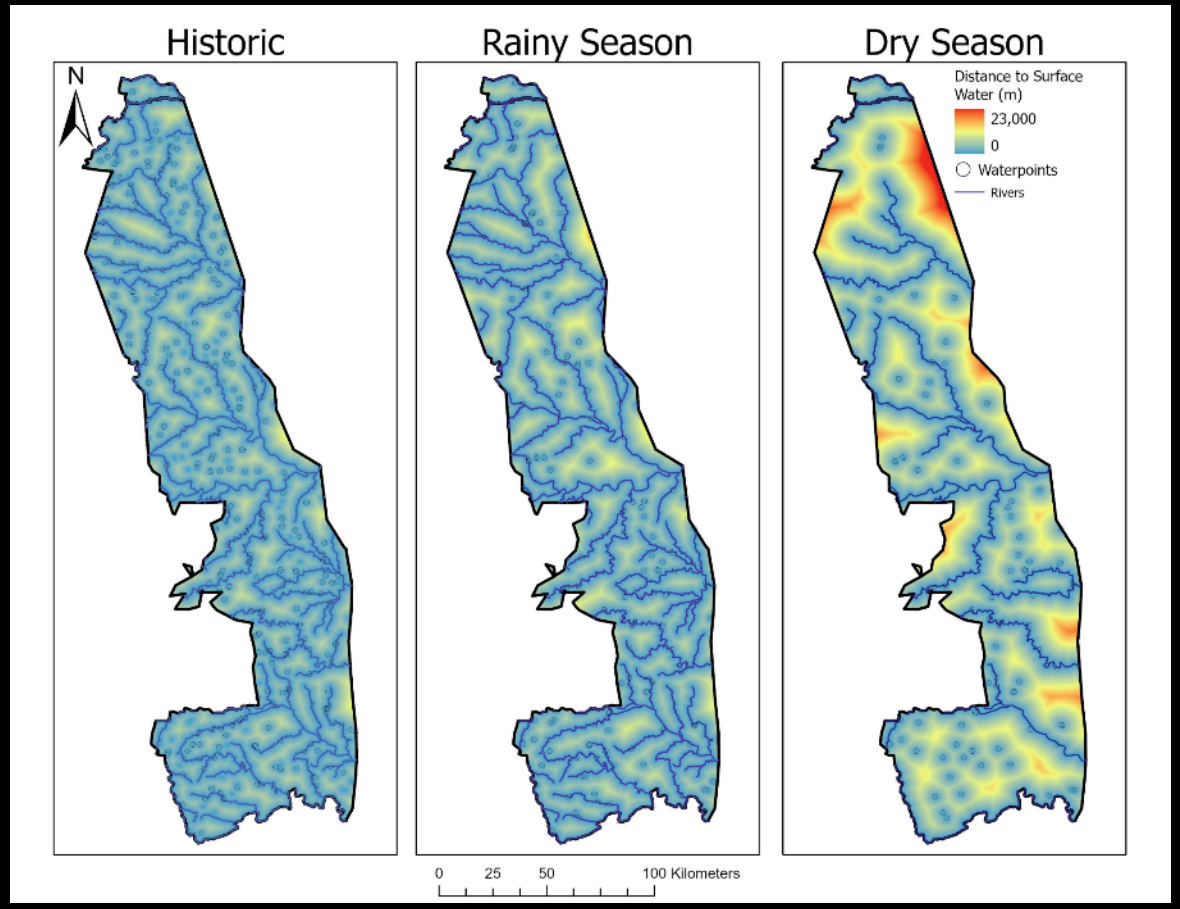


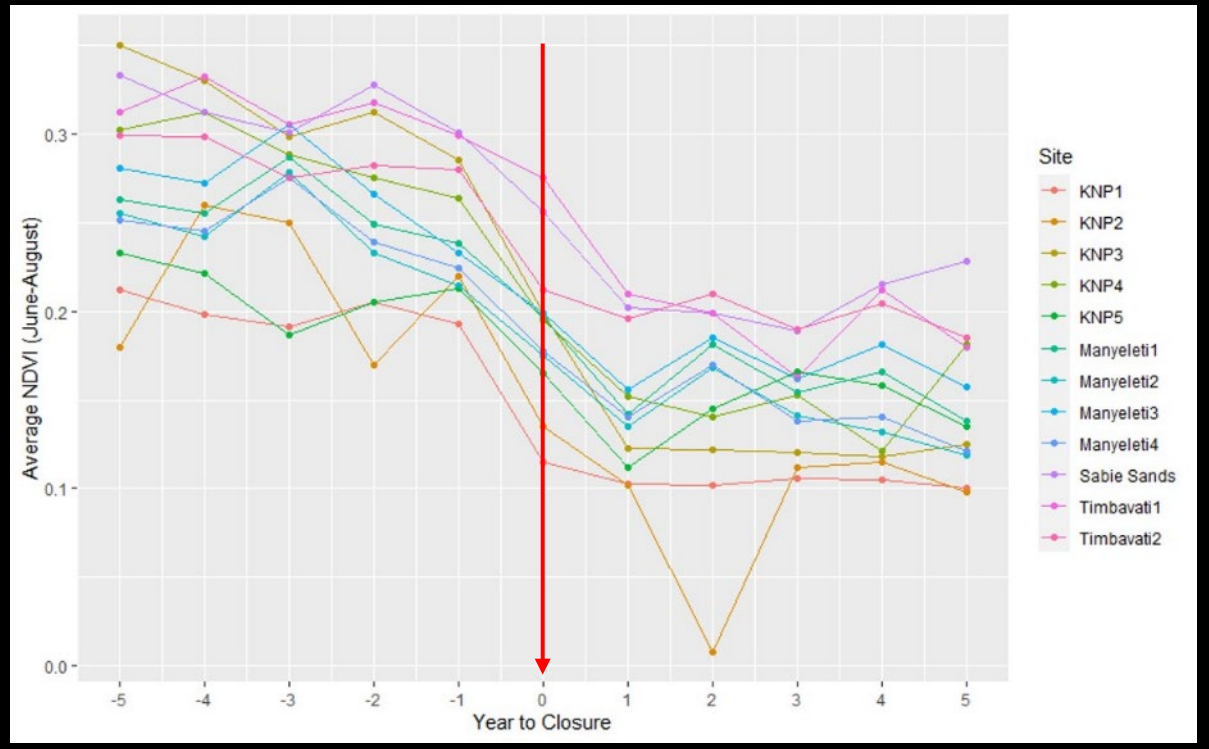
- Part of a NASA LCLUC project (also led by PI Vogeler)

- Developed multi-tier LULC products
  - 30 m resolution national-level LU
  - 10m resolution urban LC across all identified urban areas
- South Africa, Ethiopia, Nigeria

- Identified urbanization-driven LULC change “hotspots” based on SDG 11.3.1
- Analyzed green space distributions and patterns (including in support of SDG 11.7.1)
- Relevant for urban change patterns and LC connectivity near protected areas

Updated Waterhole Distributions & Status





Seasonal Waterhole Wildlife Occupancy

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Guild	Species
Mega-herbivores	African Elephant White Rhinoceros Giraffe
Large Herbivores	Cape Buffalo Plains Zebra
Small-Medium Herbivores	Blue Wildebeest Greater Kudu Impala
Carnivores	African Lion Leopard Spotted Hyena

Categories of Variables	Metric
Waterhole Characteristics	Distance to next nearest waterhole Area Shape (area-perimeter ratio) Perennial or ephimeral
Vegetation structure	Woody Height Woody Cover Herbaceous Biomass
Climate	Dry season temp min Wet season temp max Preciptiation min and max

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- All species in the guild are considered water-dependent and preferred larger, perennial sources.
- When visiting ephemeral pan sites during the dry season, generally closer to another perennial source
- Both elephant and giraffe benefit from woody forage to meet their dietary needs (higher woody heights and cover), while white rhinoceros are primarily grazers and selected higher herbaceous biomass.

BIOLOGICAL DIVERSITY & ECOLOGICAL CONSERVATION

Thank You:

Project Team
Local Partners
Local Field Guides
NASA Funding