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], Sharon Hall [4], Melissa McHale [2]

1 Colorado State University
2 UBC
3 University of Michigan
4 Arizona State University

Project Team

Co-PIs

David Bunn - UBC

Jody Vogeler - CSU

Students/Researchers

Steve Filippelli - CSU

Derek Fedak - CSU

Co-Is

Melissa McHale - UBC

Neil Carter - UofMI

Sharon Hall - ASU

End Users

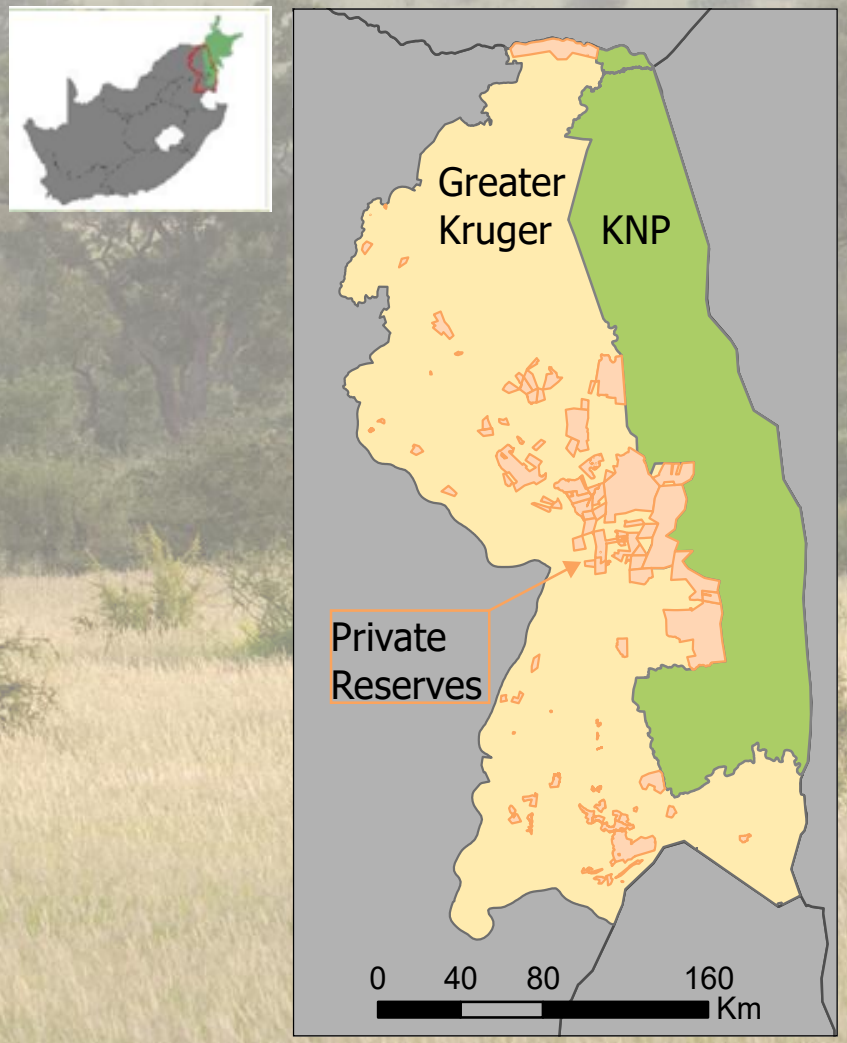
South African National Parks

Nsasani Trust

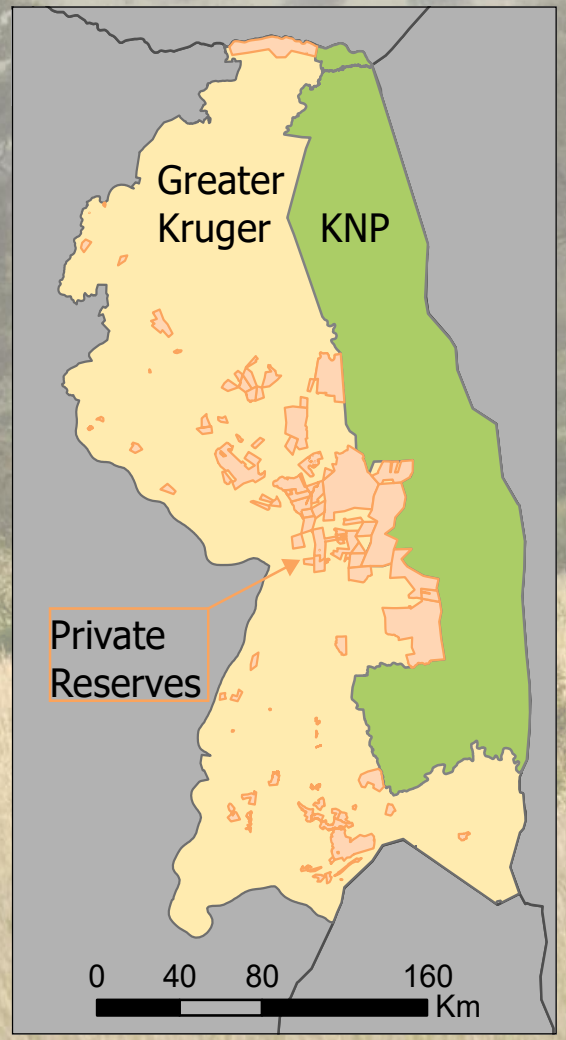
Associated Private Nature Reserves

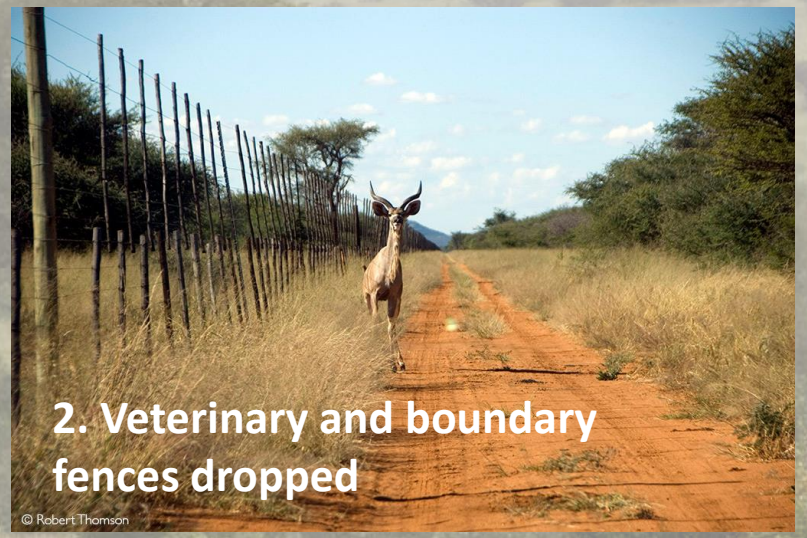
Agricultural Research Council, South Africa/SAEON

Greater Kruger National Park Region (GKNP)



GKNP Rewilding Management & Conservation Challenges





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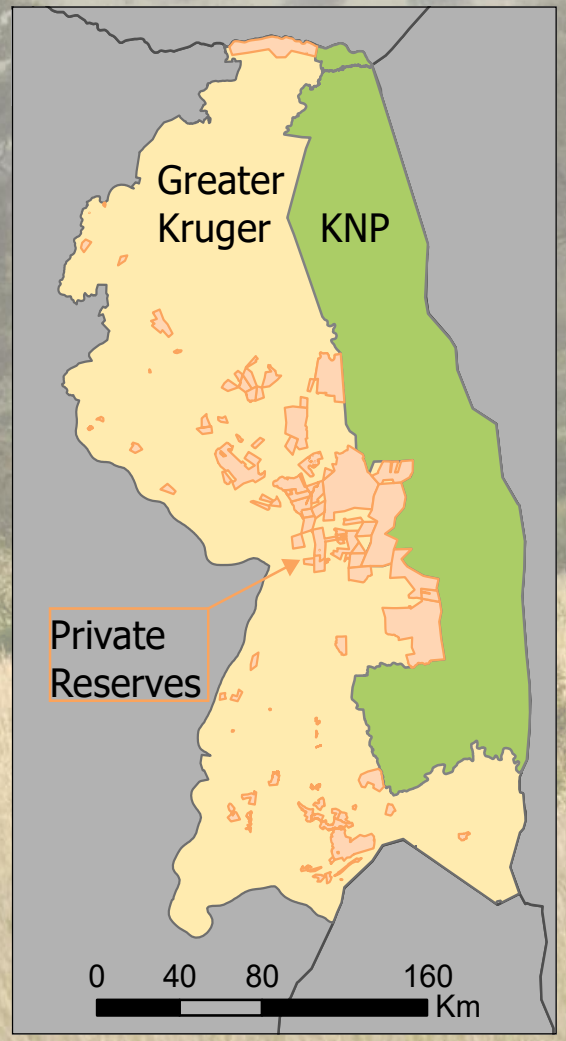

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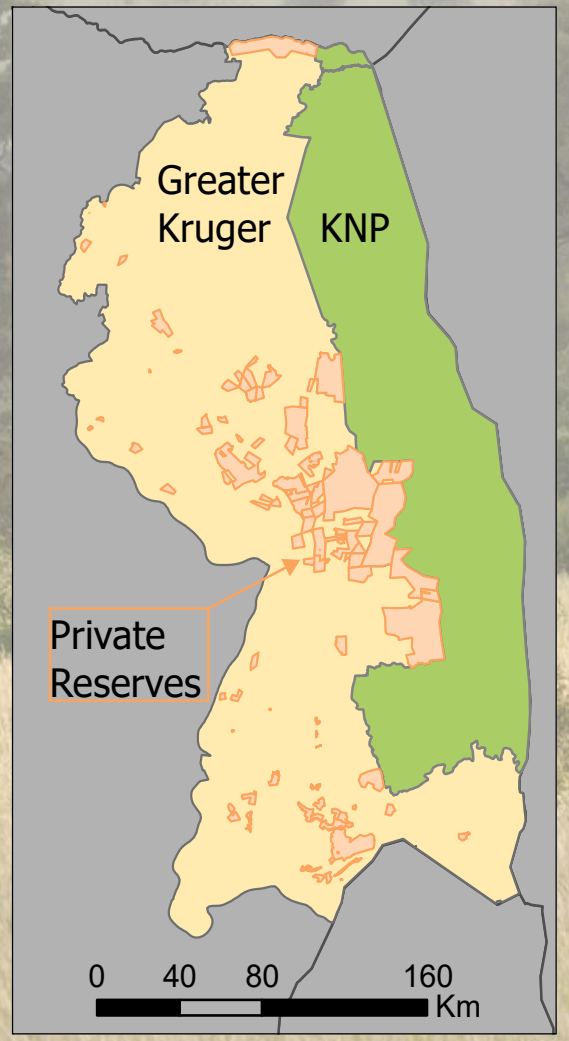

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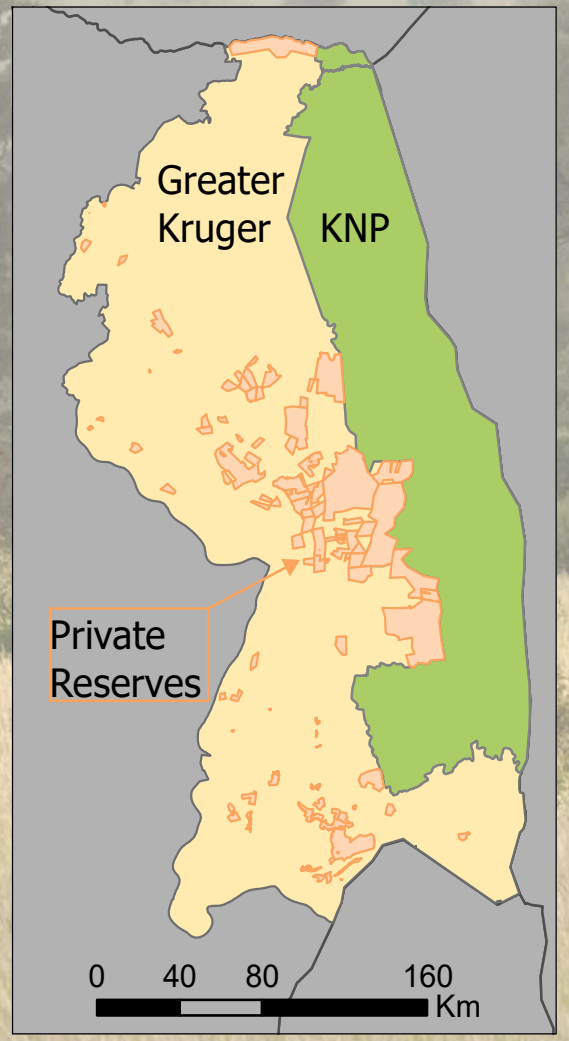

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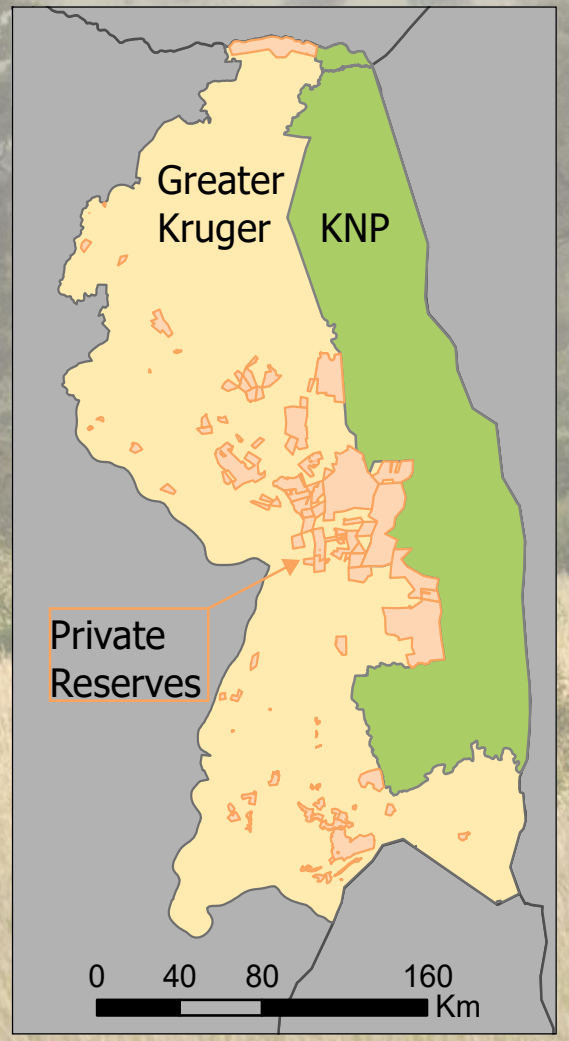

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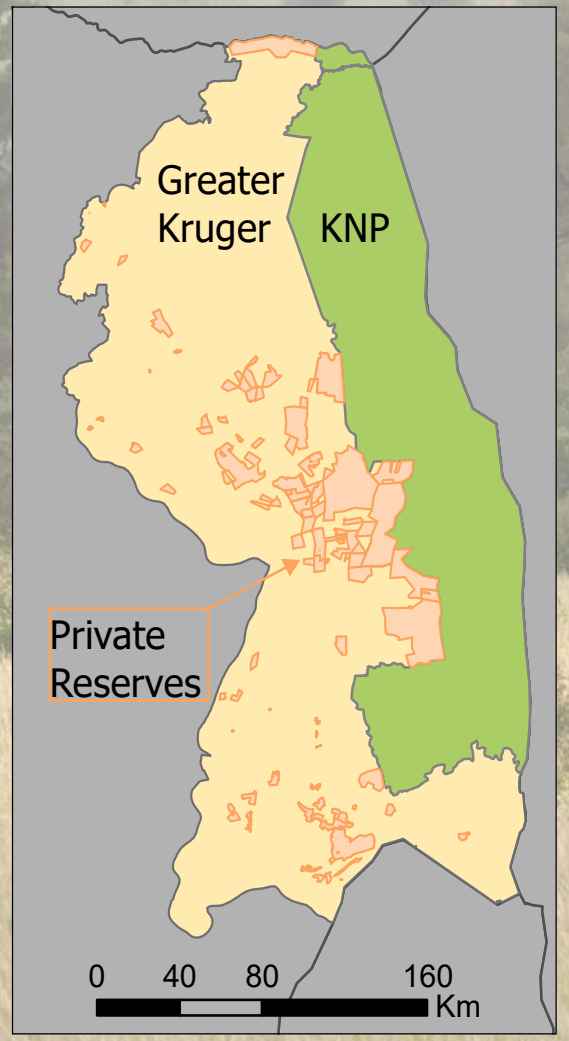
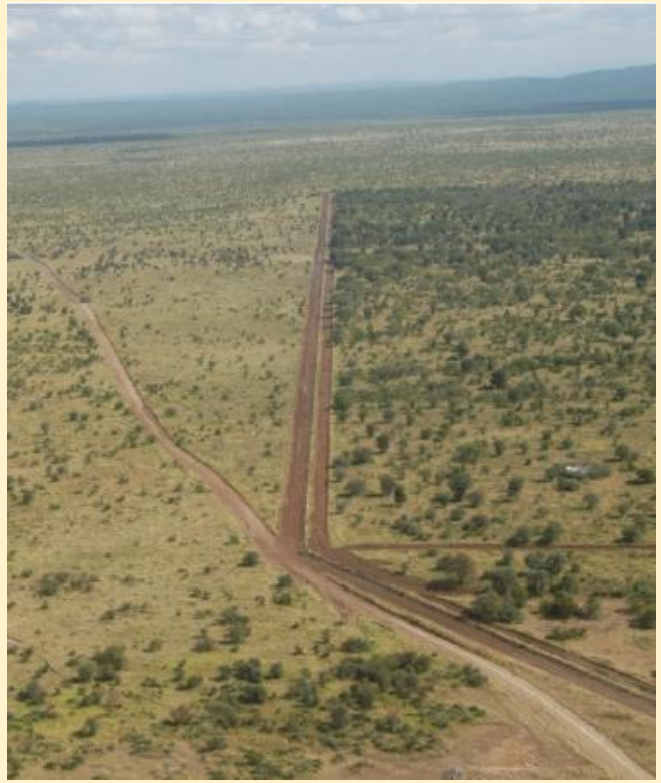


Target objectives/outcomes (End-user Input)

Characterize current vegetation patterns & changes



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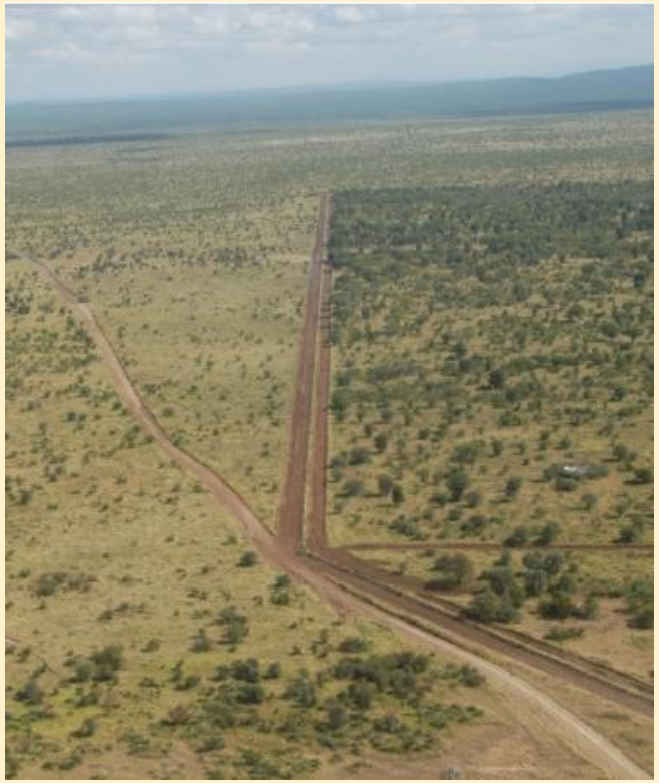

Predict habitat & connectivity for focal species

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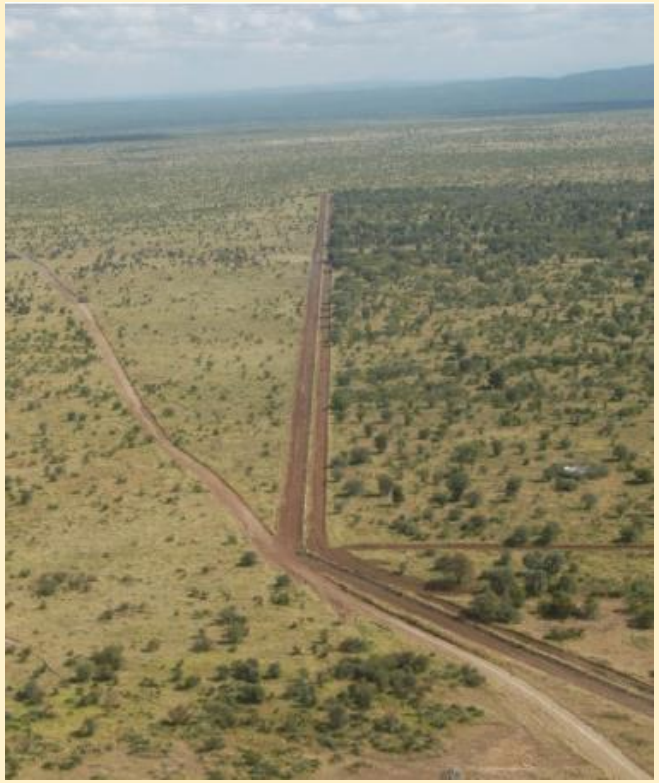
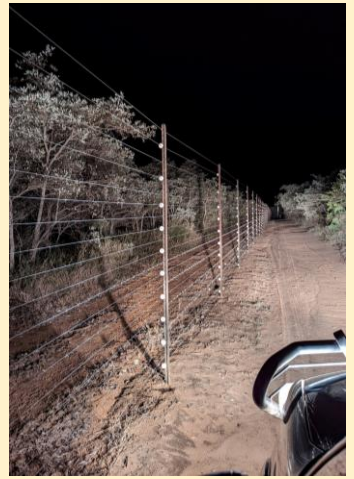


Predict habitat & connectivity for focal species

Develop Management Forecasting tool

Focused on potential consequences of waterhole management and fence removal decisions.



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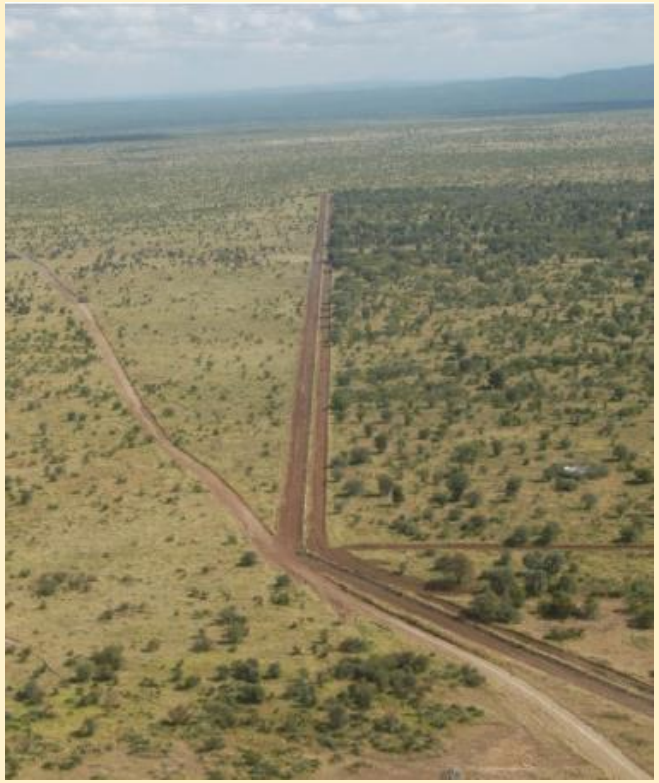

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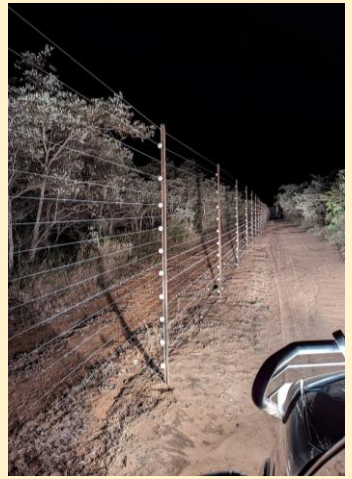

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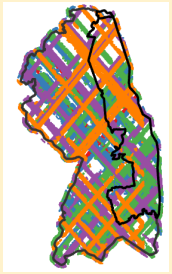
Characterize current vegetation patterns & changes

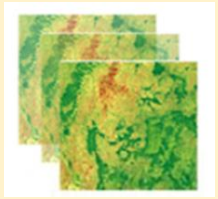
GEDI Footprints



Field Data

+

Continuous Satellite Predictors



E.g., Landsat time series, PALSAR

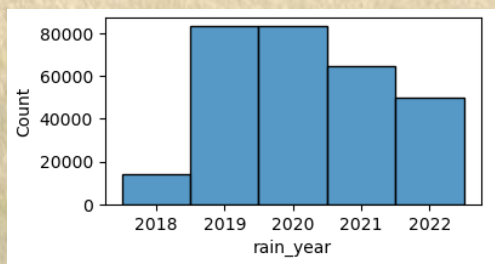
Vertical Structure Metrics (e.g., RH98, cover, FHD)

Patch Classes (e.g., combo of herbaceous and woody cover classes)

Vertical Structure Metrics:

Scaling-up GEDI metrics to continuous extents

300k samples



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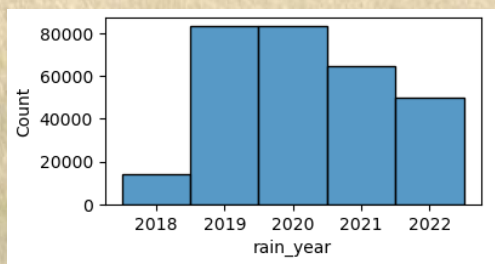
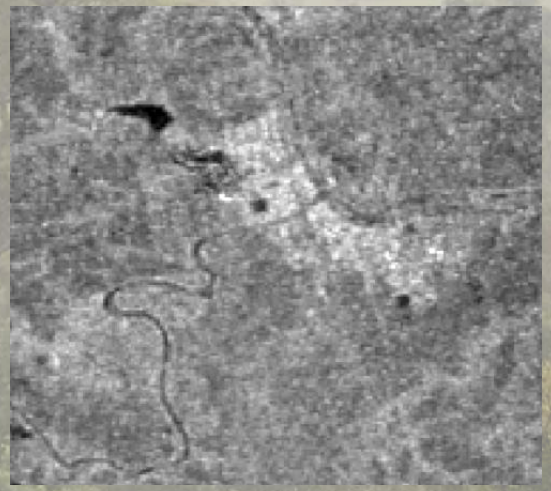


Predictors

- Landsat time series
  - wet and dry seasons using Landtrendr
- PALSAR
  - Using PALSAR v2 mosaics for 2007-2010, 2014-2022
  - Multi-temporal speckle filter and power conversions
- Random Forest Models for RH98, Cover, FHD, and PAI

Before speckle filter



After speckle filter

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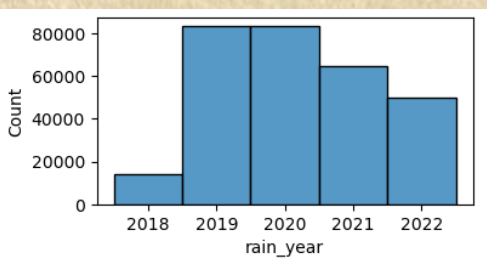

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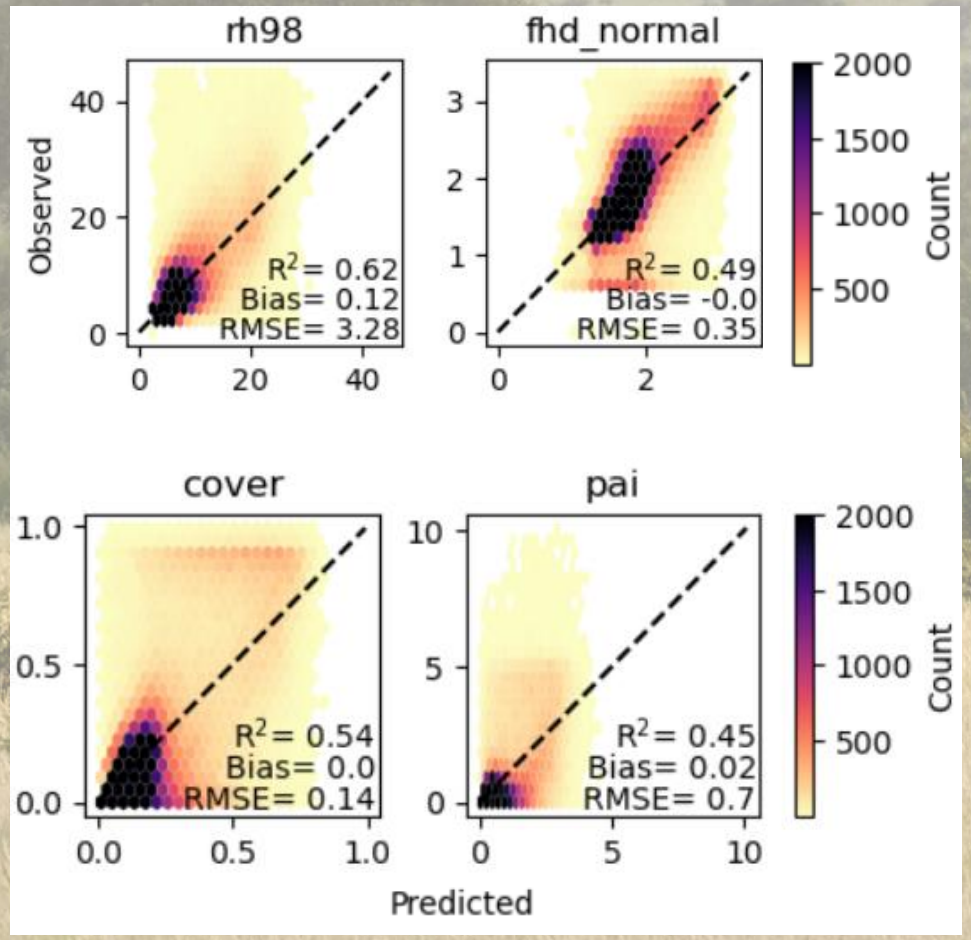

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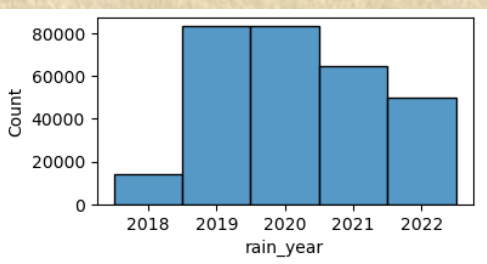
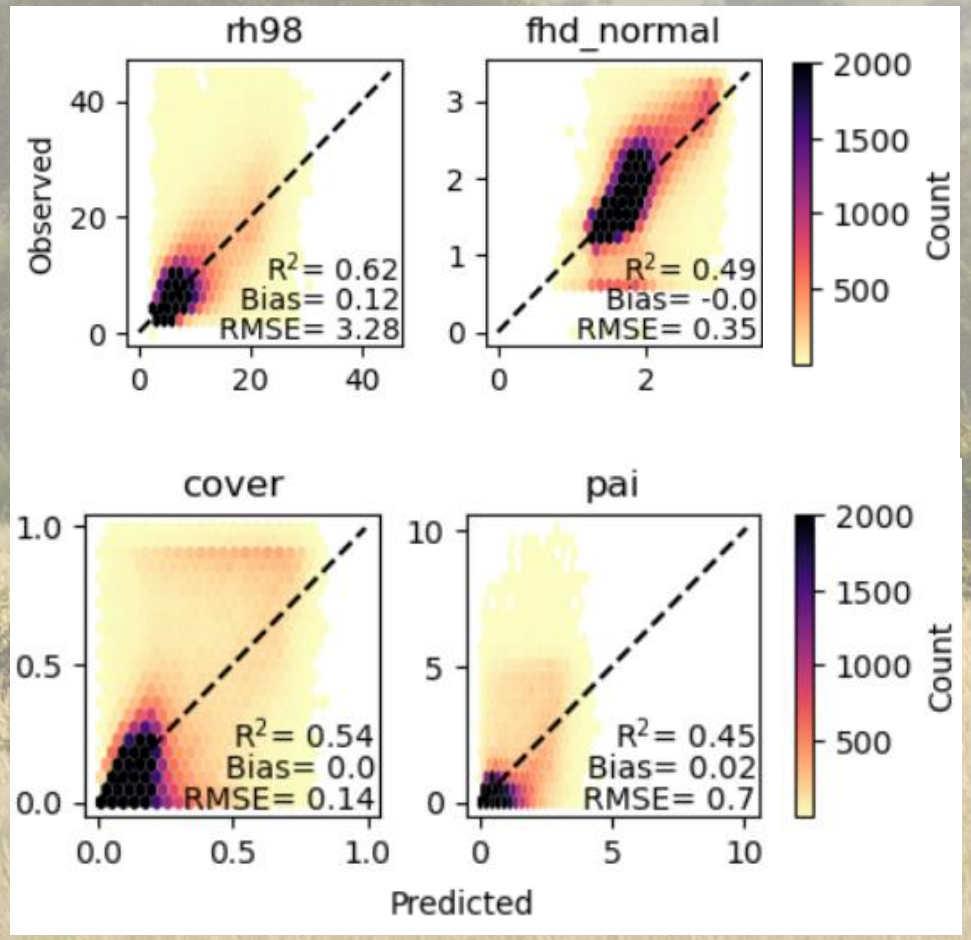


Predictors

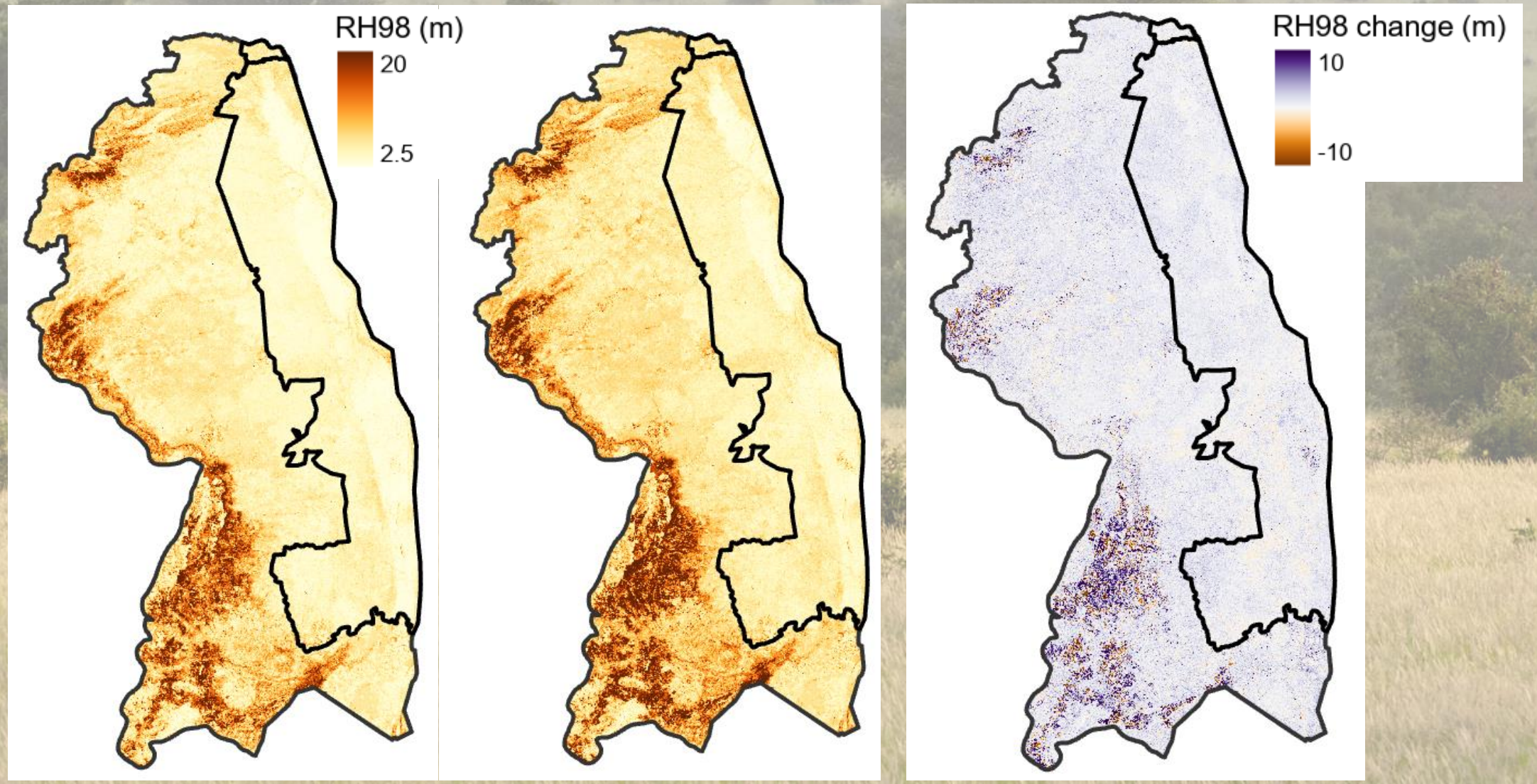
- Landsat time series
  - wet and dry seasons using Landtrendr
  - **Next steps will include testing CCDC**
- PALSAR
  - Using PALSAR v2 mosaics for 2007-2010, 2014-2022
  - Multi-temporal speckle filter and power conversions
  - **Next steps may include cross-calibration between PALSAR 1&2**
- Random Forest Models for RH98, Cover, FHD, and PAI



Vertical Structure Metrics:

Scaling-up GEDI metrics to continuous extents

2015 **2022** **Change**



Vertical Structure Metrics:

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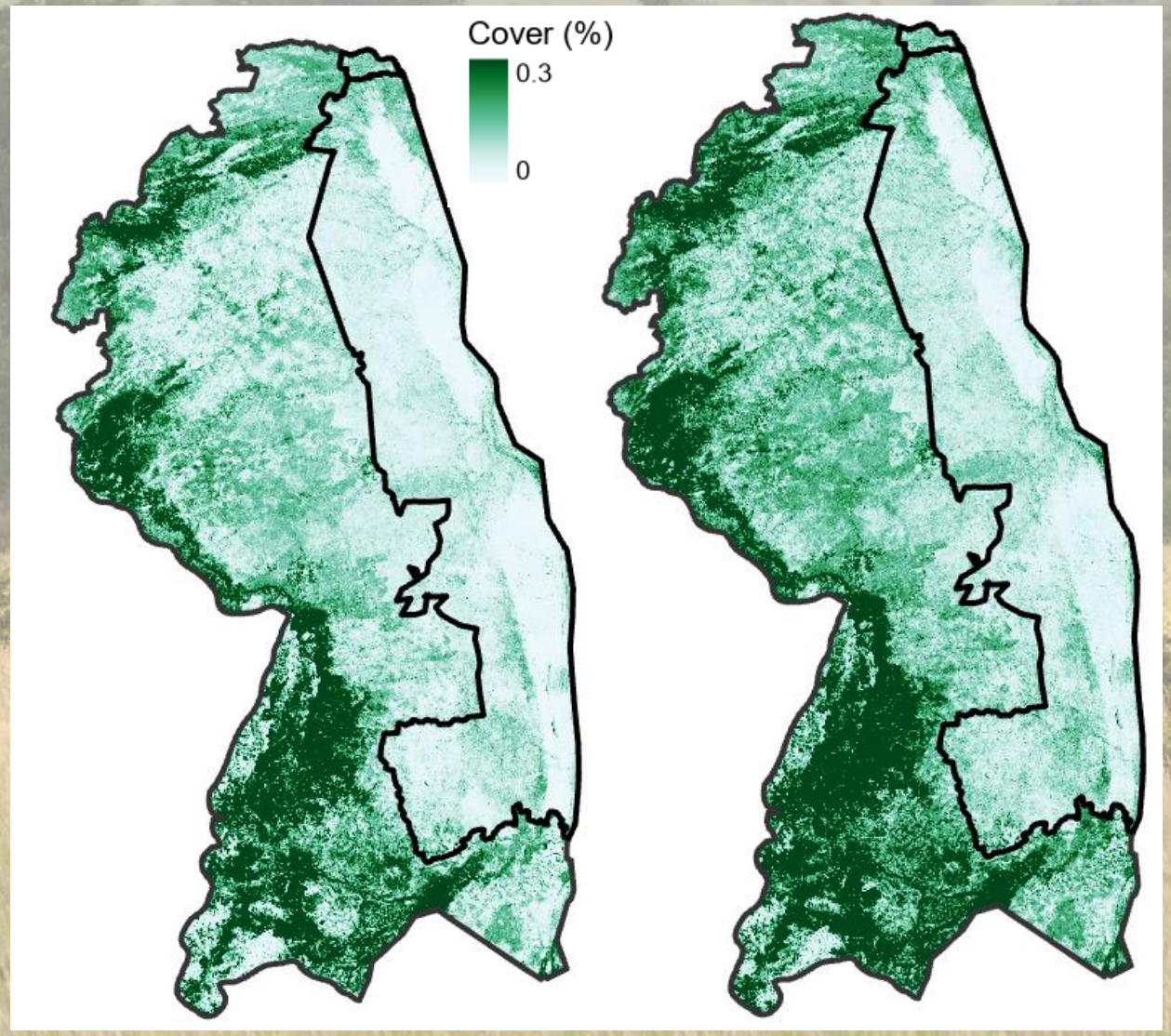
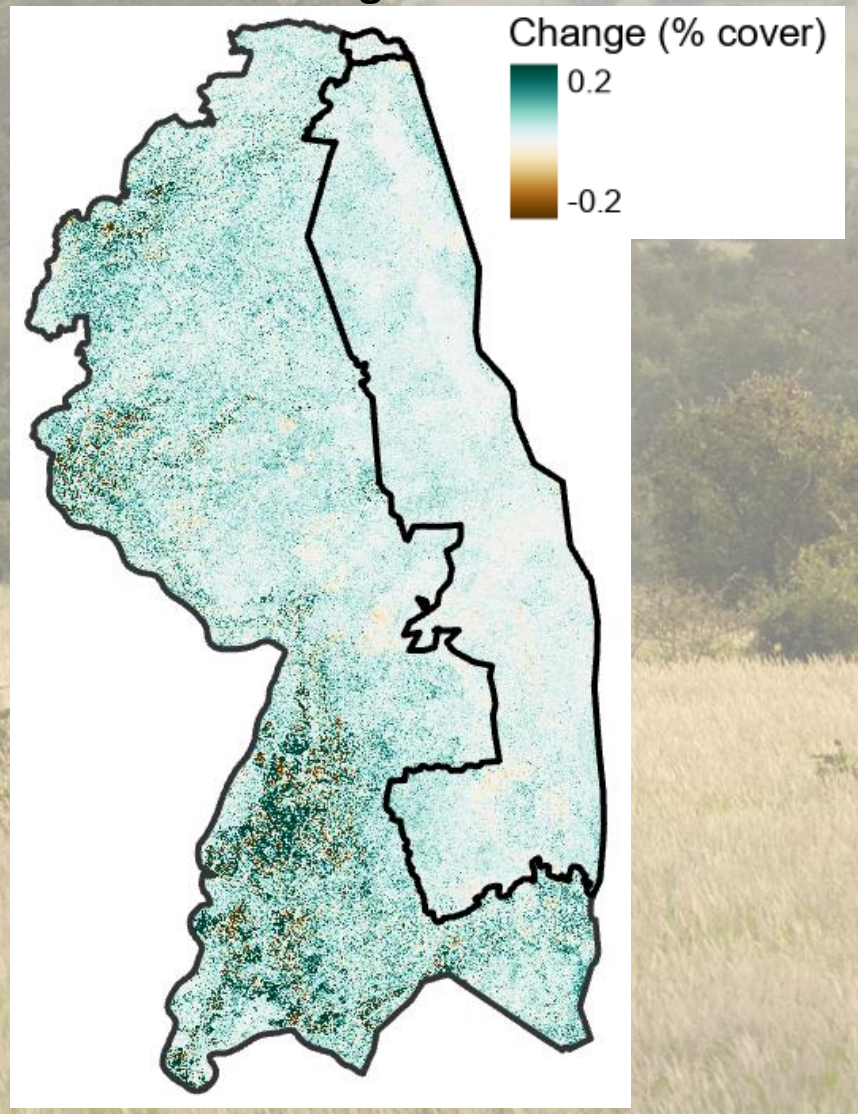
2015 **2022** **Change**





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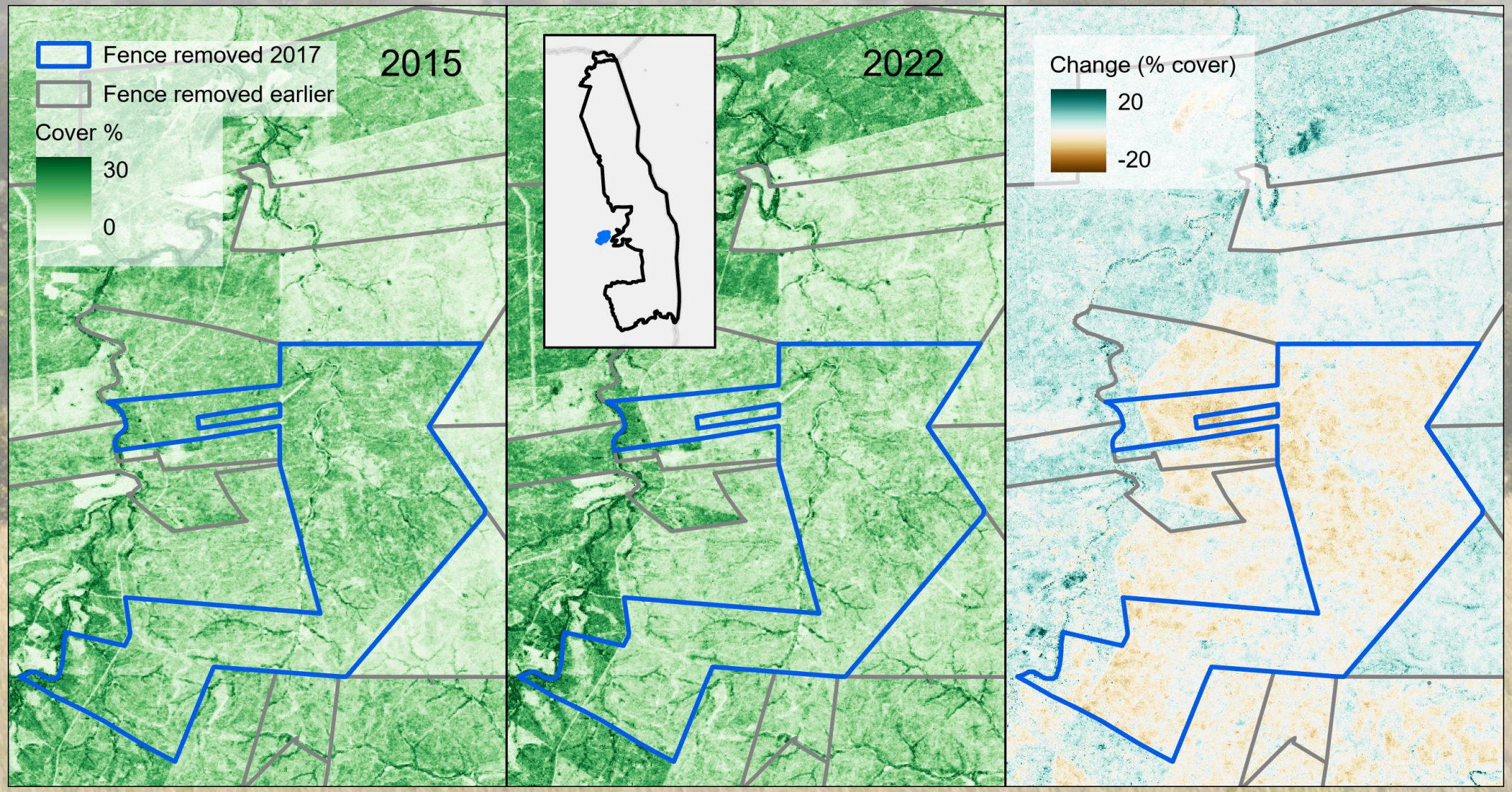

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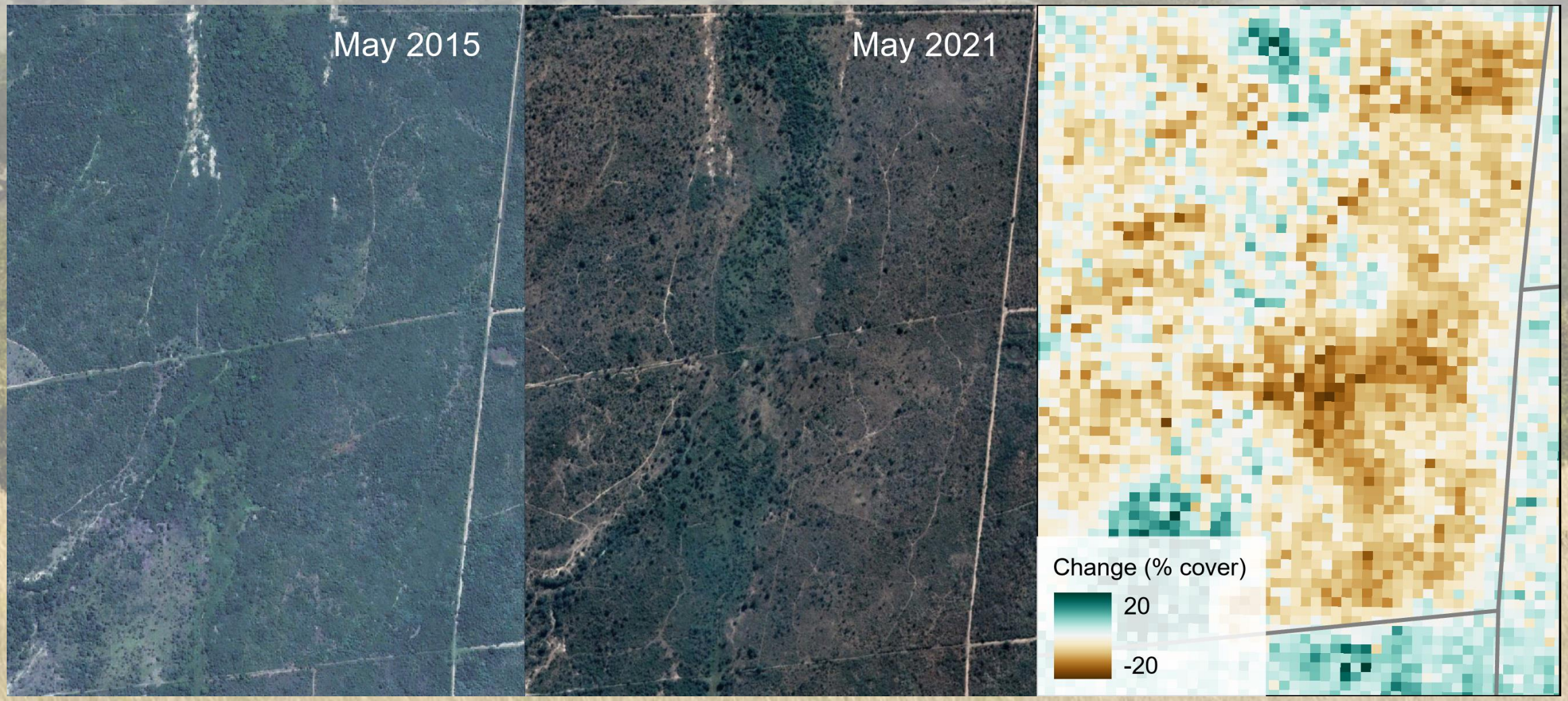
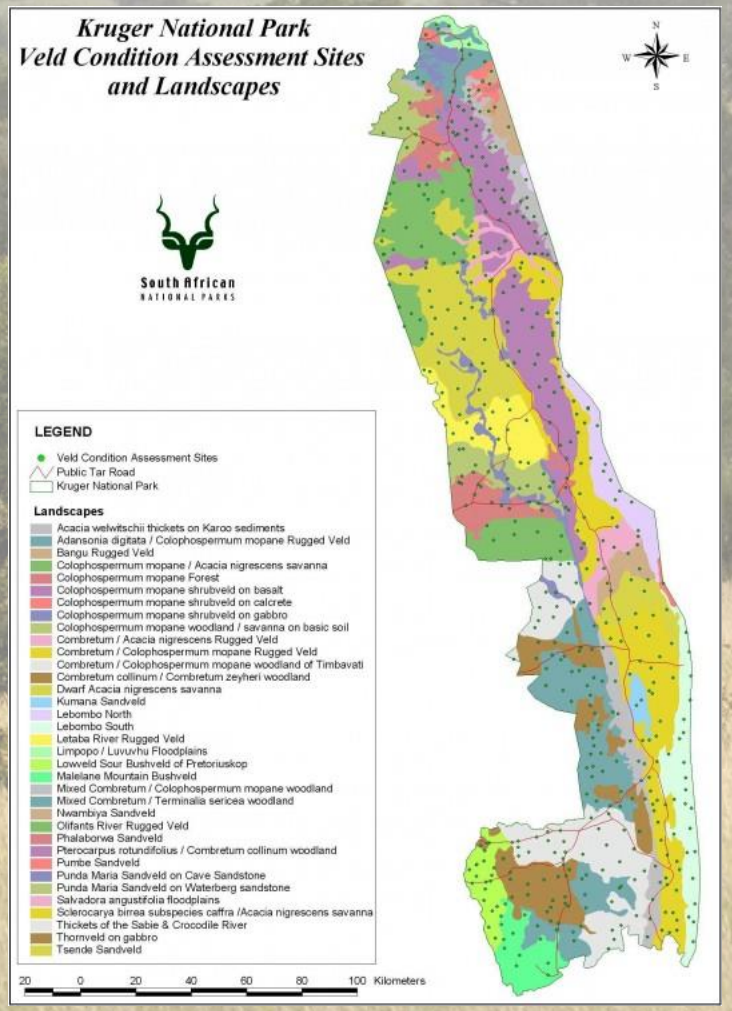


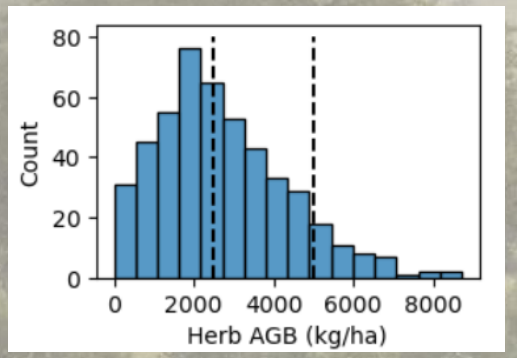
Reductions in predicted canopy cover from both forest clearing and fires between 2015 and 2021.

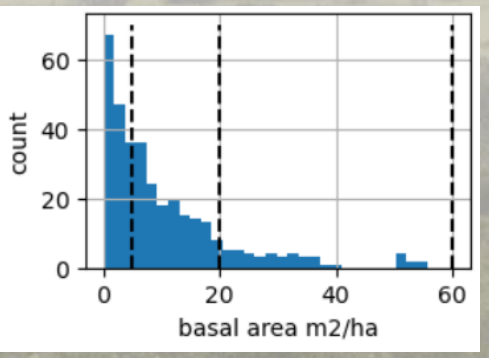
Vegetation Patch Classes:

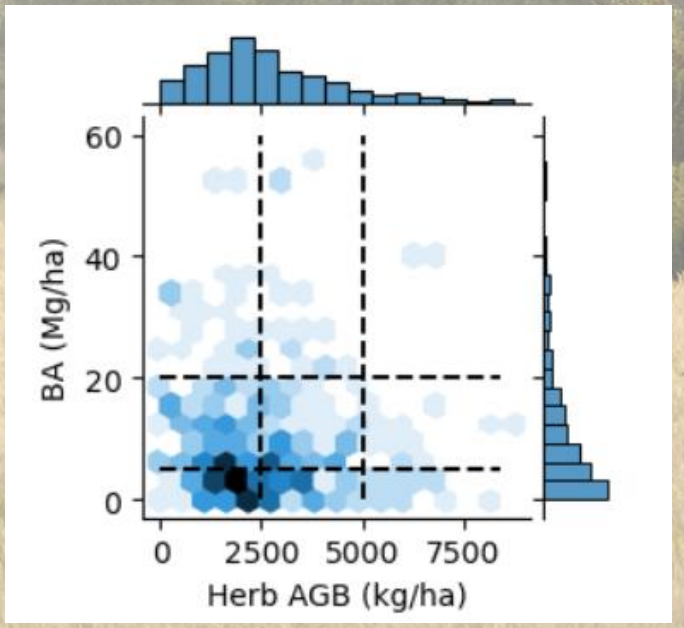
Combination of herbaceous and woody cover classes in patch classification



Venter 1990 Landscapes







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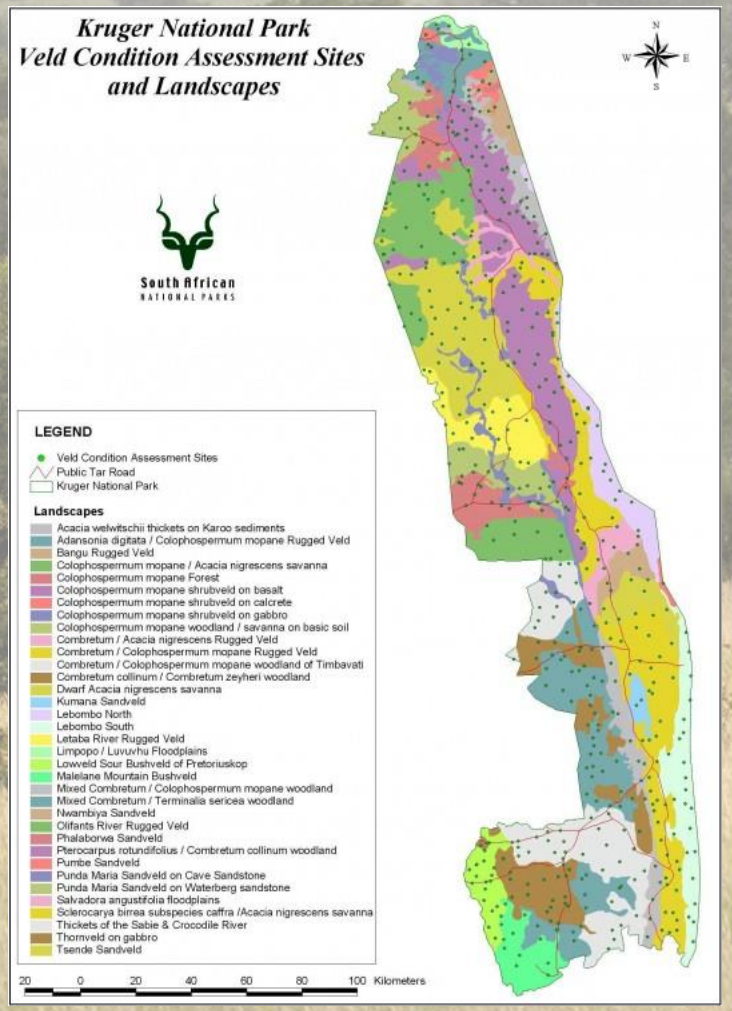
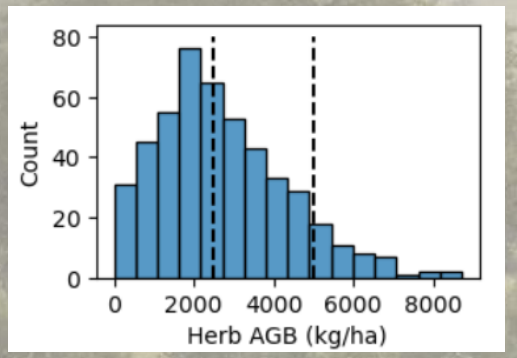
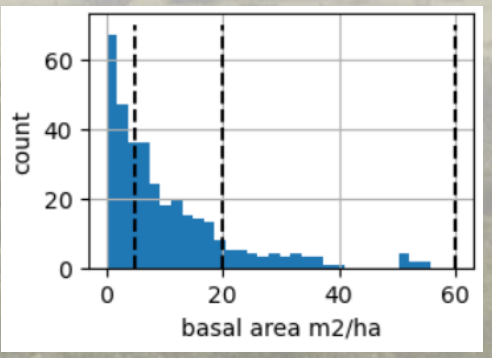


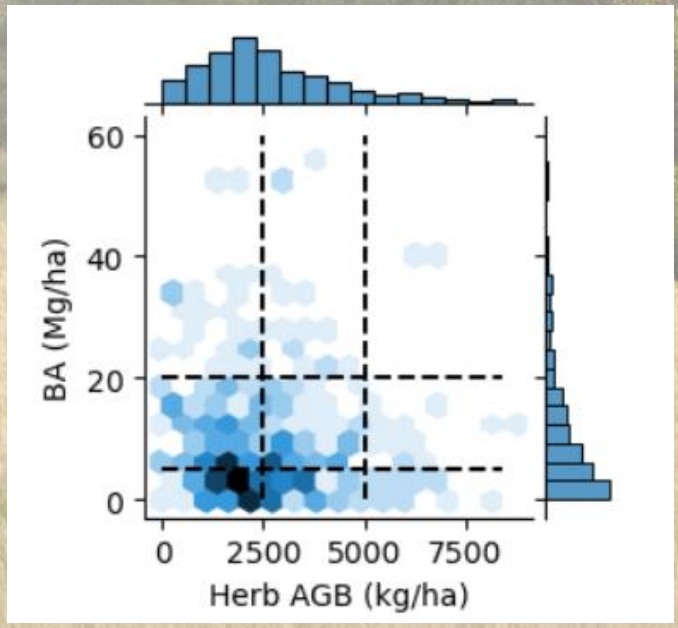
Venter 1990 Landscapes

Mixed Vegetation Classes

- VCA reference plots
  - Herbaceous biomass and woody basal area
- Predictors
  - Landsat time series (Landtrendr and CCDC)
  - PALSAR



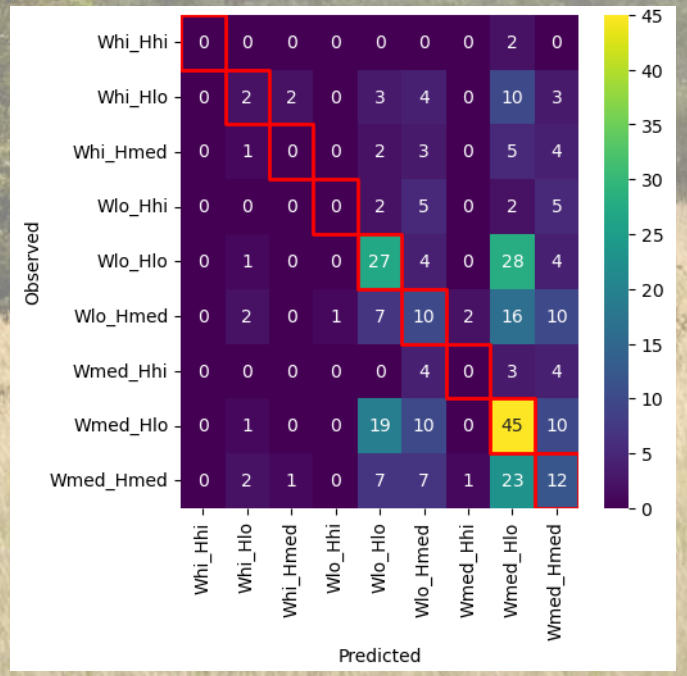


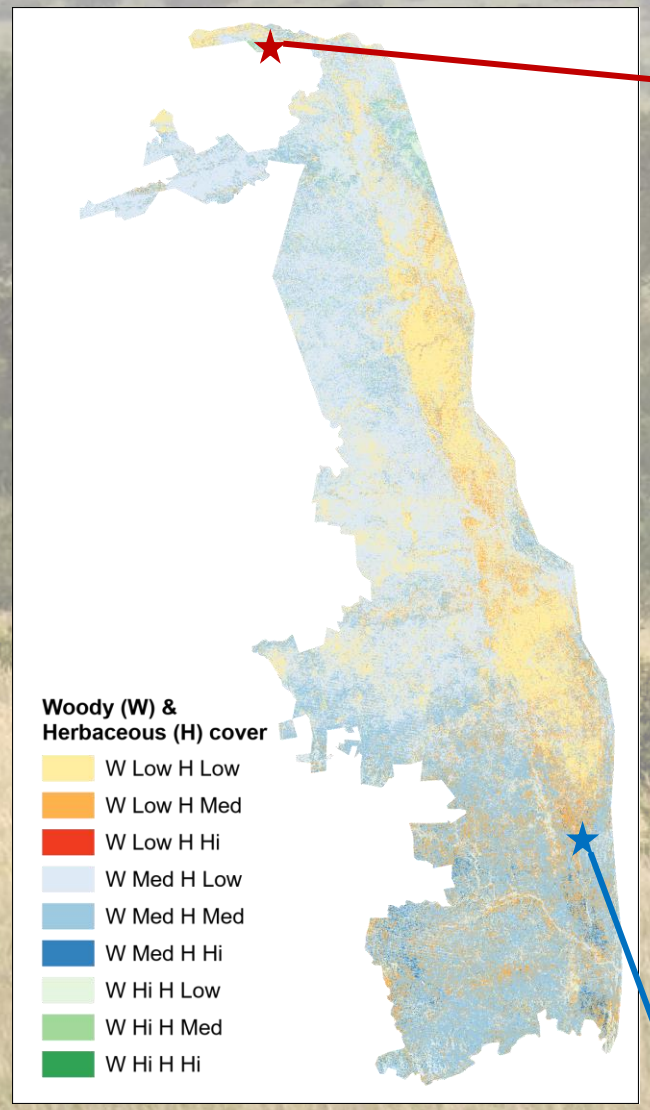


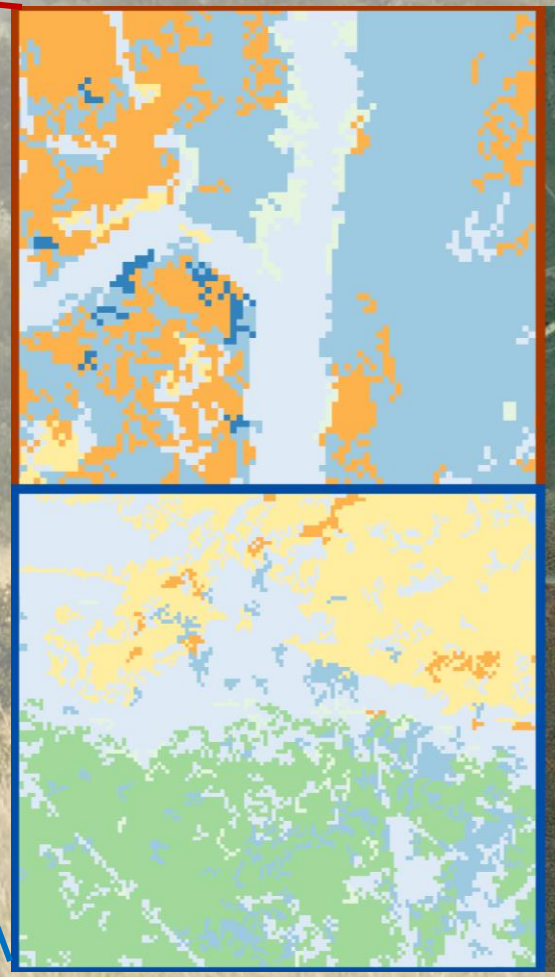
Vegetation Patch Classes:

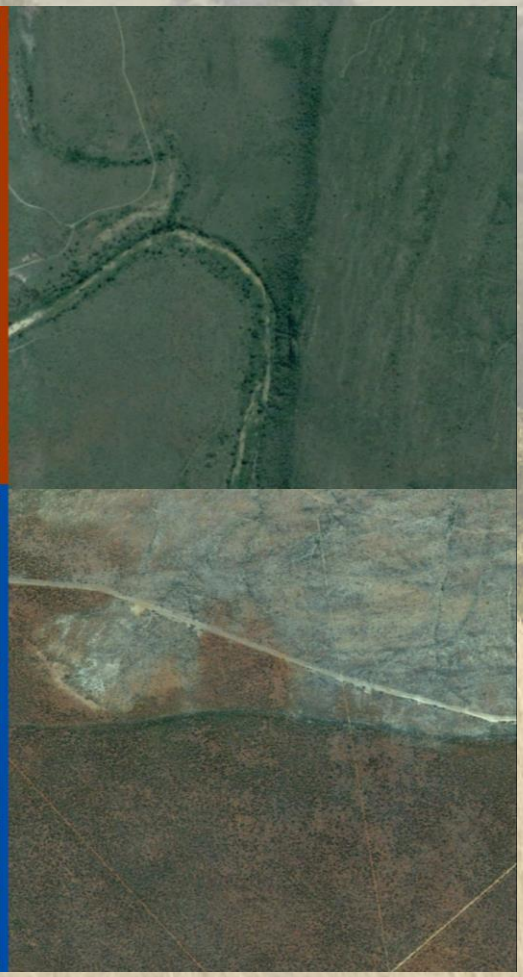
Combination of herbaceous and woody cover classes in patch classification

- Overall accuracy currently 0.32
- Many issues from messy reference data
- Expanding with APNR data
- Highest confusion between Wlo_Hlo & Wmed_Hlo,









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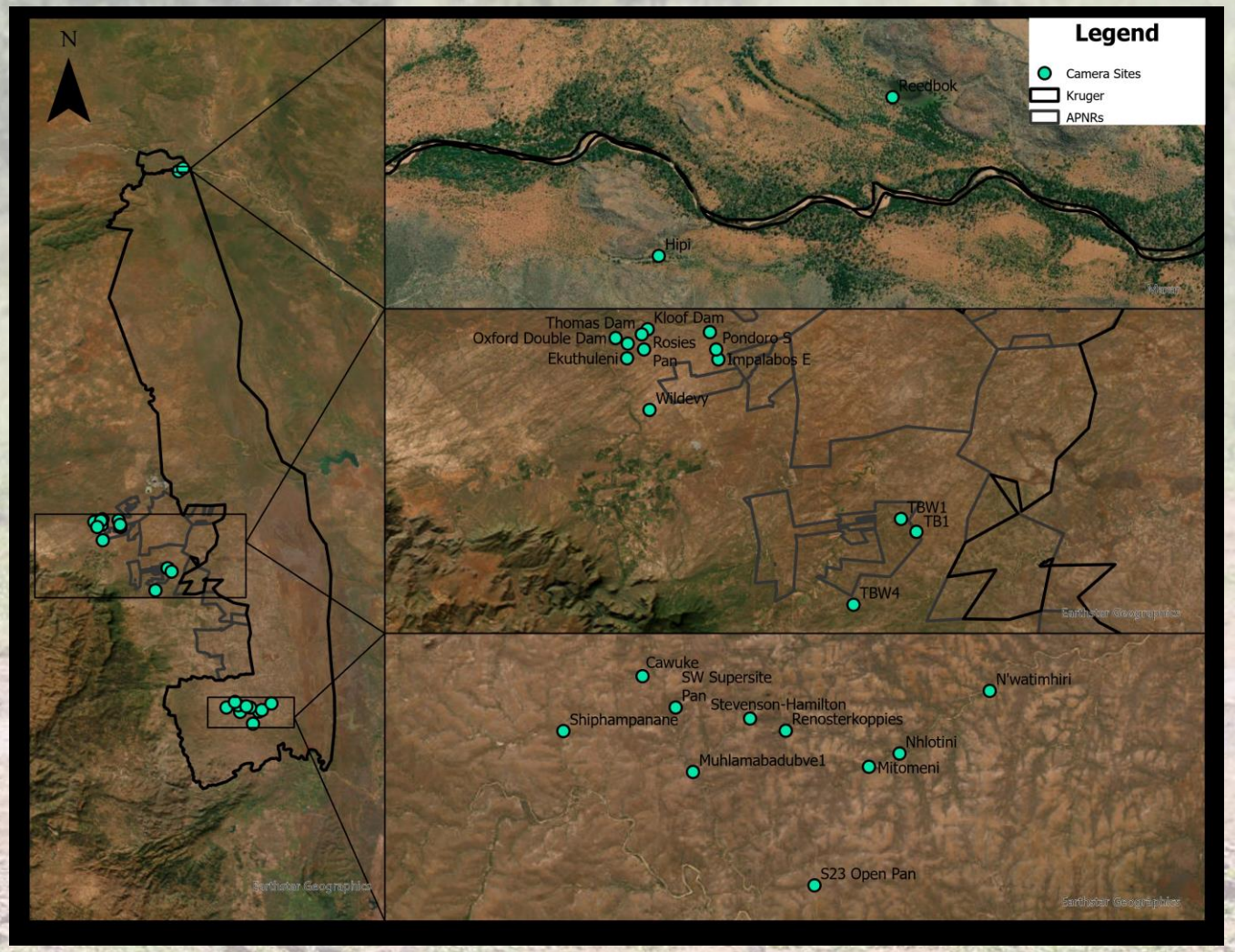
Predict habitat & connectivity for focal species

Develop Management Forecasting tool

Wildlife Occupancy and Connectivity

Wildlife Occupancy and Connectivity

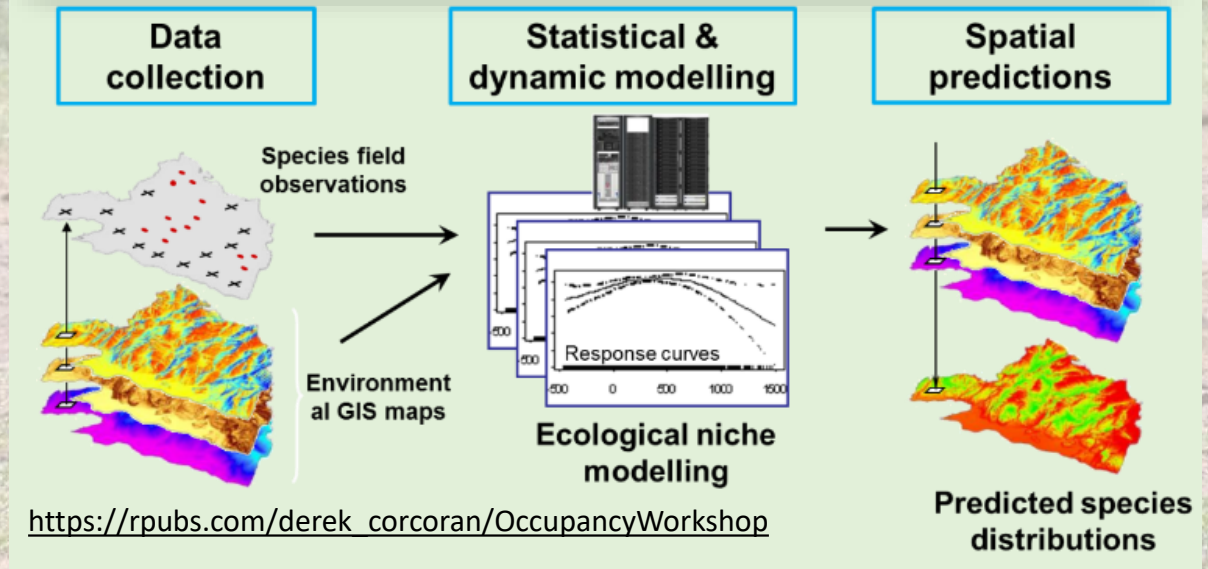


- Camera data collection focused on seasonal waterhole occupancy
- Will supplement with SANParks aerial survey data for larger occupancy modeling to further inform the connectivity models.

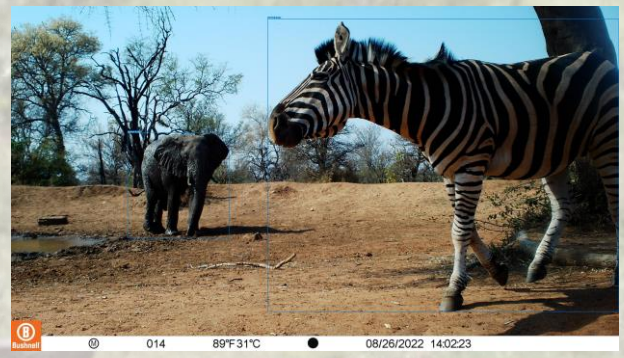
Wildlife Occupancy and Connectivity

Occupancy Modeling Covariates

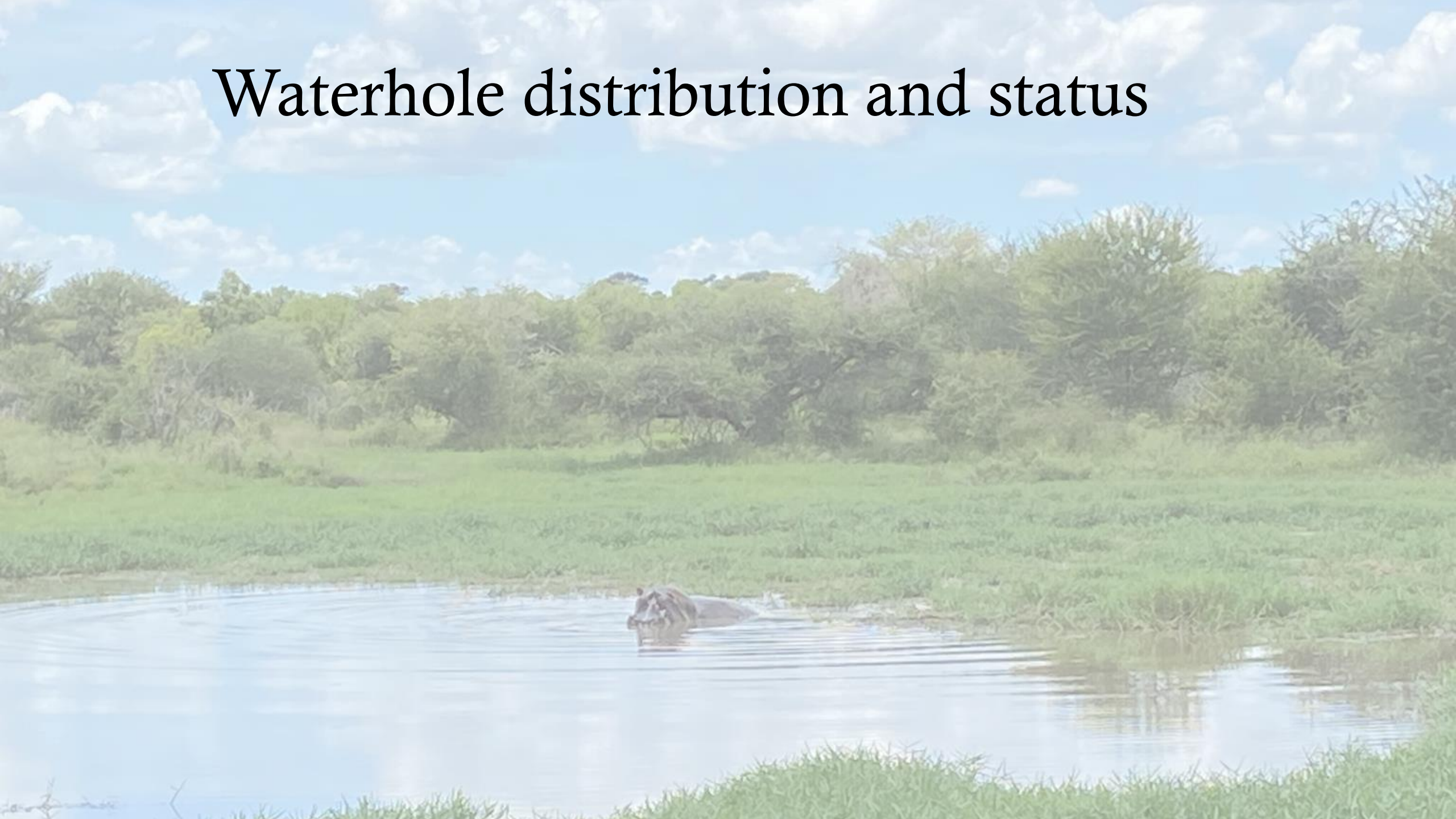
Category	*Variable*	*Distribution*	*Original Source(s)*
Landscape	Distance to nearest surface-water	Gamma	SANParks, Dept of FFE, ARC, TA
	Normalized Difference Greennes Index (NDVI)	Normal	Landsat 8
	Normalized Difference Wetness Index (NDWI)	Normal	Landsat 8
Habitat	Canopy Height (RF98)	Gamma	GEDI
	Canopy Cover (proportion of woody biomass)	Beta	GEDI
	Grassland/Savanna Classification	Binomial	Dept of FFE
	Ephemeral or Perennial Waterhole	Binomial	Landsat 8
Climate	Monthly Average Temperature	Normal	WorldClim
	Monthly Cumulative Precipitation	Gamma	WorldClim
Management	Artificial or Natural Waterhole	Binomial	SANParks, ARC, TA
	Private or Public Management	Binomial	Land Ownership



https://rpubs.com/derek_corcoran/OccupancyWorkshop



Waterhole distribution and status



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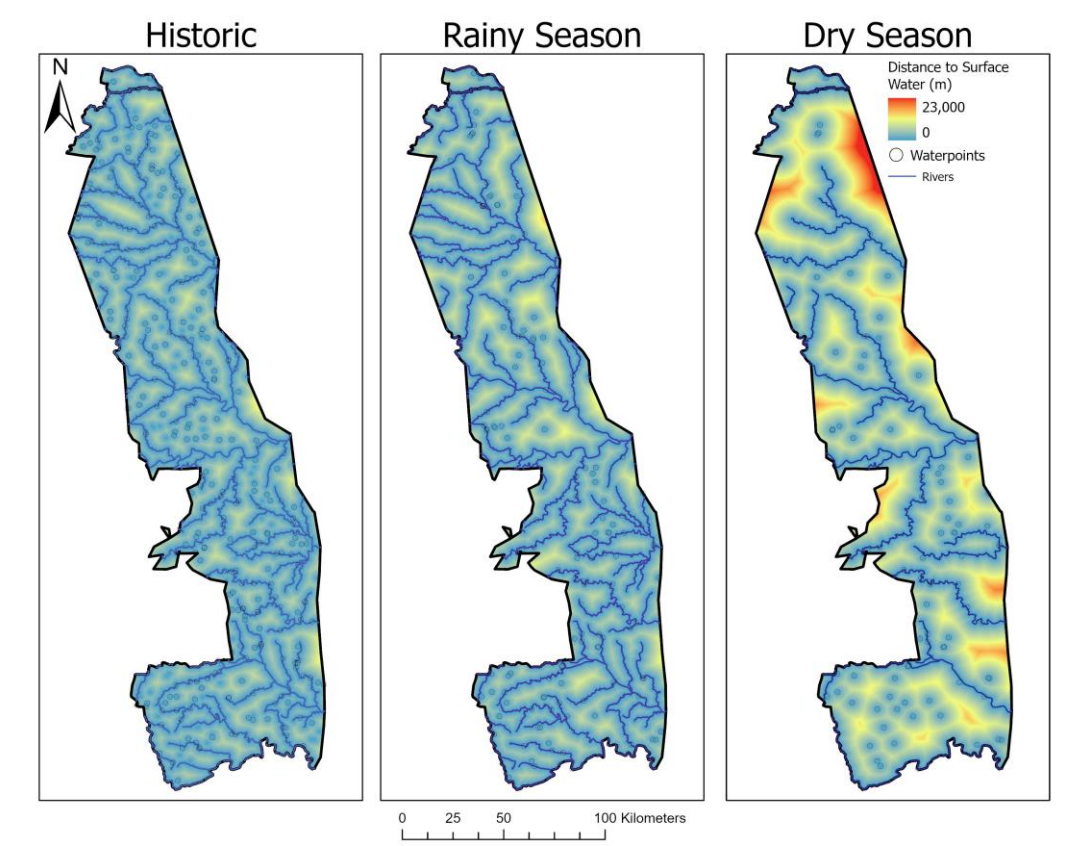
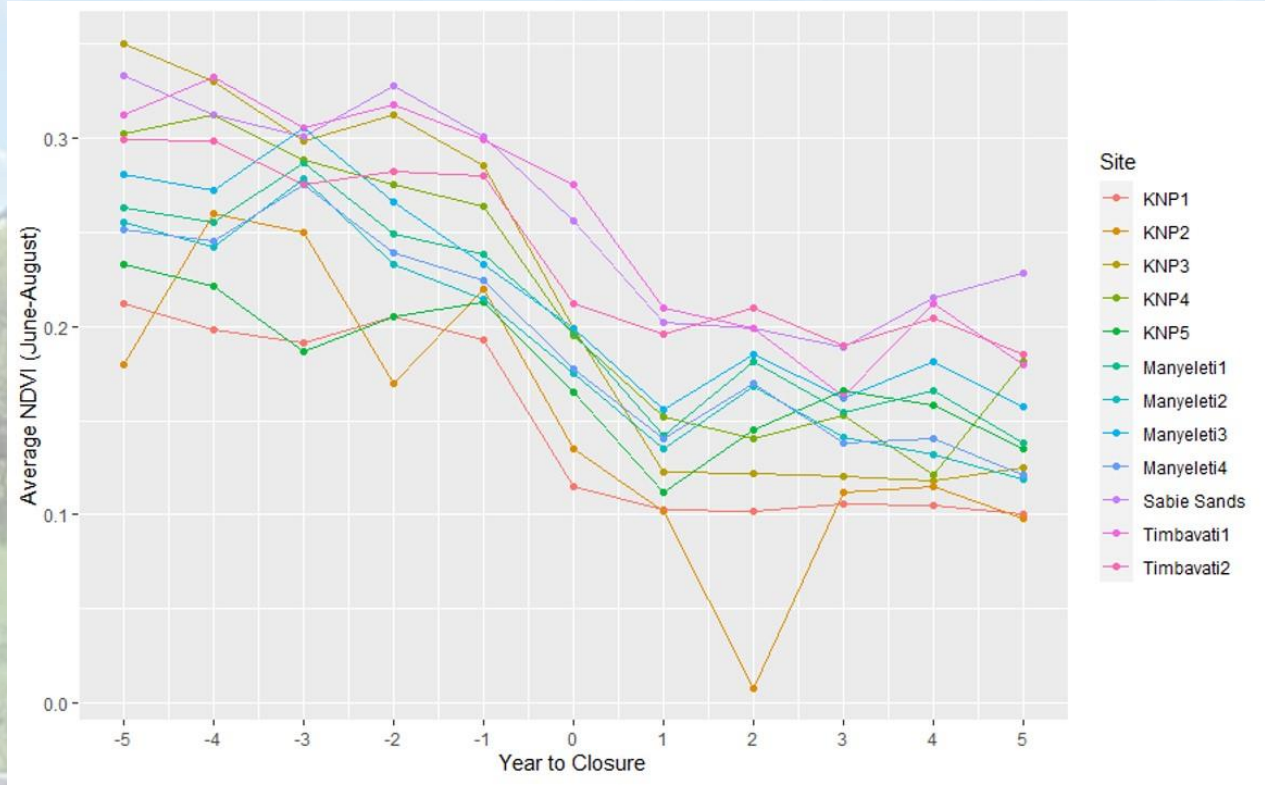
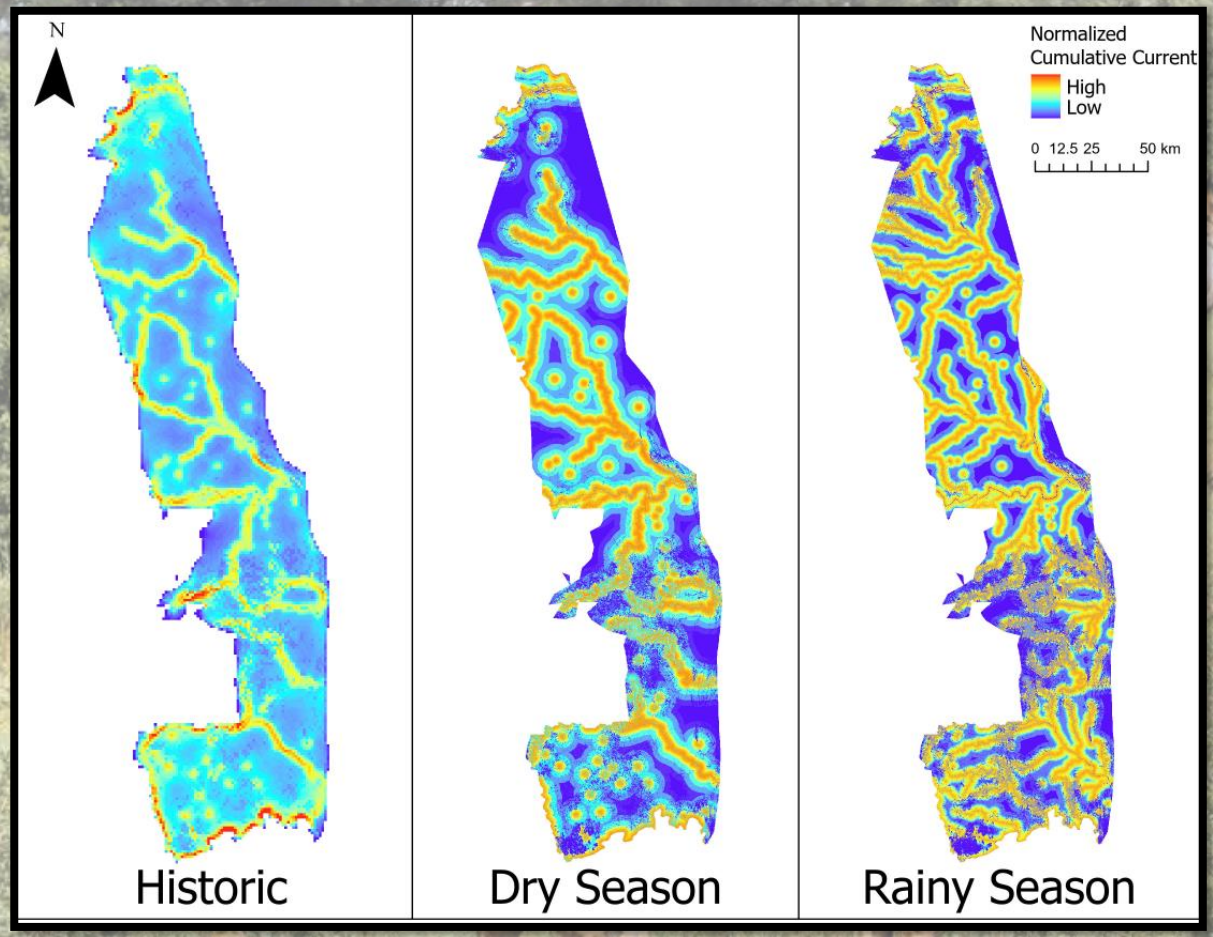


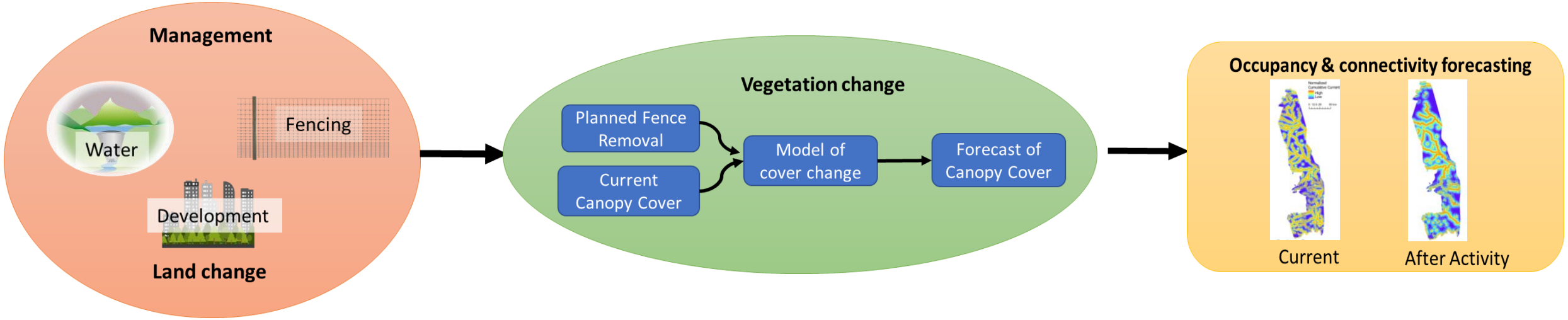


From Occupancy to Habitat Connectivity

- Occupancy models to inform seasonal “resistance” layers
- Circuit Theory [Circuitscape/Omniscape]
- Based on changing environmental variables



Decision Support Tool



Thank you!

A special thank you to all our South African team members!