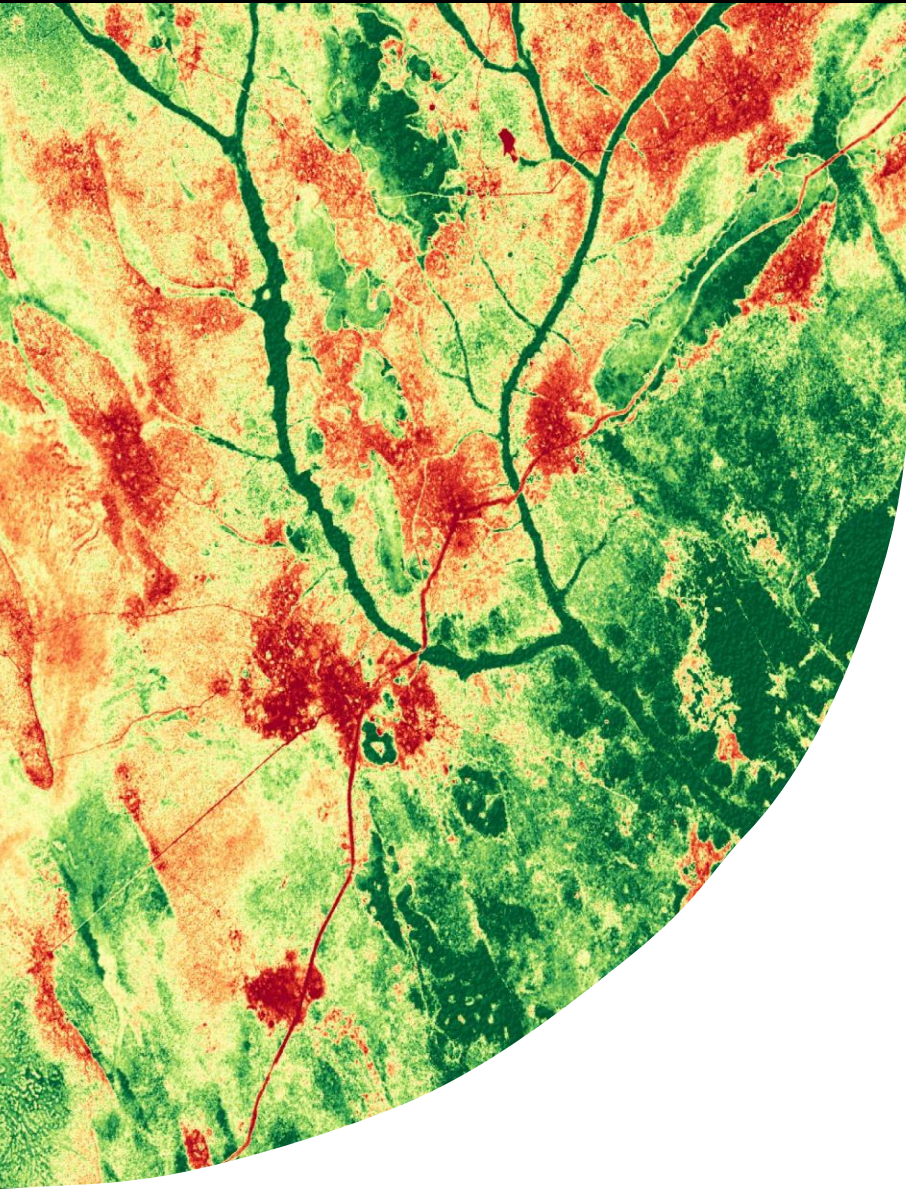




National Aeronautics and
Space Administration



Garissa County Ecological Conservation

Mapping and Characterizing Invasive Shrub
Encroachment across Kenyan Savannas to Protect
Endangered Hirola Antelope Habitat

Nancy Nthiga, Angie Cruz, Raj Yadav, Jessica
Sirois (Analytical Mechanics Associates)

Colorado – Fort Collins | Spring 2025



Our Team



Nancy Nthiga



Angie Cruz



Jessica Sirois



Raj Yadav



Hirola Antelope (*Beatragus hunteri*)

- Most endangered antelope in the world
- Restricted to a small area in Eastern Kenya
- Relies on grassland habitat

Grassland conservation and restoration is key for hirola conservation and benefits local community livelihoods



Image credit: Hirola Conservation Program



Image credit: Hirola Conservation Program



Community Concerns

Tourism Decline



Image credit: Wiki Commons



Image credit: Wikimedia Commons

Depleted Grazing Locations for Livestock and Wildlife



Image credit: UNEP / Lisa Murray

Threat to Pastoralism



Image credit: Pastoralist Girls Initiative (PGI)

Human-wildlife Conflict

Project Partner

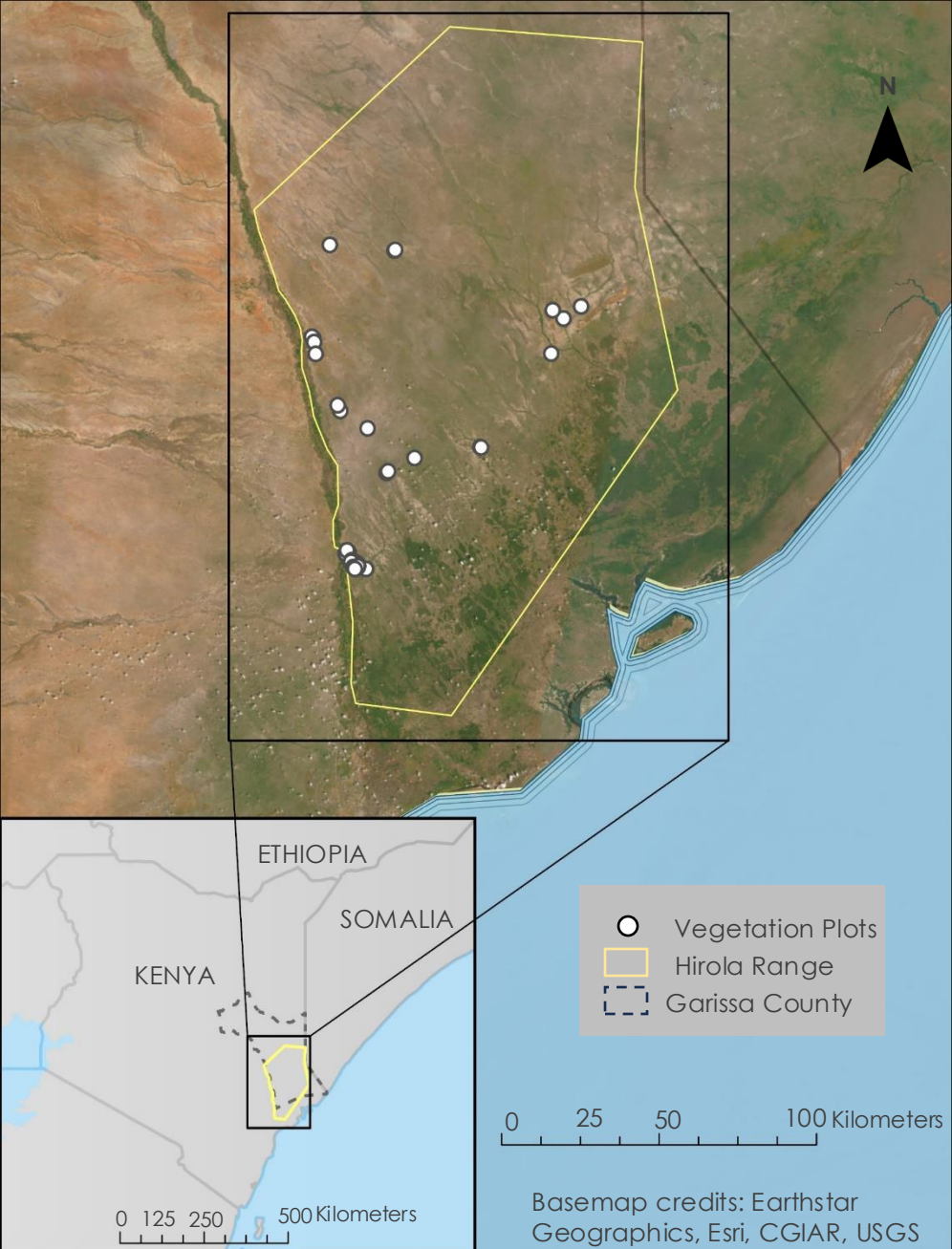
The Hirola Conservation Program

- Adaptive management approach
- Managing conservation efforts
- Focus on scientific research
- Combining local indigenous knowledge

Recent efforts include:

- Manual removal of invasive woody shrubland
- Seed planting for native grassland restoration





Study Area & Period



Current Hirola Range

- Eastern Kenya
- Garissa County
- 18,811 km²

Study Period

- 1986 – 2025

Area Concerns

- *Prosopis juliflora*

Region Characteristics

Rainy Season		Dry Season	
Long Season	Short Season	Long Season	Short Season
Apr. – Jul.	Nov. – Dec.	Jan. – Mar.	Jul. – Oct.

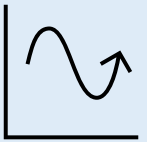


Project Objectives

Assess Woody Vegetation: Utilize Earth observation data to study changes in woody vegetation over time



Analyze Spatiotemporal Expansion Trends: Quantify patterns of woody encroachment



Exploring Prosopis Prediction: Understanding the feasibility of predicting single-species vegetation, like *Prosopis juliflora*



Earth Observations

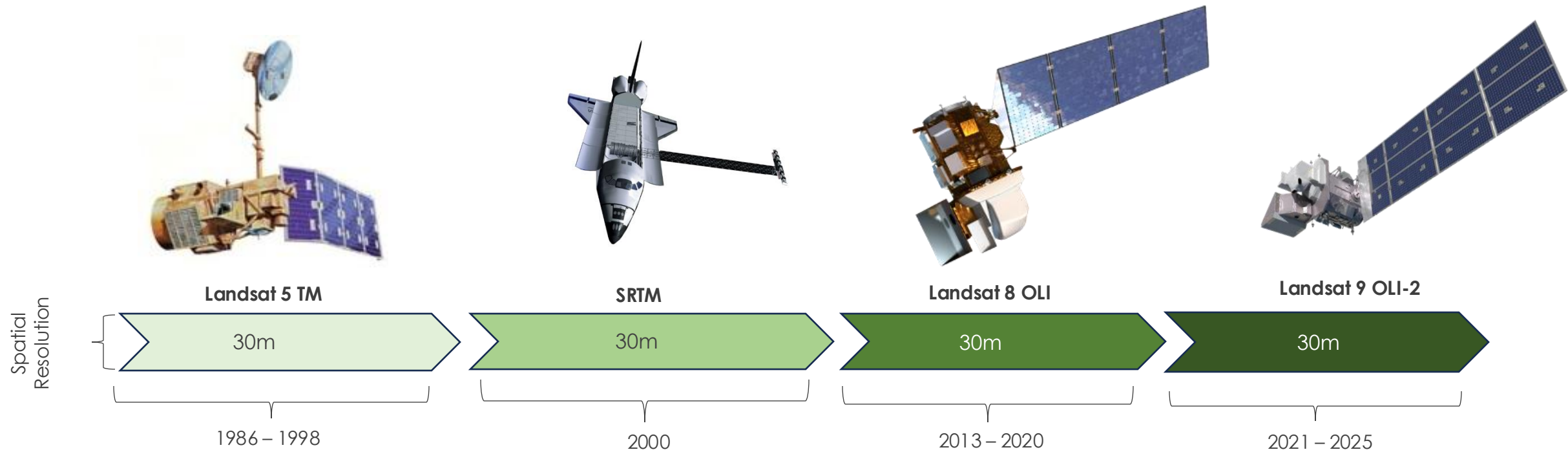
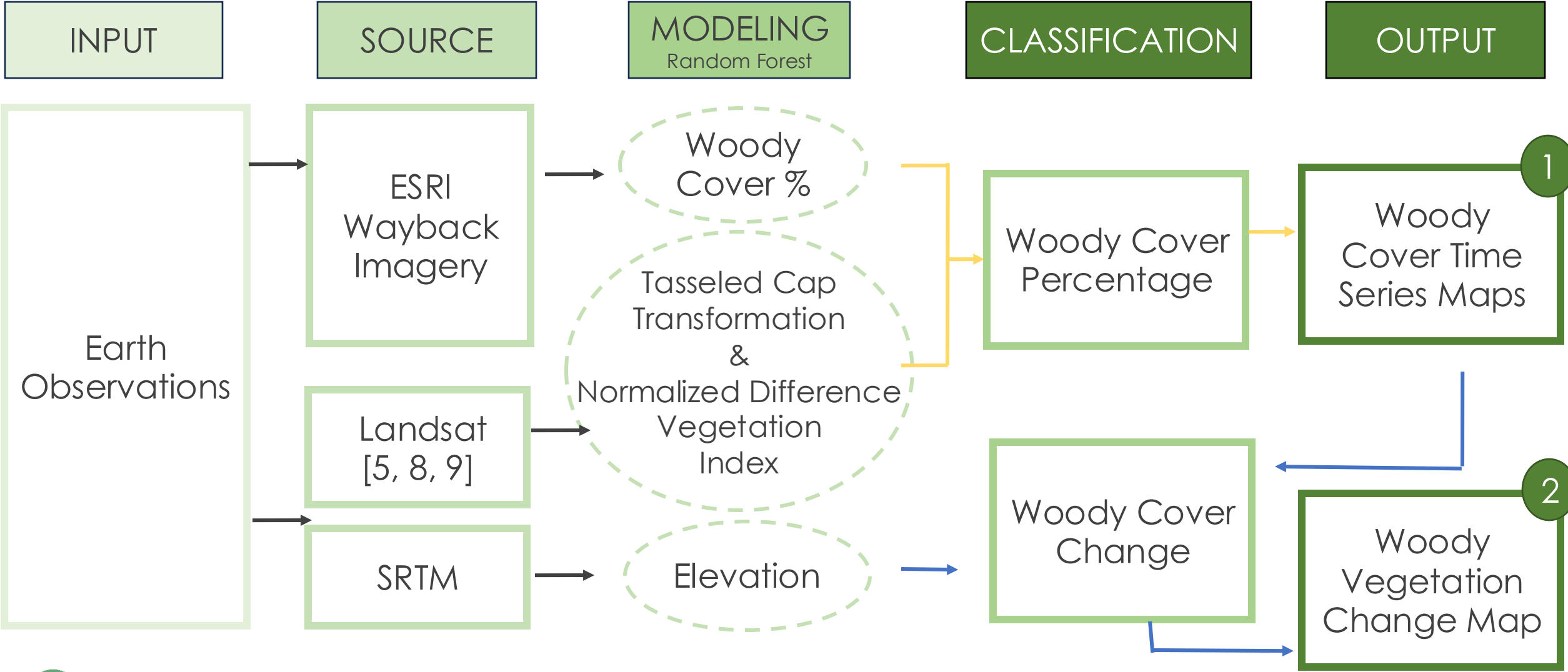
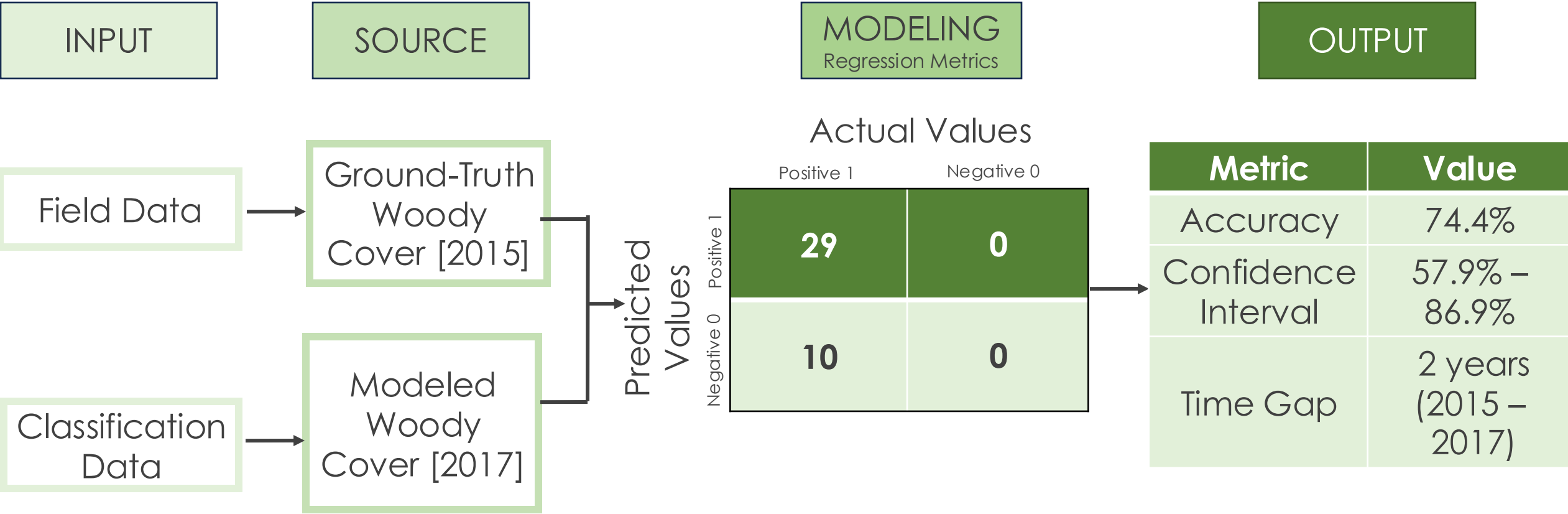


Image credits: NASA, Google Earth

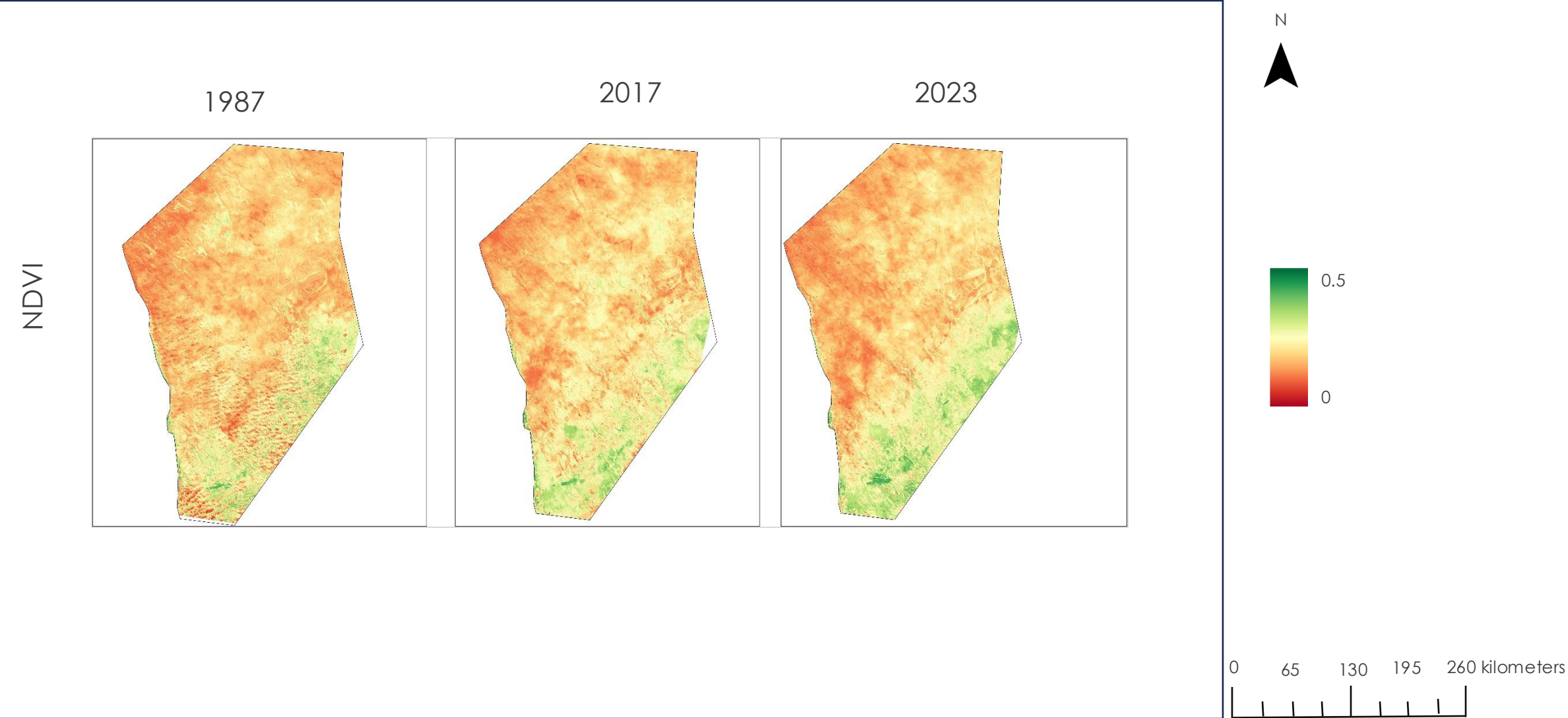
Methodology: Detection



Methodology: Accuracy Assessment



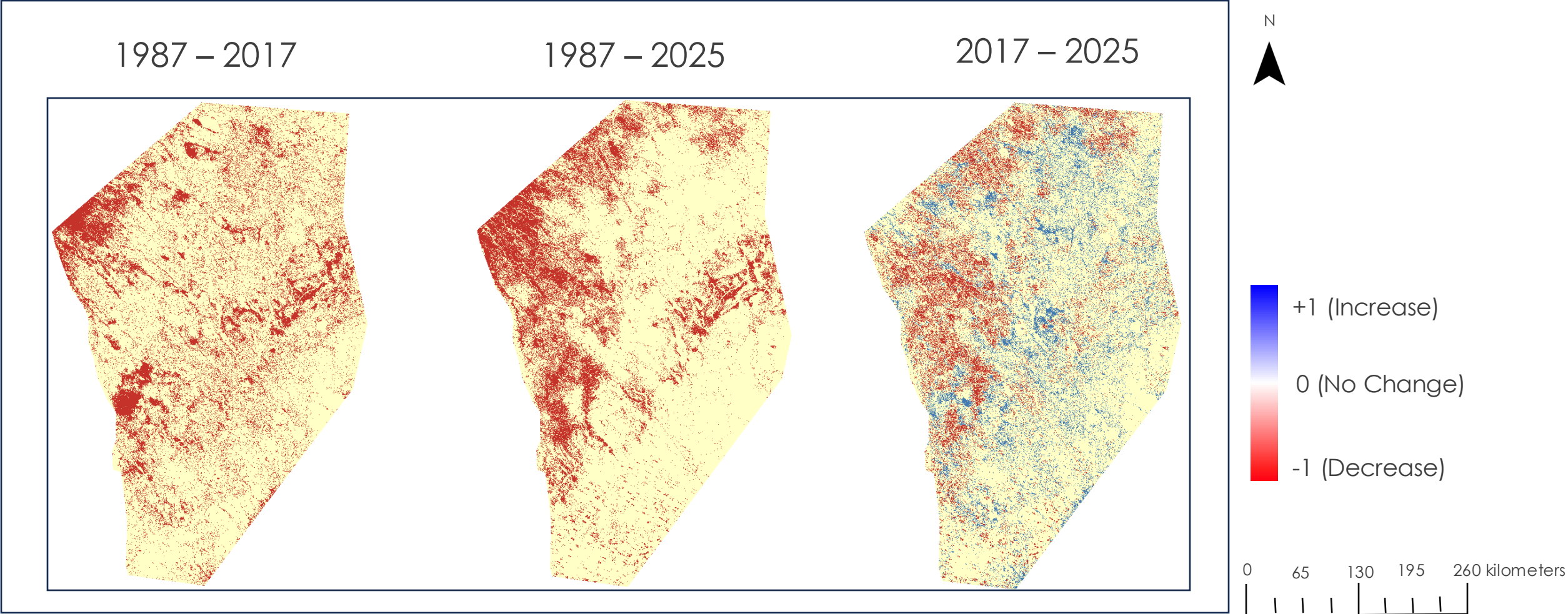
Results: Vegetation Trends (1987 – 2023)



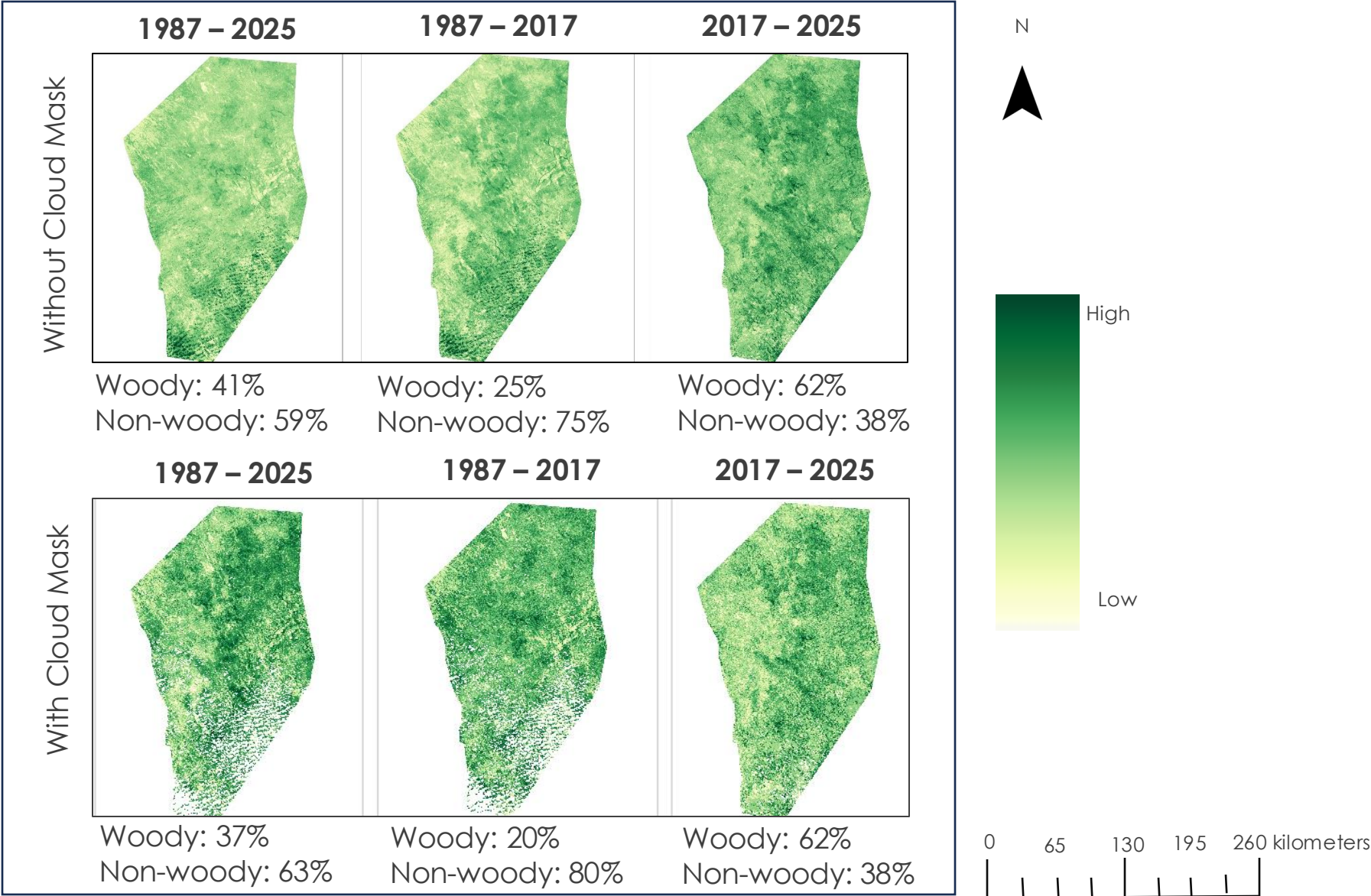
Results: Woody Vegetation Density Time Series Map (1987 – 2025)



Results: Woody Vegetation Binary Change Patterns (1987 – 2025)



Results: Woody Vegetation Encroachment Progression



Limitations

Historical Imagery

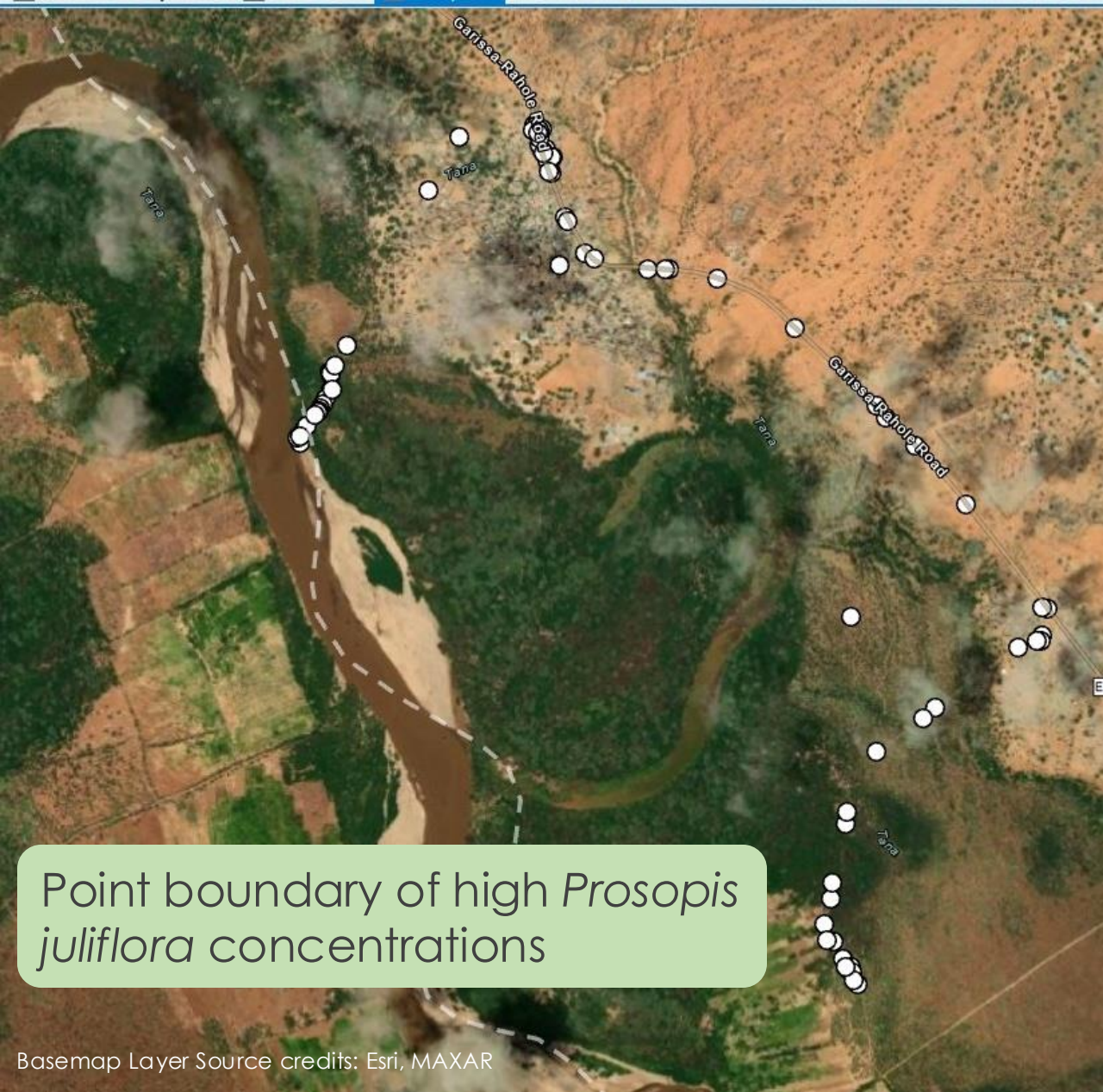


Cloud Free Imagery



High Resolution Imagery





Limitations – *Prosopis juliflora*

Species of Concern

- Invasive shrub native to South America
- Outcompetes native species
- Threatens grassland habitat
- Dense growth impedes wildlife movement

Mapping Limitations

- Habitat: Tana River floodplain
- Location: Outside of study area
- Extent: Bordered by trails and roads

Feasibility study can set the foundation for species specific analyses in the future



Feasibility & Partner Implementation

Feasibility

- ✓ Feasible to use NASA EO-1 to analyze woody shrub encroachment **DEPENDENT** on study period
- 🔍 High resolution imagery limited to recent years (2017 – 2025)
- 🏠 Not feasible to use NASA EO-1 to track *Prosopis juliflora* in this case

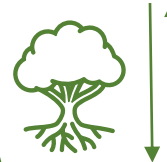
Potential Partner Implementation



NDVI time series maps could aid in visualizing vegetation trends and transition zones



Indices may help prioritize restoration areas



Woody vegetation maps could help identify encroachment regions at risk of losing grassland habitats



Conclusion

Statistics:

- 41% of the landscape showed an increase in woody vegetation cover from 1987–2025
 - 62% of the landscape showed an increase from 2017–2025

Potential Impact:

- Showcase issue & communicate to local communities
- Predict future trends in encroachment
- May guide habitat restoration for hirola & other affected wildlife

Deliverables **may** provide insight for decision-making

- Track patterns in woody vegetation for preventative action
- Identifying areas of significant encroachment for management & removal

Image credits: Hirola
Conservation Program



Acknowledgements

Partners from the Hirola Conservation Program

- Dr. Abdullahi Ali, Sangale Edwin, Mohamed Hussein

Science Advisor

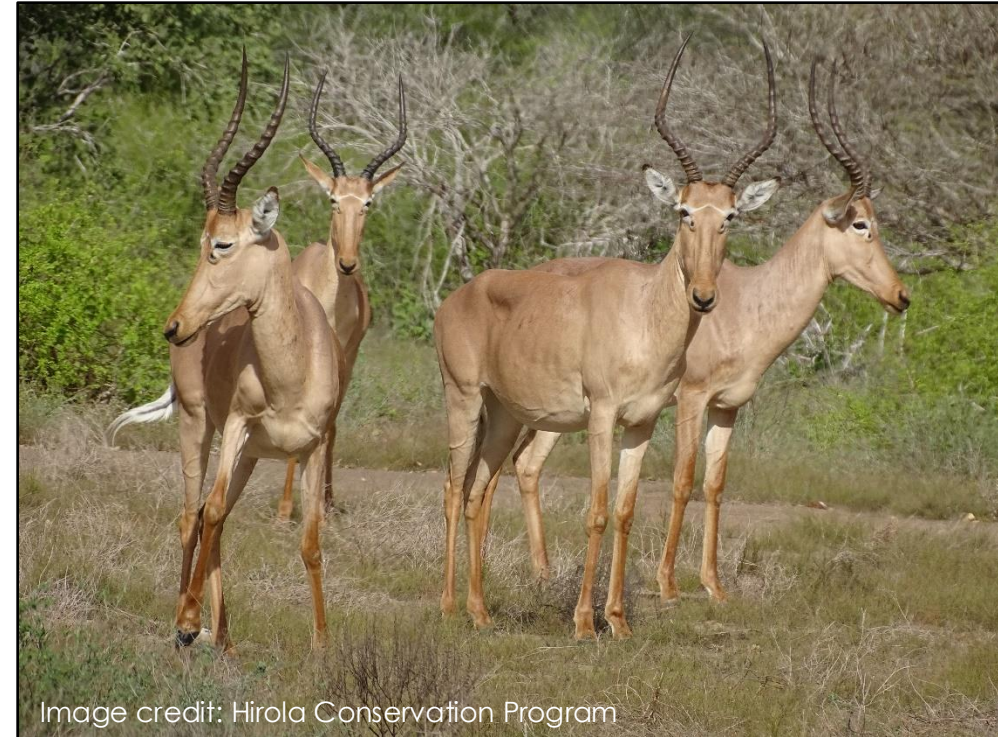
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- Truman Anarella (Lead at Colorado – Fort Collins)
- Isabel Tate (Project Coordination Fellow)

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- Dr. Kent Ross (NASA Langley Research Center)



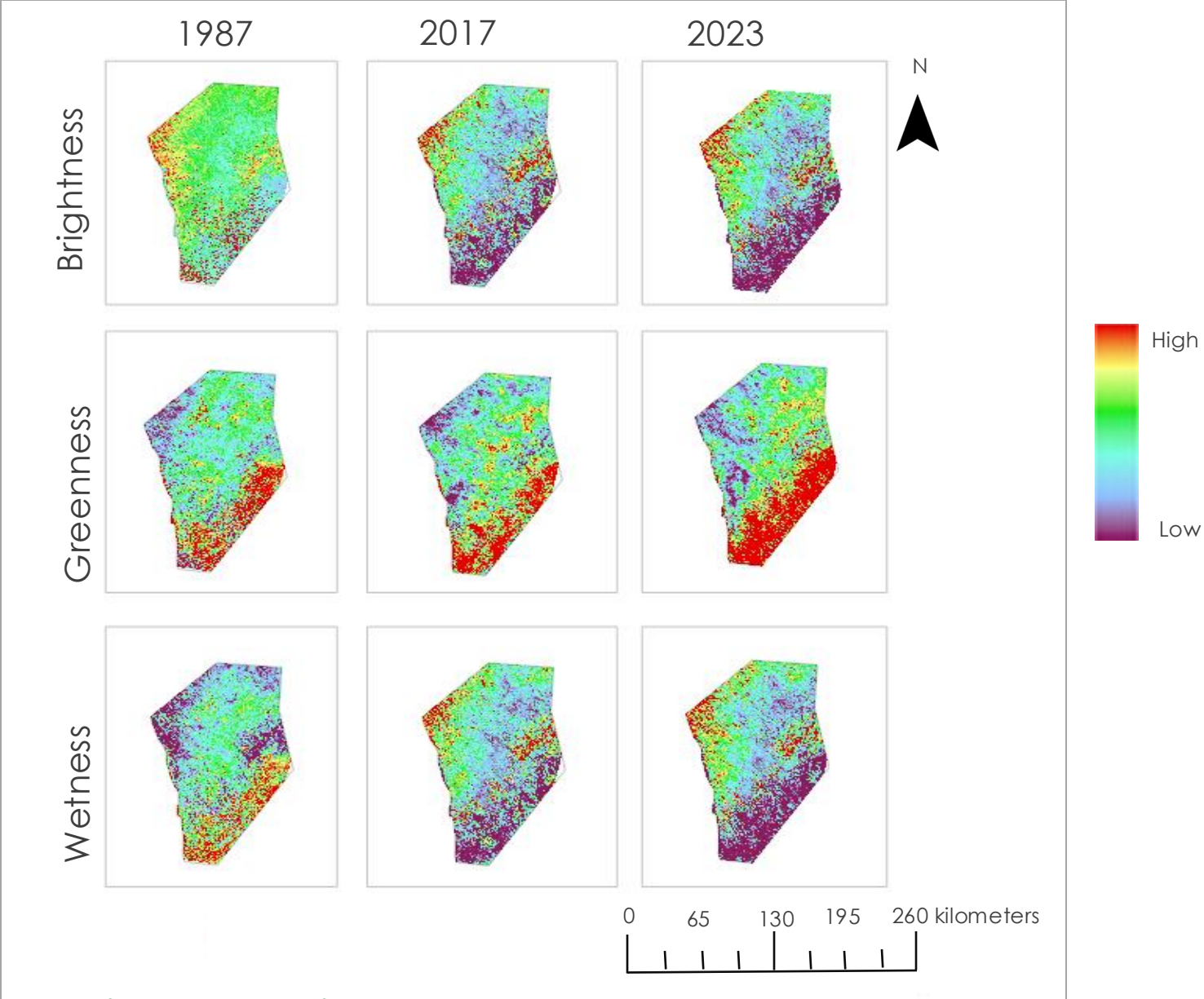
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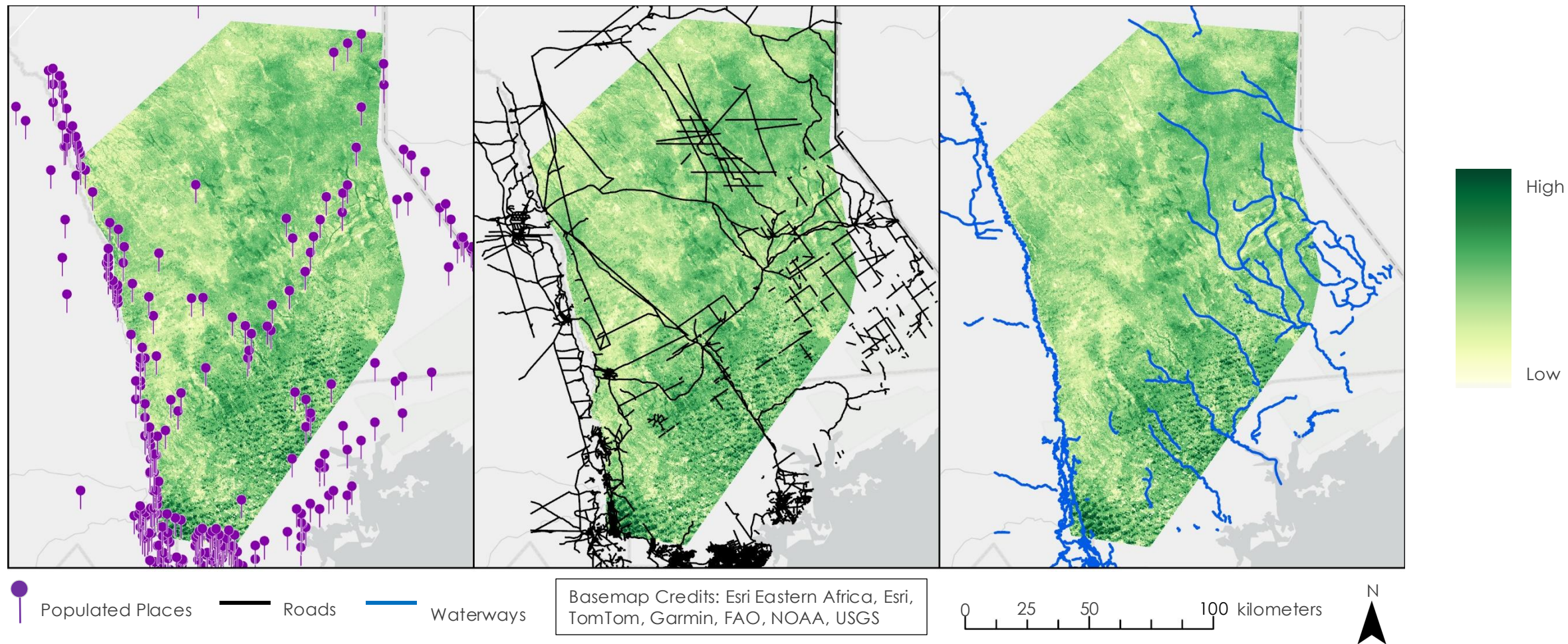
Backup Slides



Results: Tasseled Cap Transformation



Additional Landscape Features



Populated places, road, and waterway datasets from Humanitarian OpenStreetMap (HOT) Team