RAMONA

Rangeland Monitoring for Africa

Using Earth Observation - Continental Demonstrator

EO for Africa Symposium 2024

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esa

GeoVille

DHI GRAS

Tasks

1) Map African rangelands
2) Quantify rangeland herbaceous biomass monthly
3) Quantify rangeland vegetation phenology
4) Define and map rangeland ecosystem types
5) Rangeland social-ecological trade-offs and performance

Extent: Africa

Resolution: 10 m

Data: Sentinel 1-3

Period: 2022 (±3 months)

An African rangeland

Also a rangeland

Still a rangeland...

Photo by Michael Munk

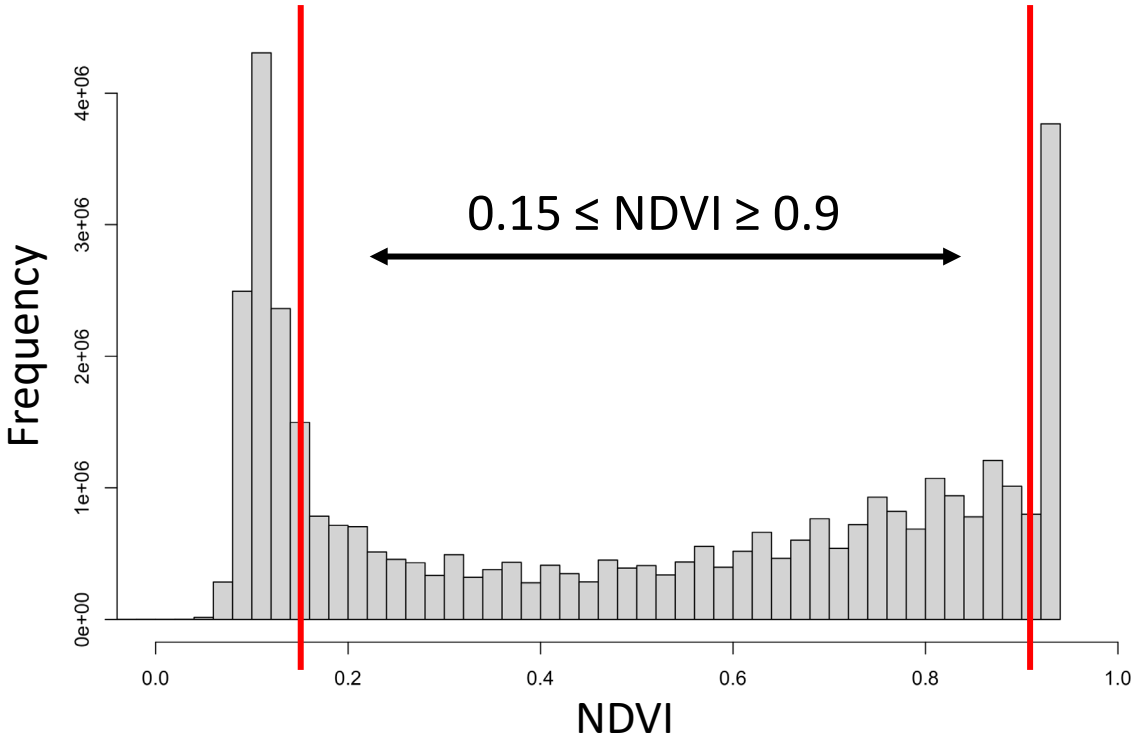
A rangeland is any vegetated land that is not cropped and not closed-canopy forest

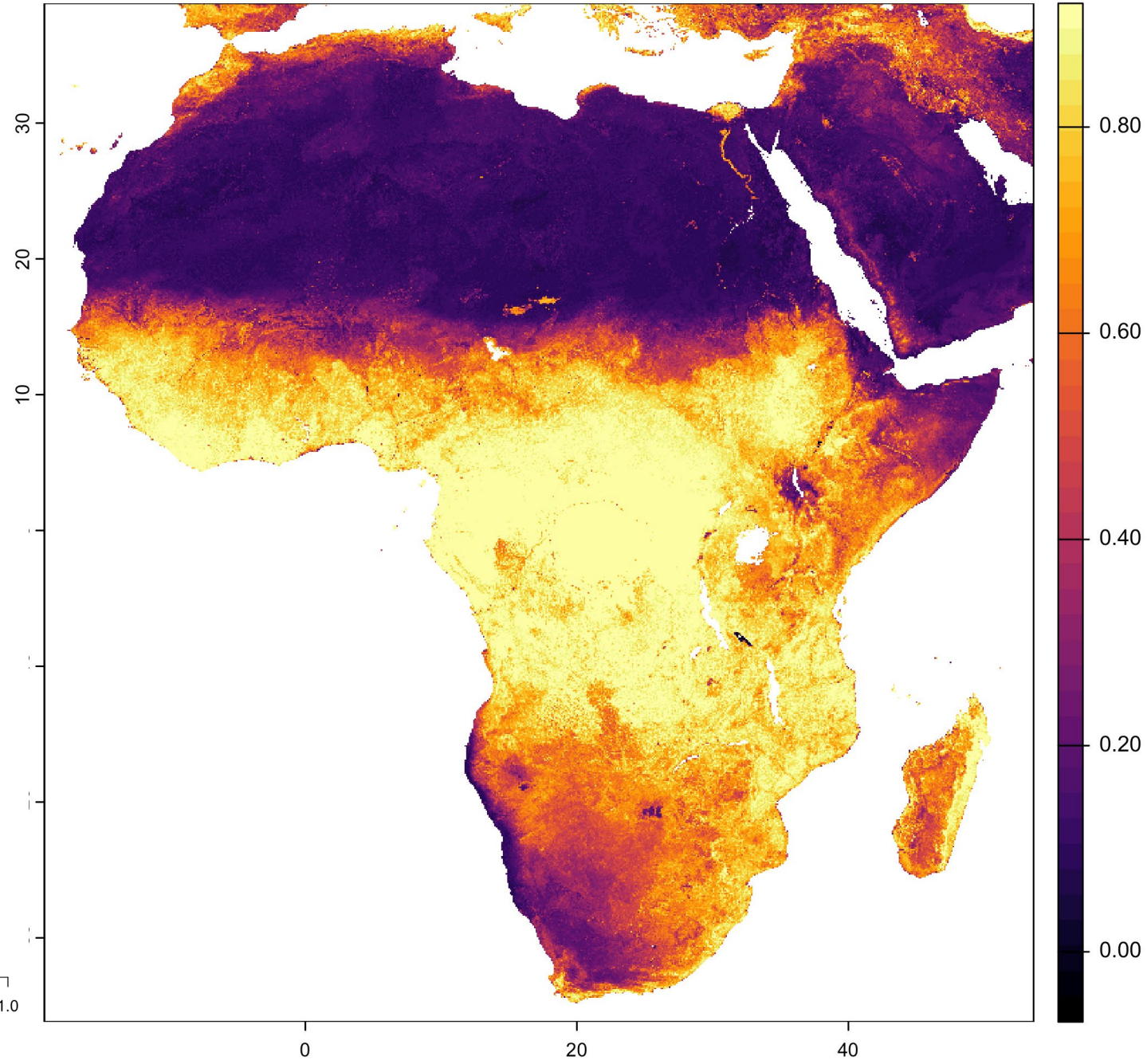
Nearly identical to FAO, IUCN, UNEP, ILRI, WWF, World Bank, etc. definitions but easier to operationalise with EO data

Mapping African rangelands – the long-term maximum envelope

African rangeland envelope

Long-term maximum NDVI
1999- 2019 from MODIS





African rangeland envelope

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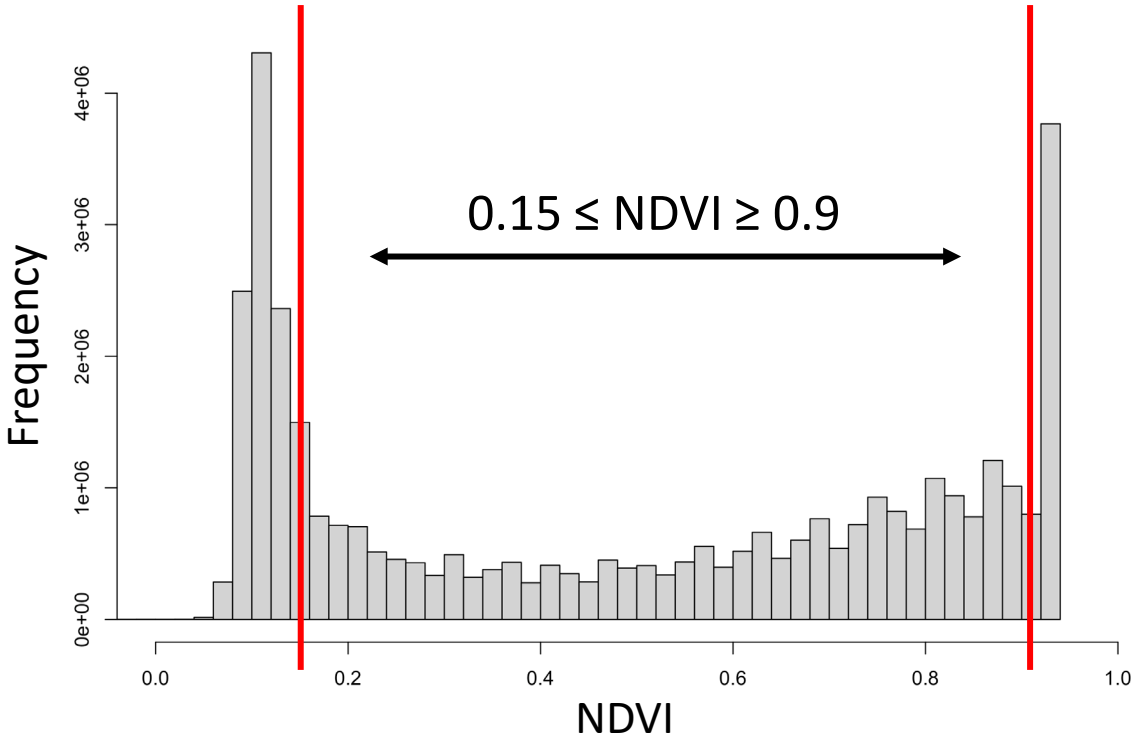
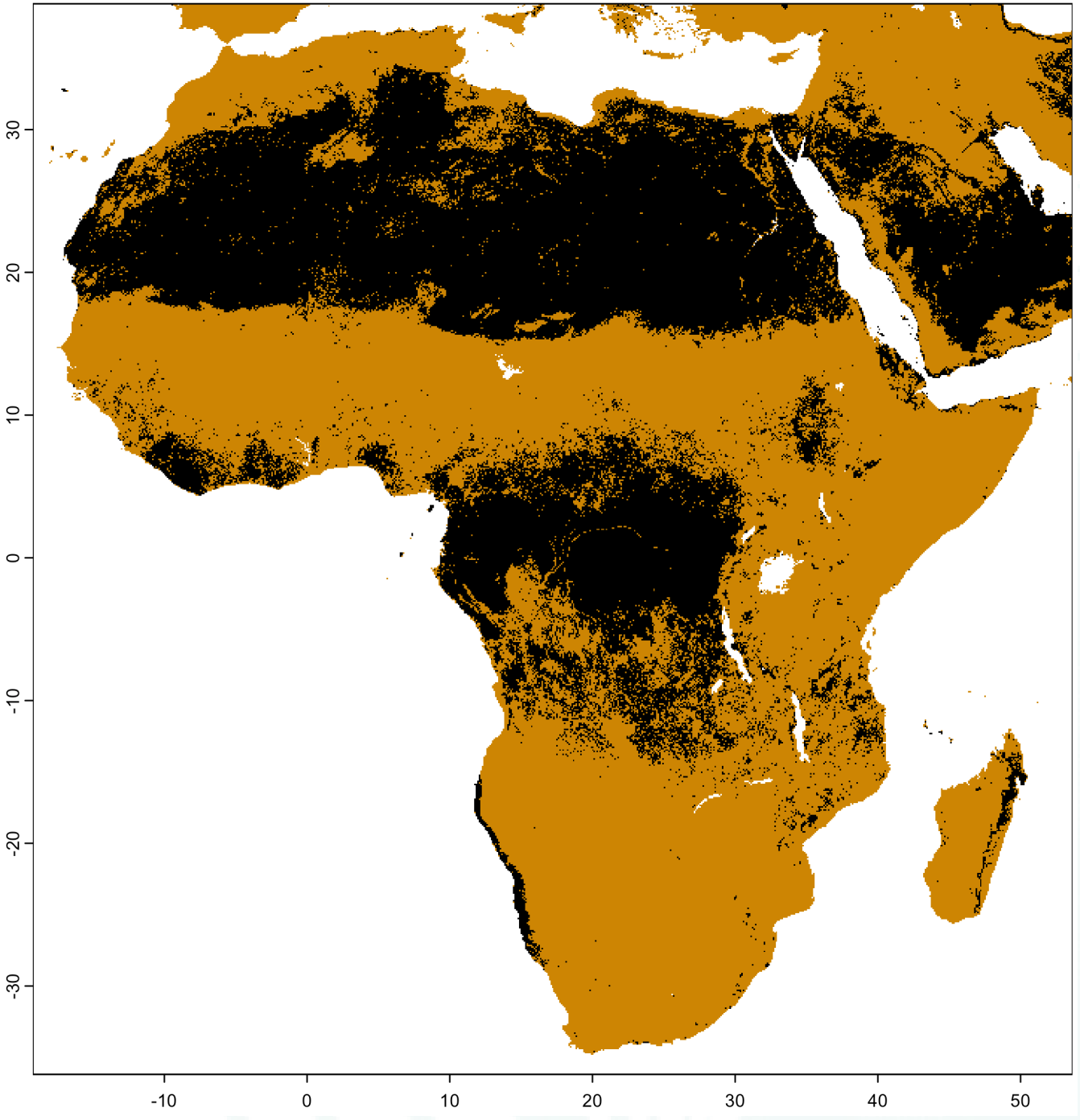


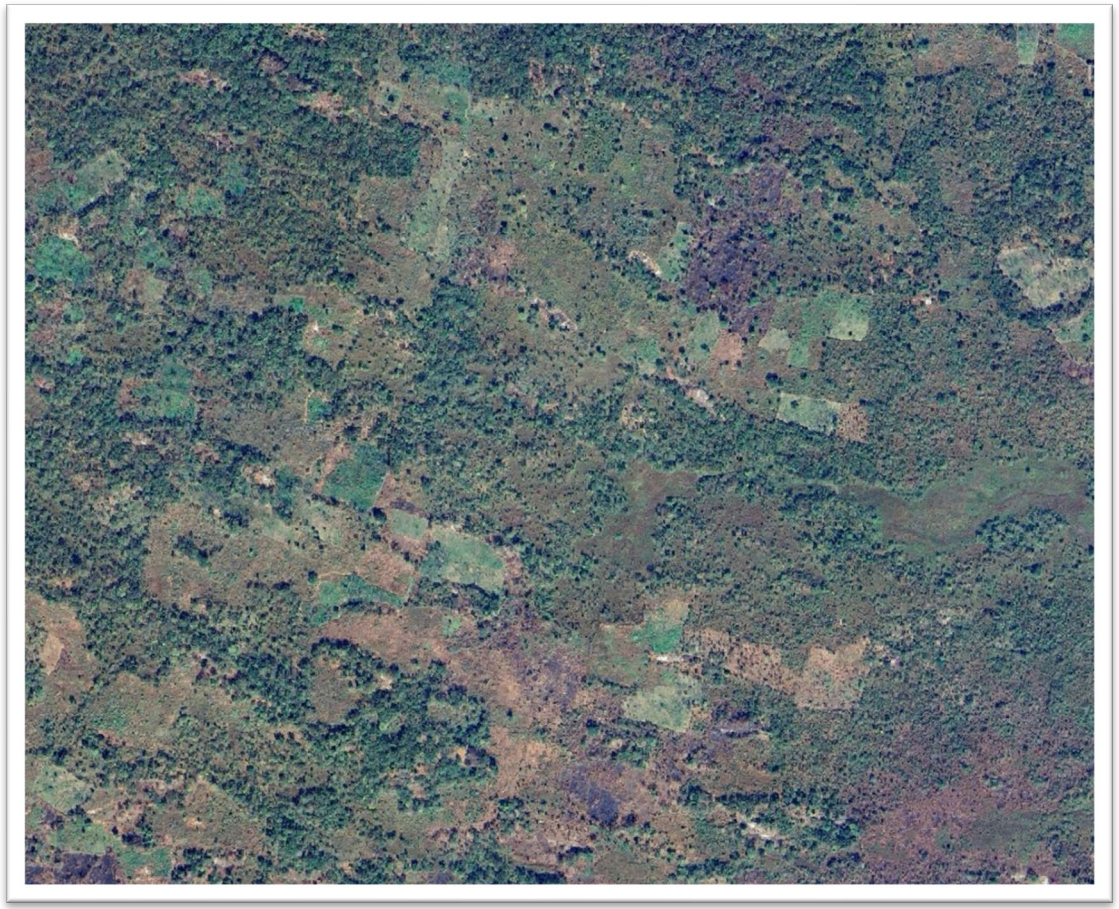


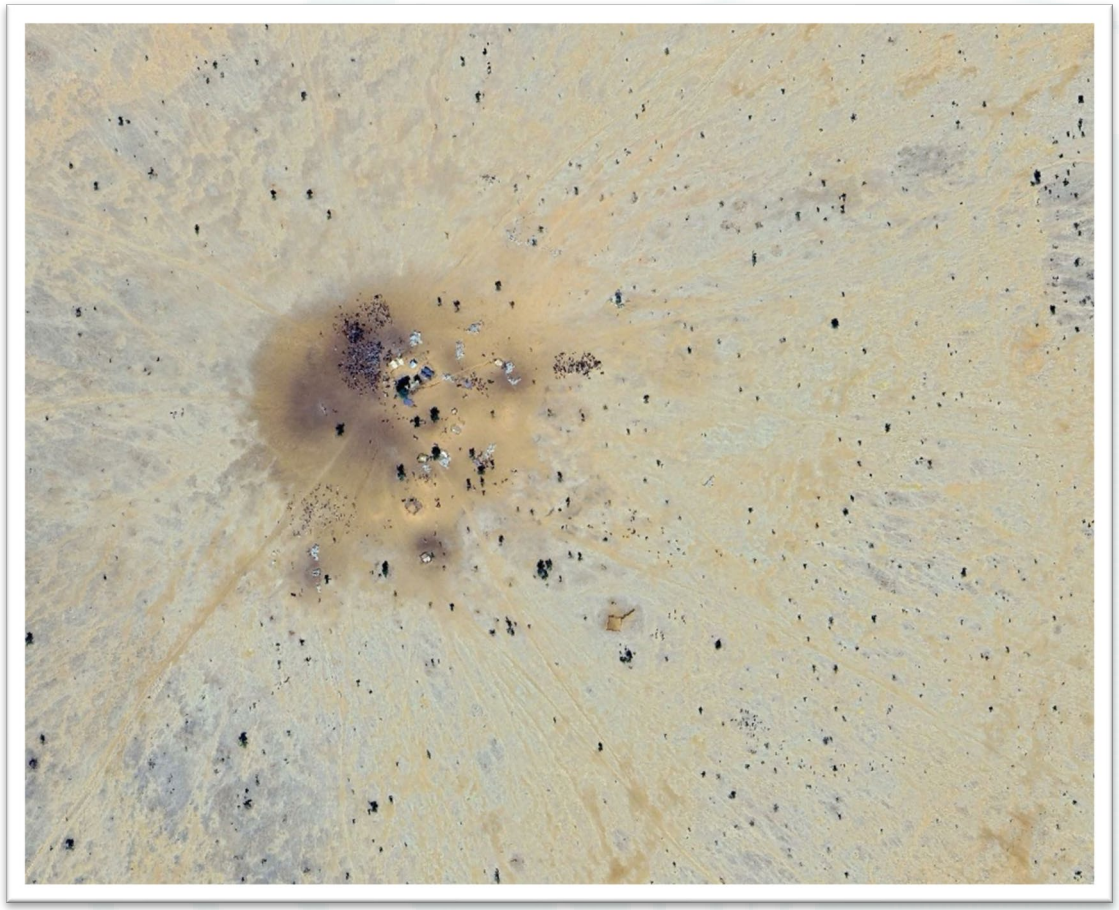
Mapping African rangelands – high-resolution 2022 rangeland extent

(i.e. within the long-term envelope)

High-resolution rangeland extent for 2022

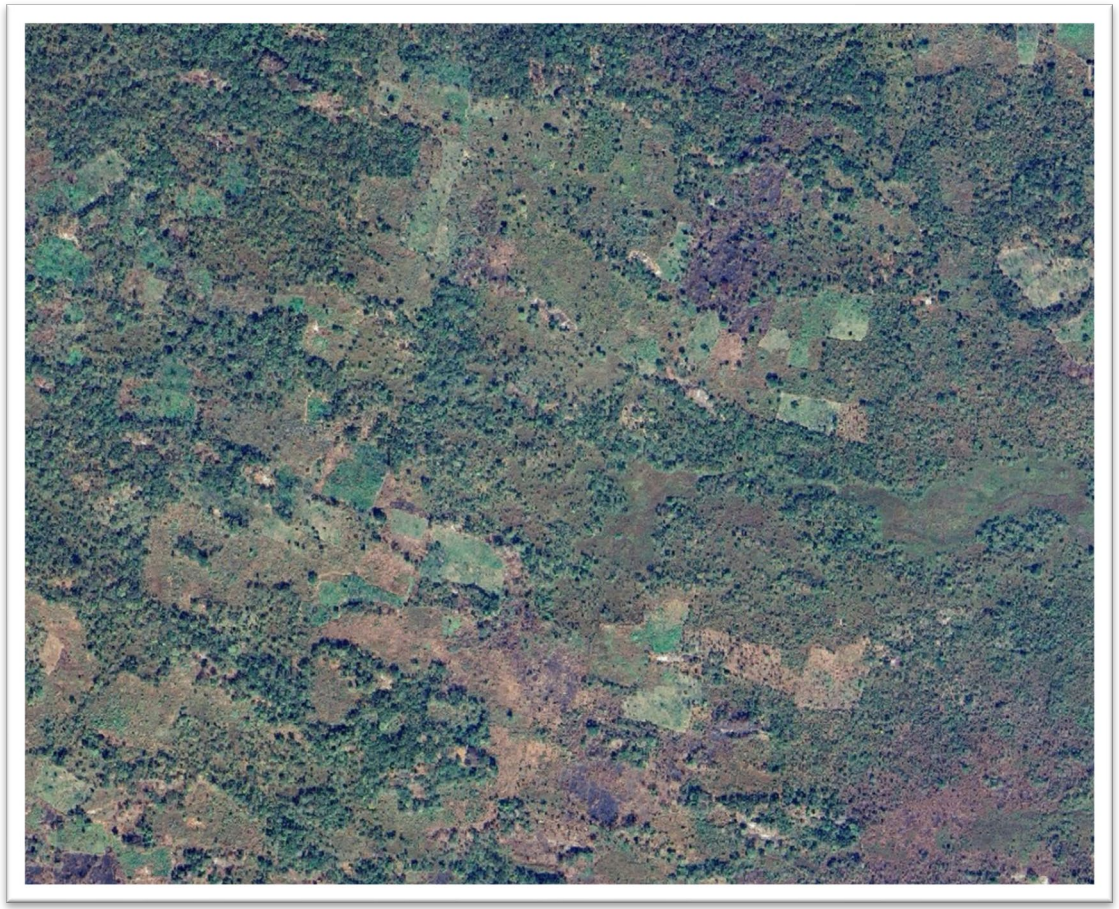
Remove unvegetated cells (max GPP = 0)

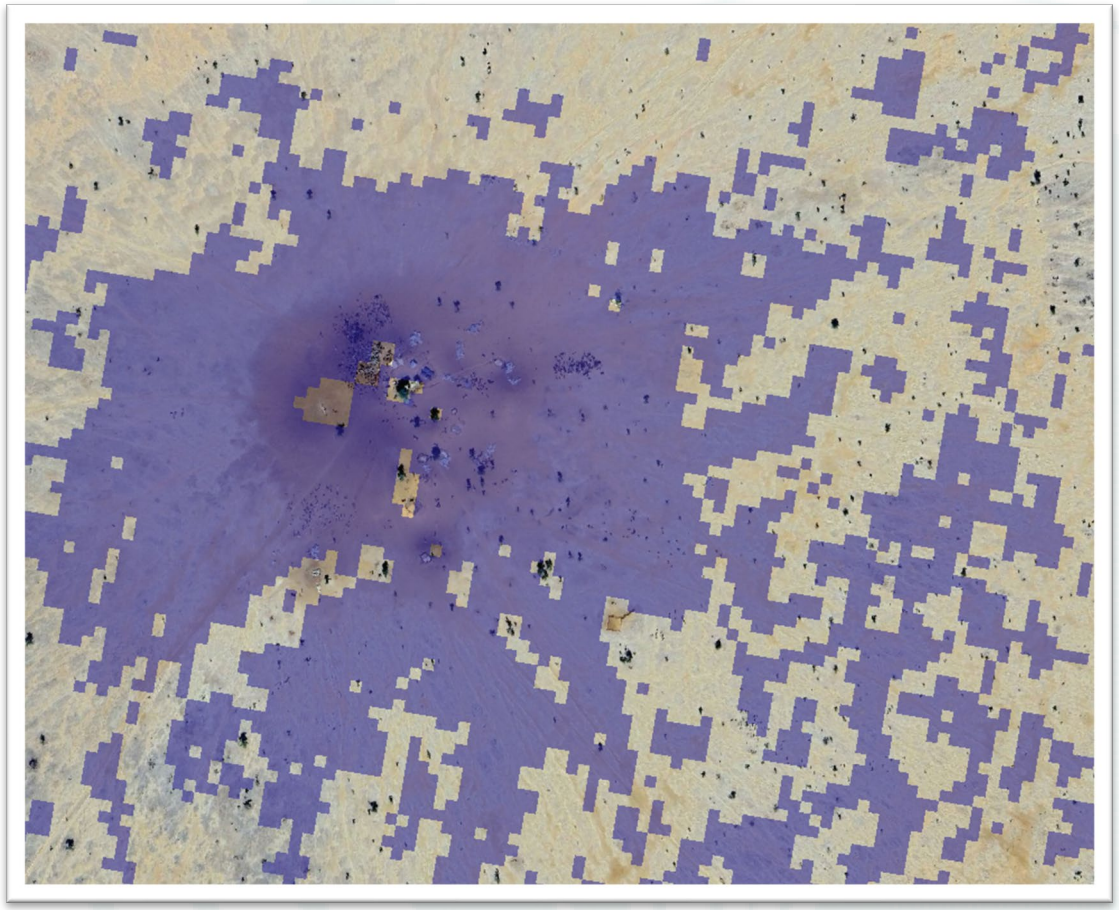




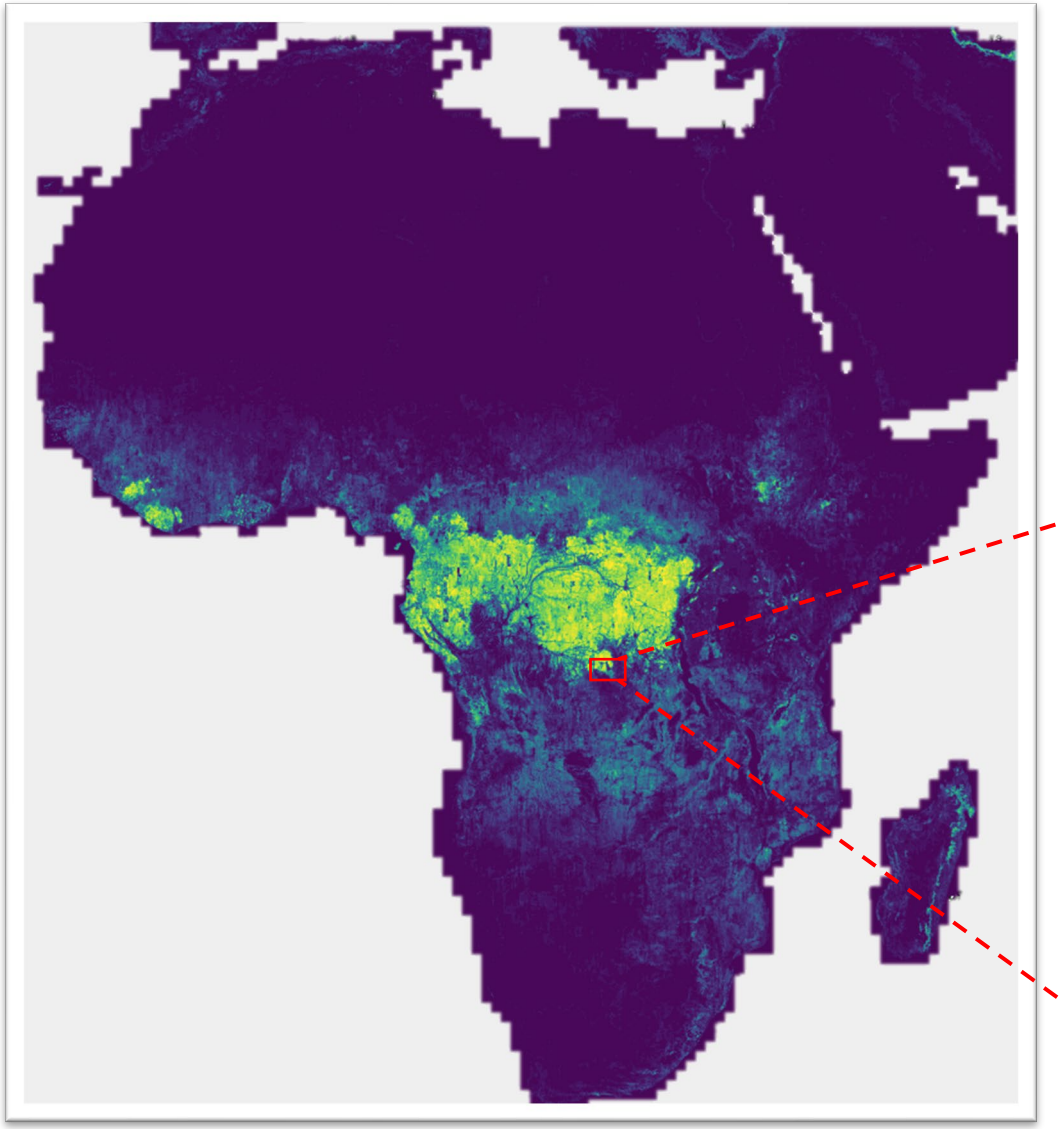
High-resolution rangeland extent for 2022

Step 1: Mask unvegetated cells (max GPP = 0)



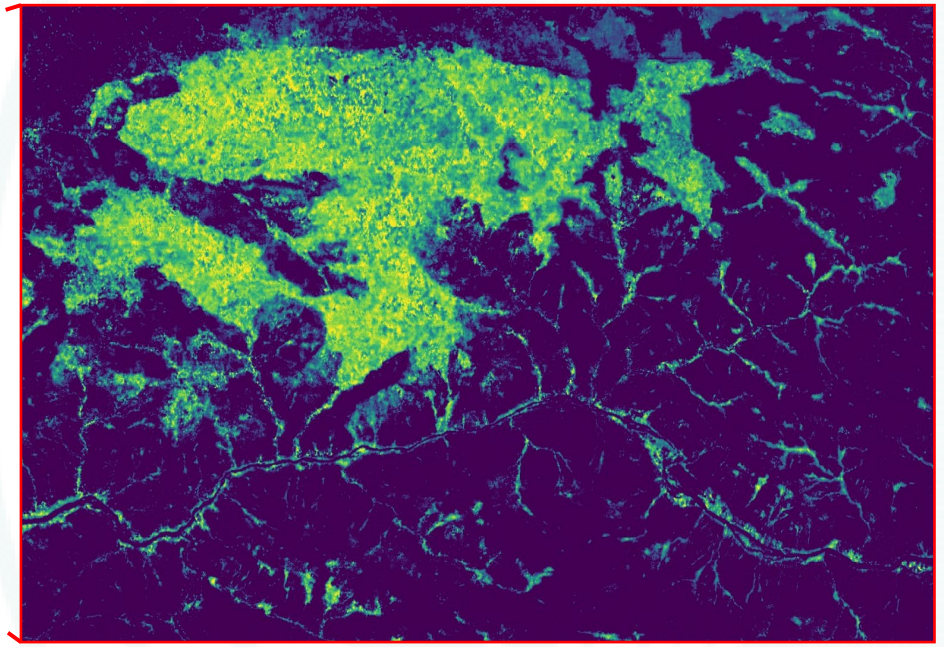


High-resolution rangeland extent for 2022



Step 2: Mask closed-canopy forest when

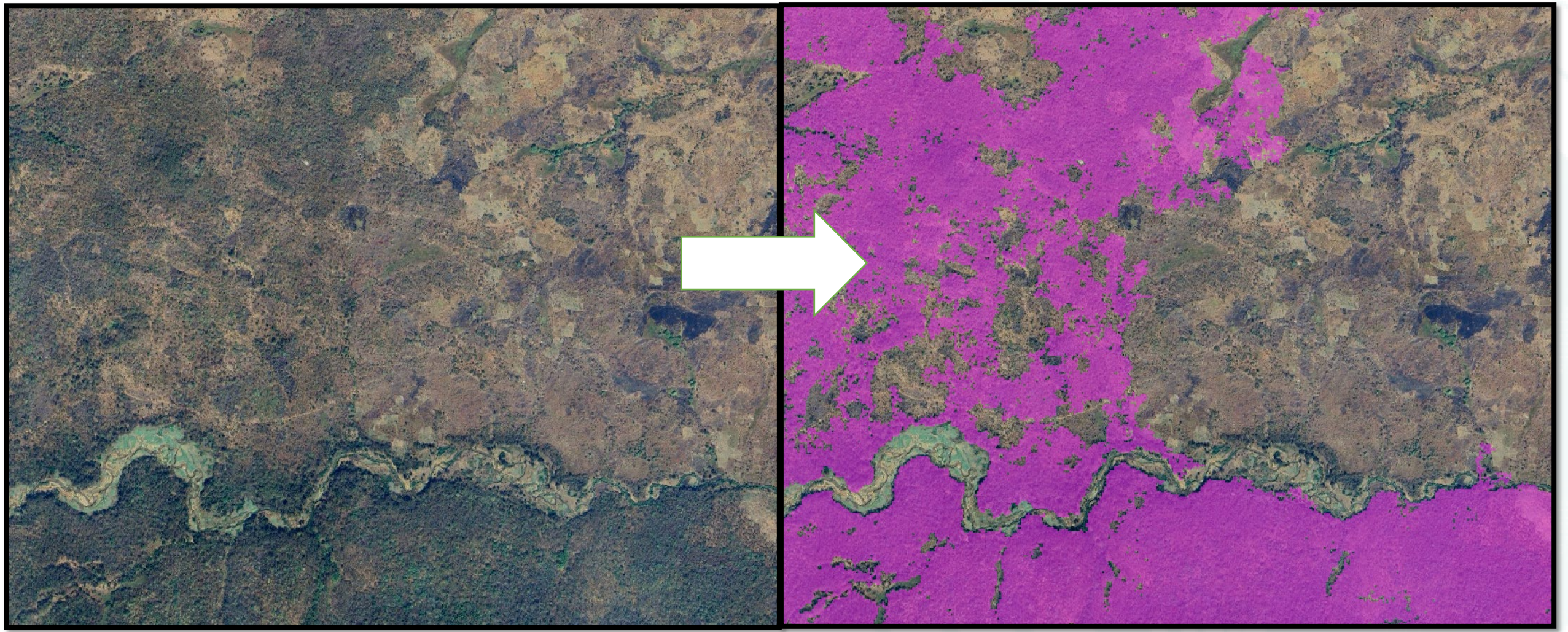
- woody cover ≥ 90%
- area ≥ 5 ha
- median canopy height ≥ 5 m



Tolan *et al.* (2024). Very high resolution canopy height maps from RGB imagery using self-supervised vision transformer and convolutional decoder trained on aerial lidar. Remote Sensing of Environment, 300, 113888.

High-resolution rangeland extent for 2022

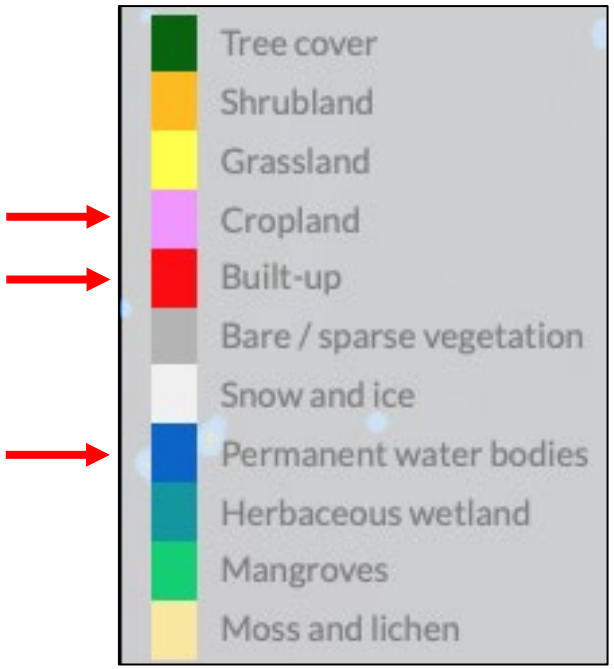
Example of masking closed-canopy forest

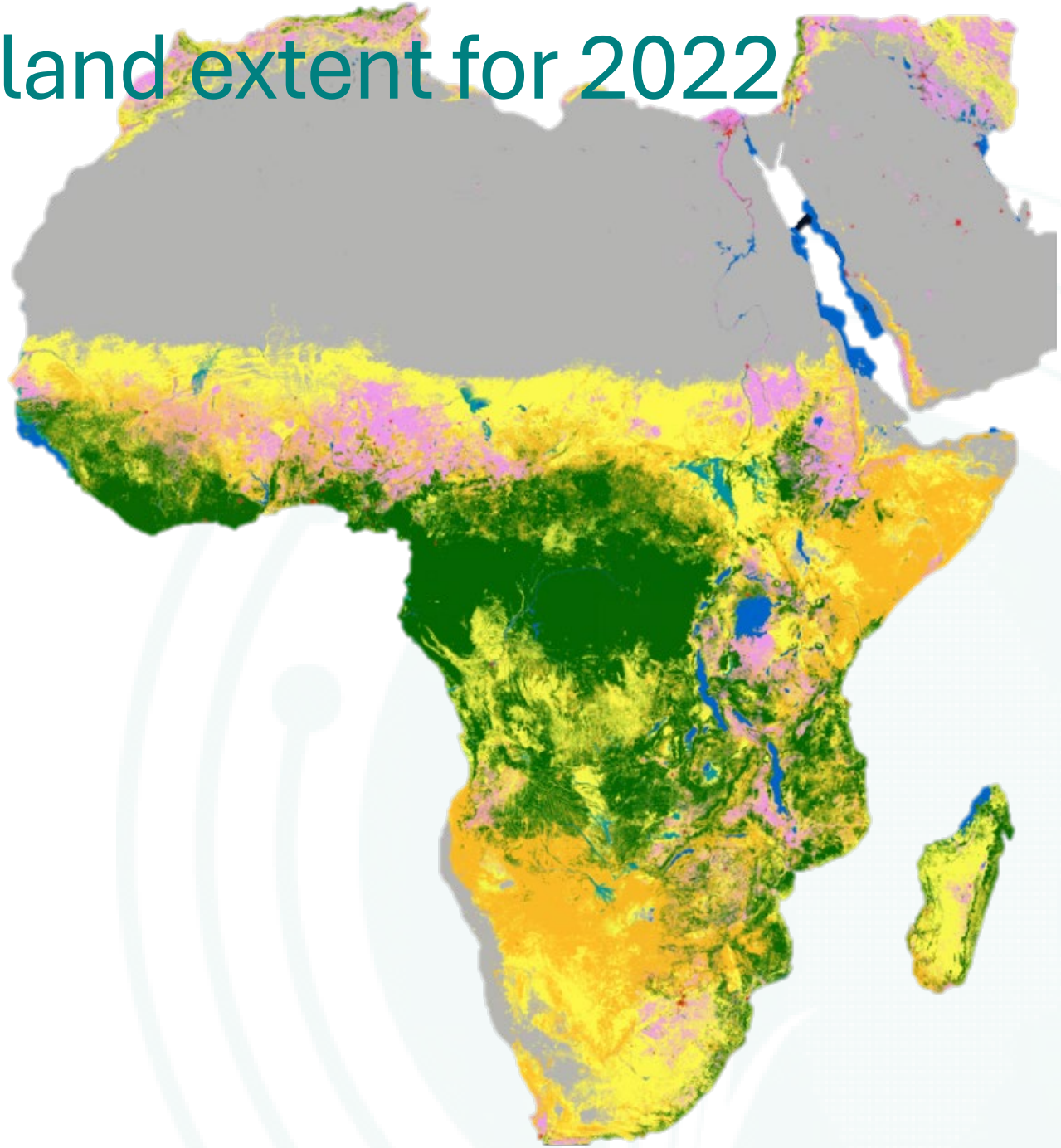


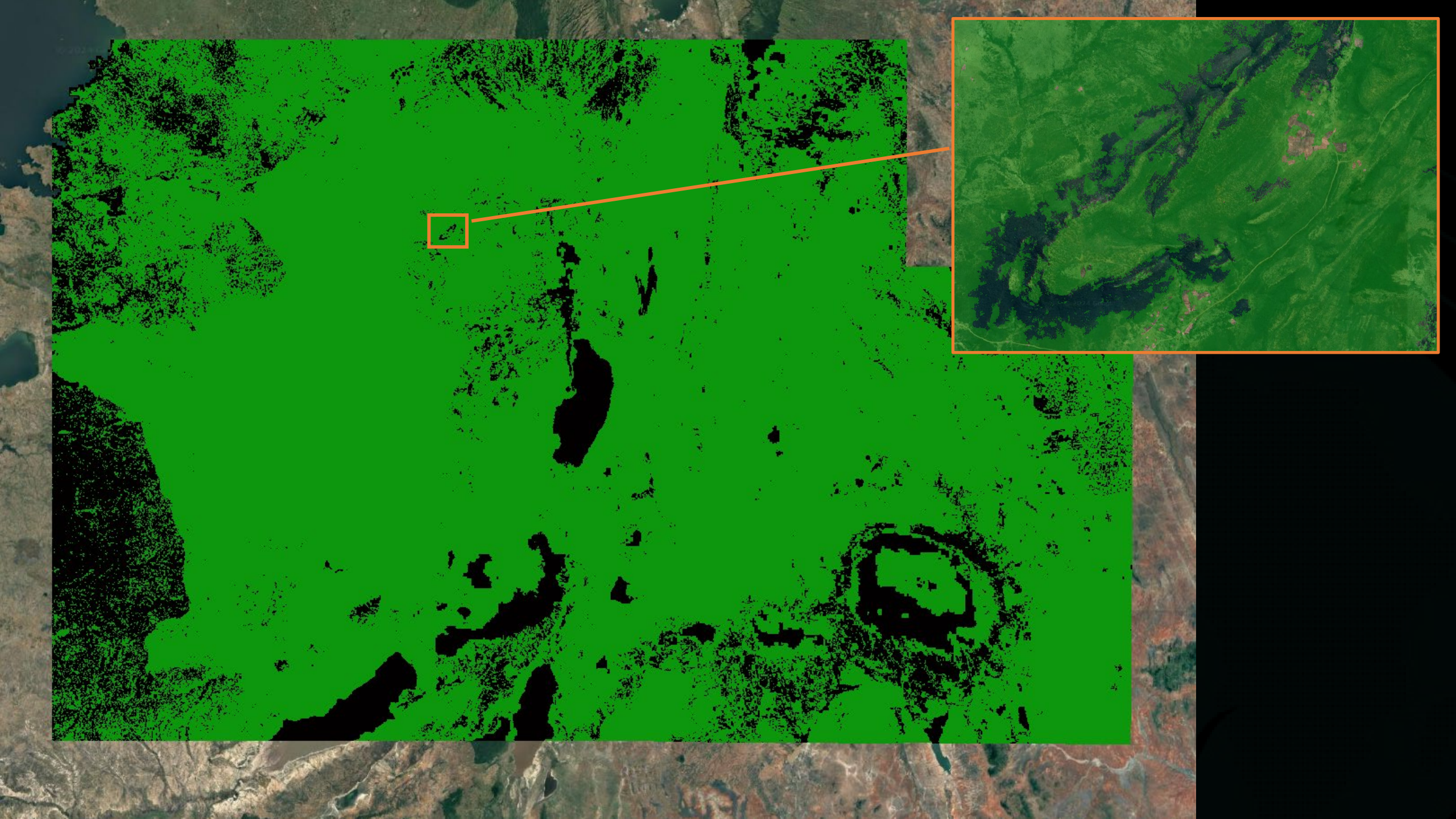
High-resolution rangeland extent for 2022

Step 3: Mask cropland and built-up area with WorldCover

WorldCover V2 2021

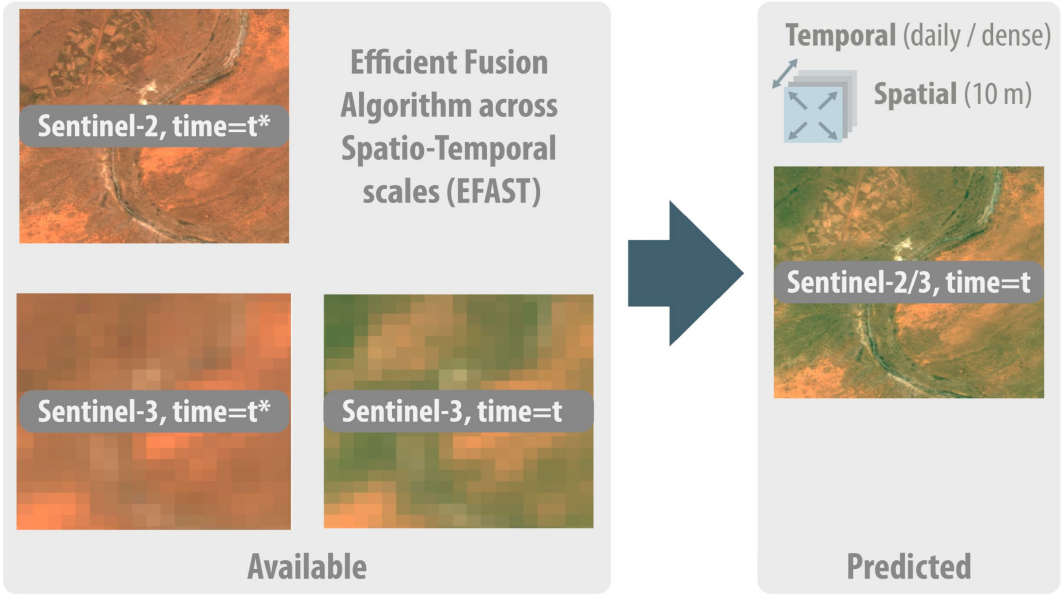


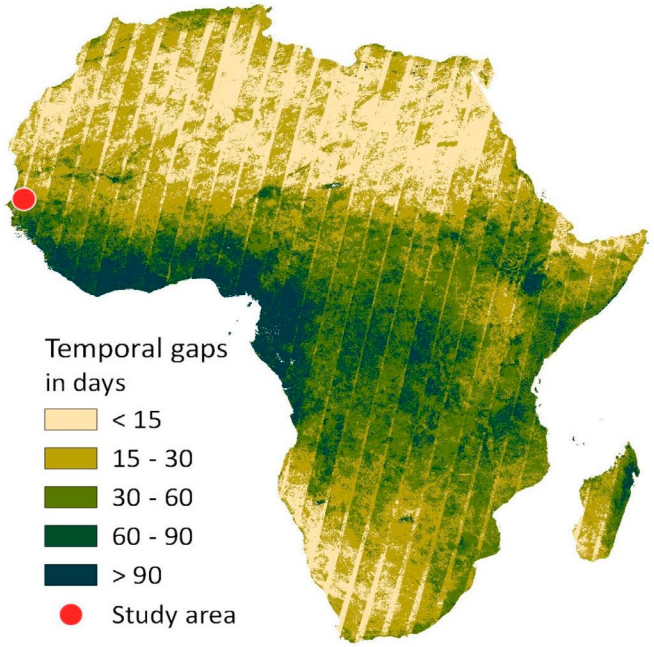


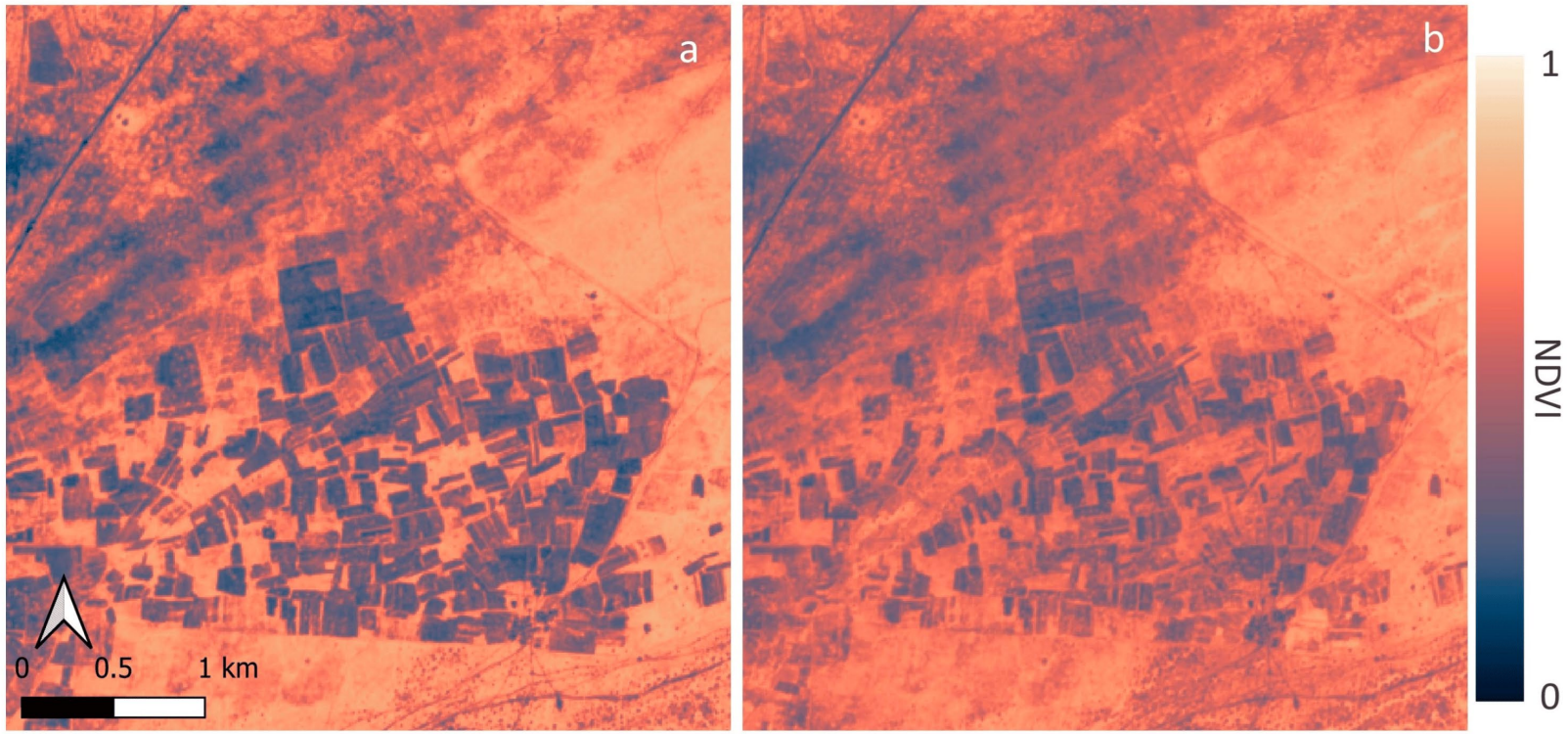


Generating high-density Sentinel-2 time series

Gap-filled Sentinel-2 time series by fusing with data from Sentinel-3 and Sentinel-1







Senty, P., Guzinski, R., Grogan, K., Buitenwerf, R., Ardö, J., Eklundh, L., Koukos, A., Tagesson, T., & Munk, M. (2024). Fast Fusion of Sentinel-2 and Sentinel-3 Time Series over Rangelands. Remote Sensing, 16(11), 1833. https://doi.org/10.3390/rs16111833

Rangeland herbaceous biomass productivity

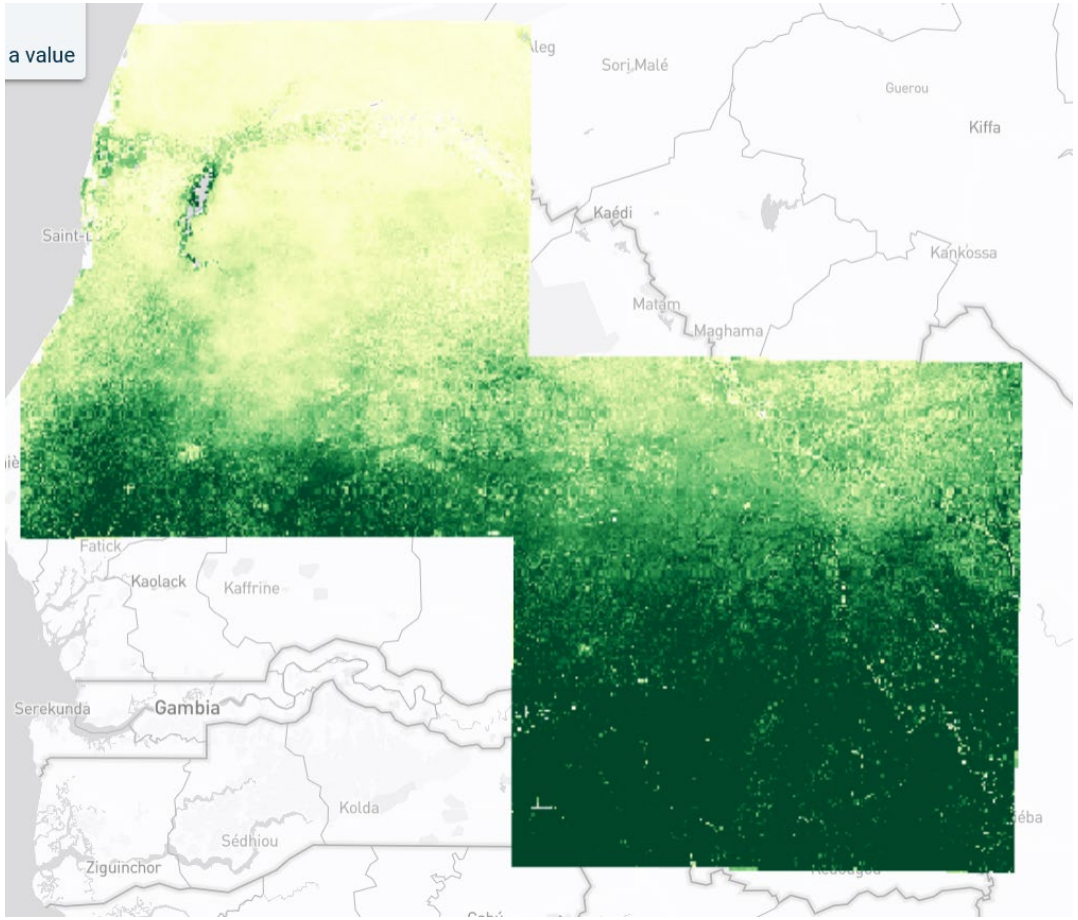
Herbaceous Biomass productivity

Workflow

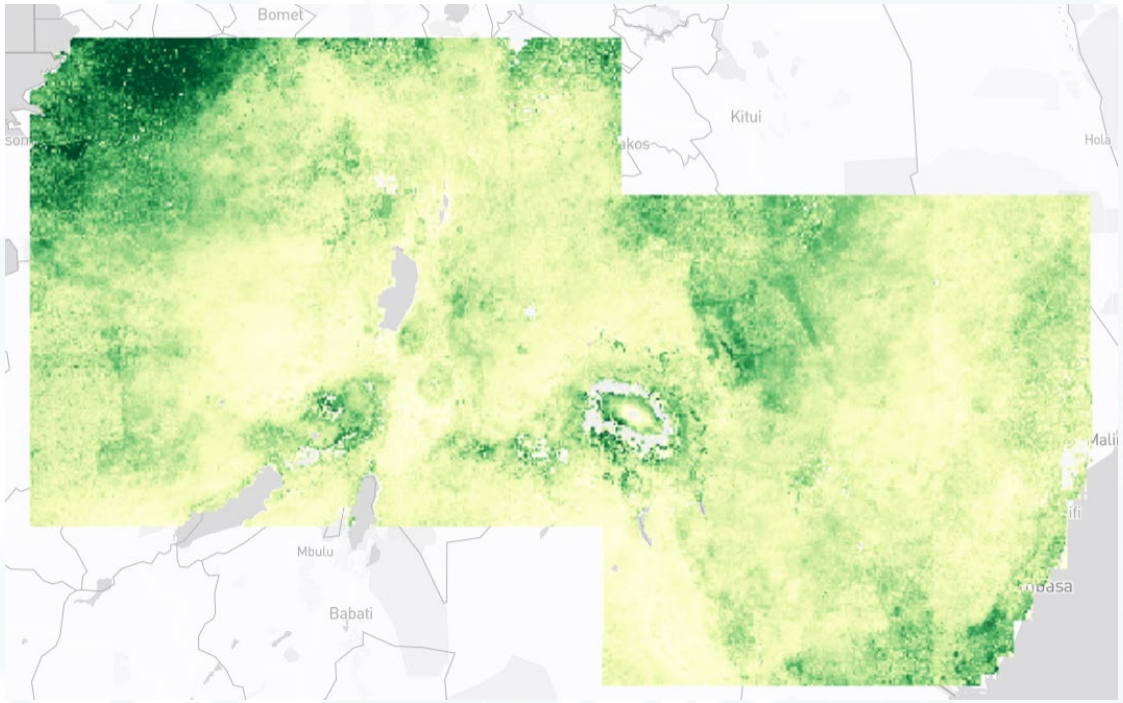
1) Intake gap-filled NDVI time series
2) Estimate 5-day GPP from a light-use efficiency model (calibrated using available eddy covariance data)
3) Separate GPP into woody and herbaceous fraction using woody cover
4) Sum GPP to monthly accrued biomass

Large-scale patterns

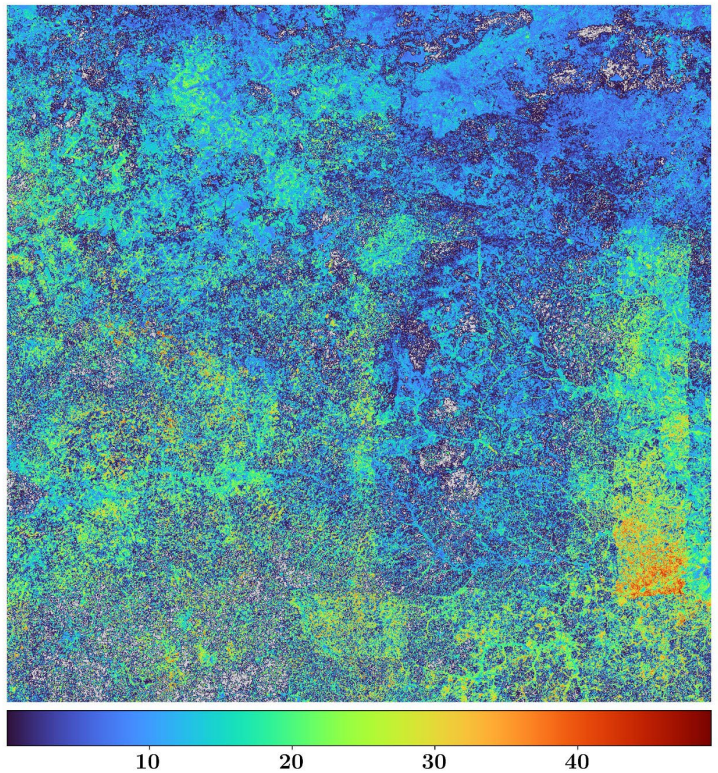
West Africa (Oct)

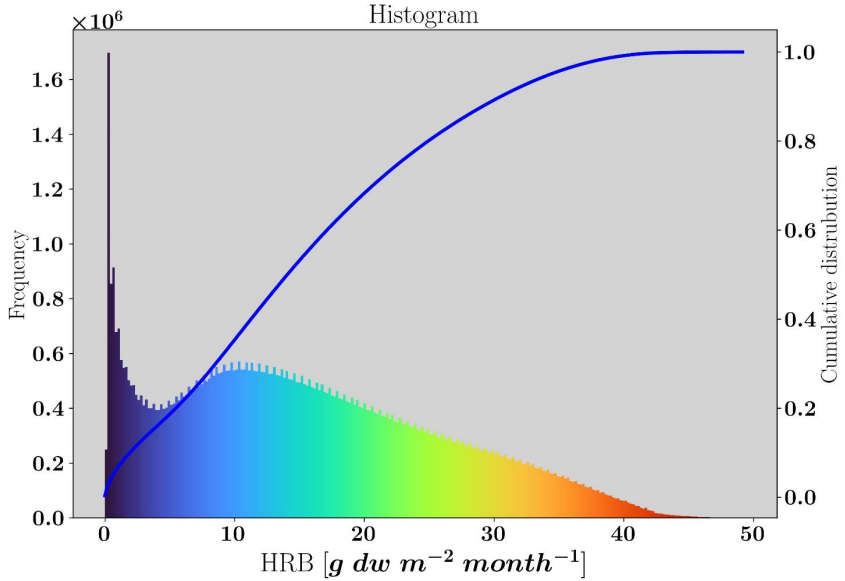


East Africa (Nov)

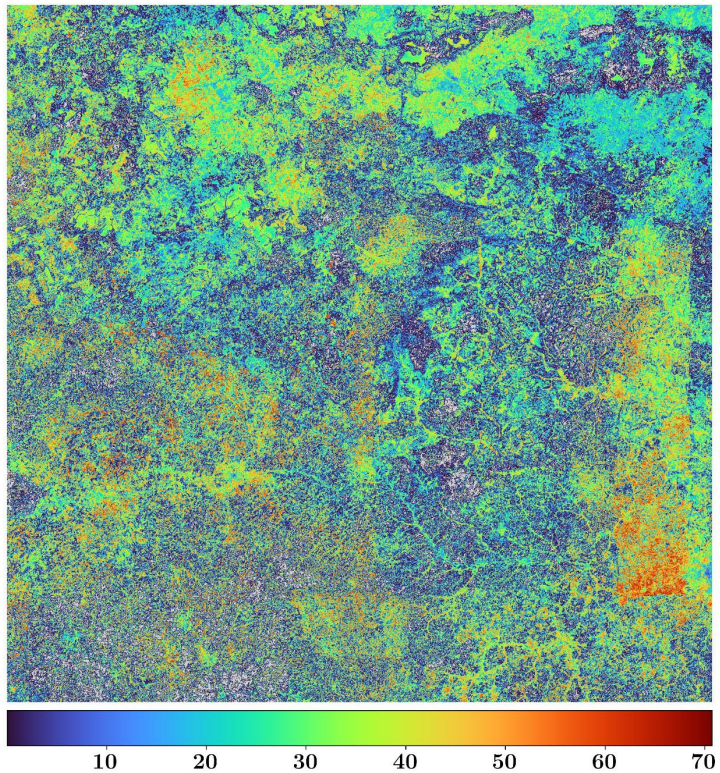


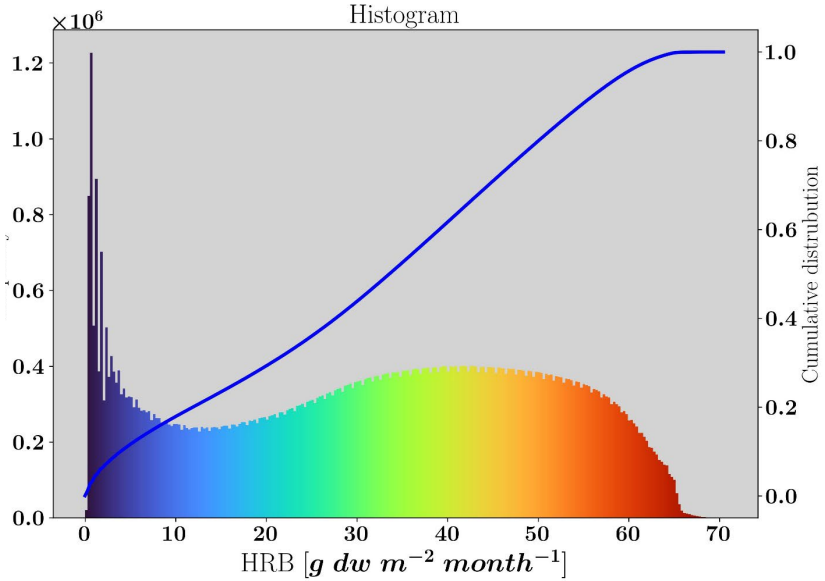
May



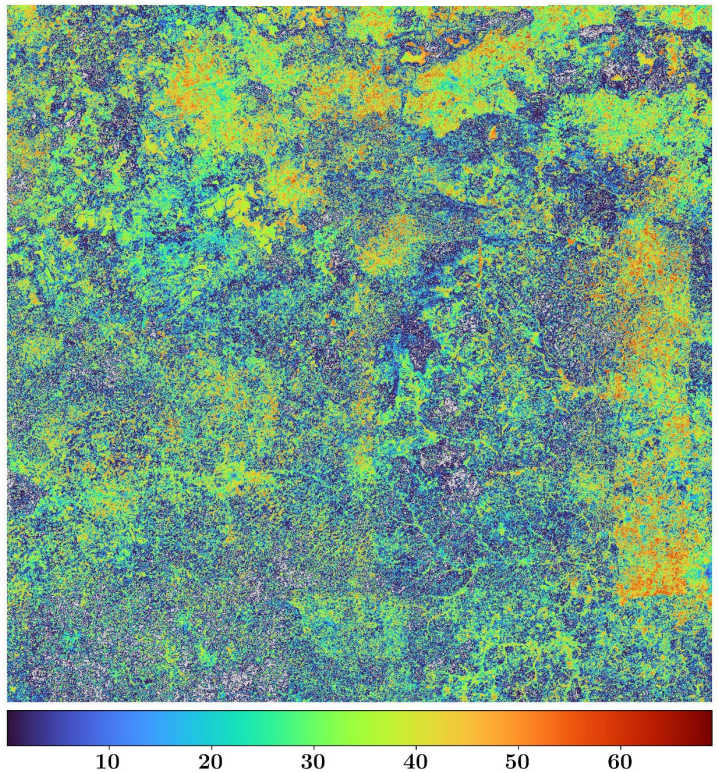


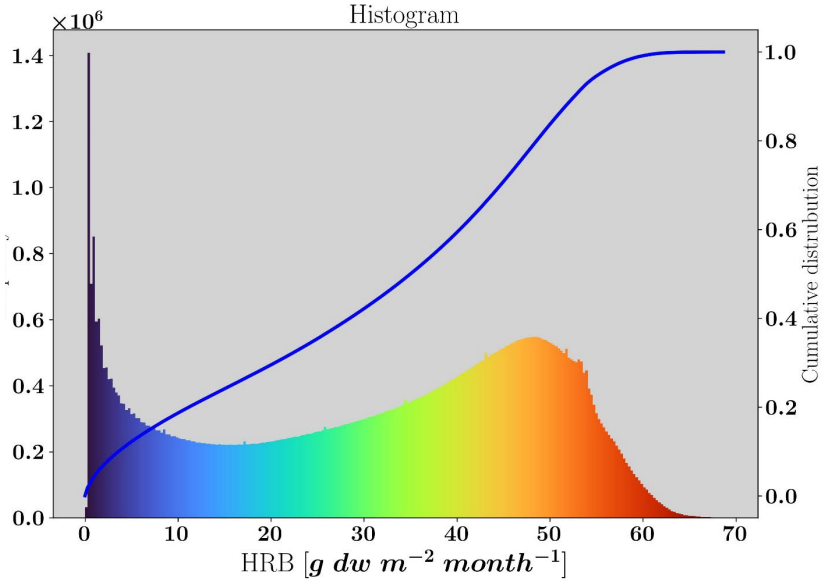
June



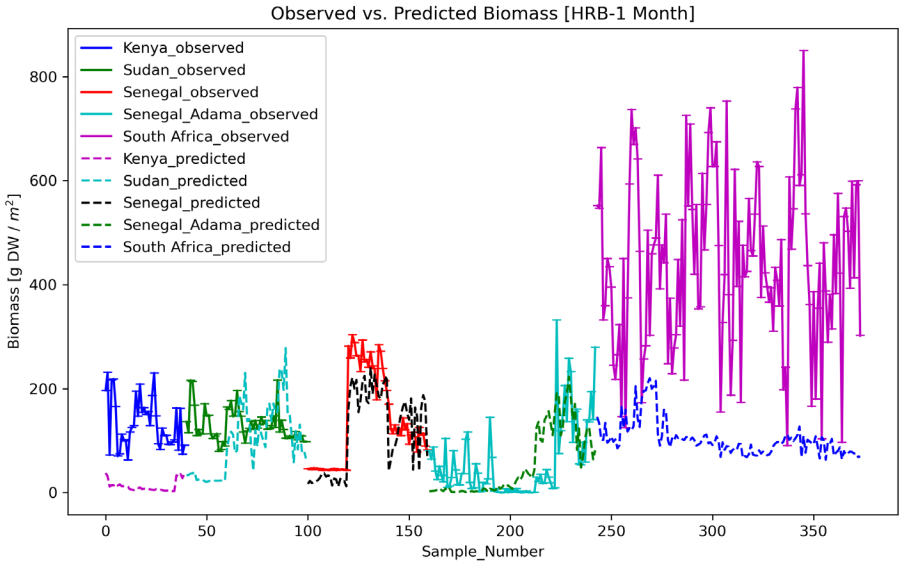


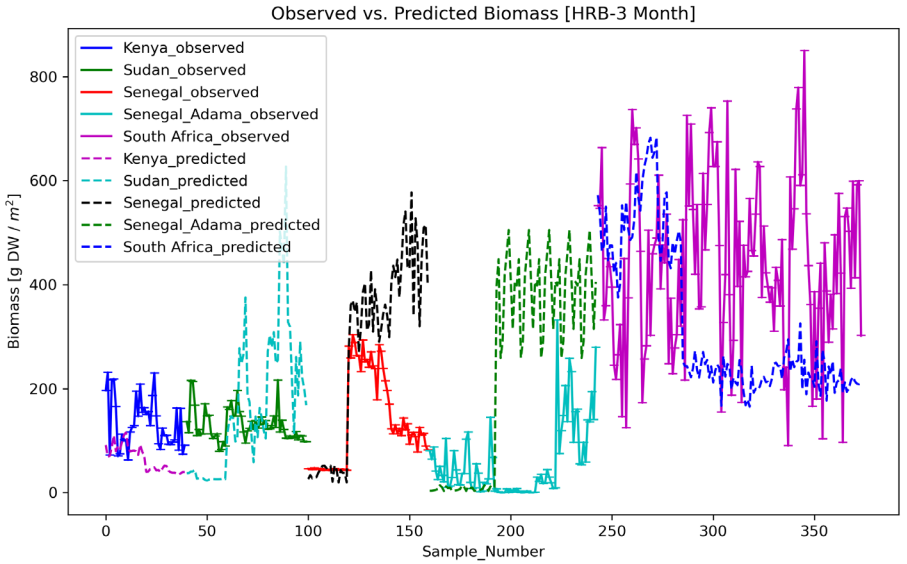
July

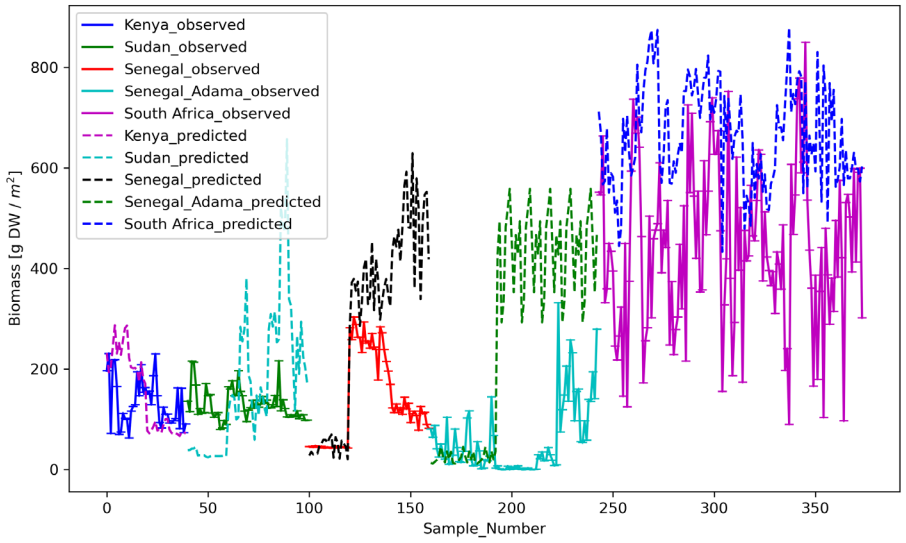


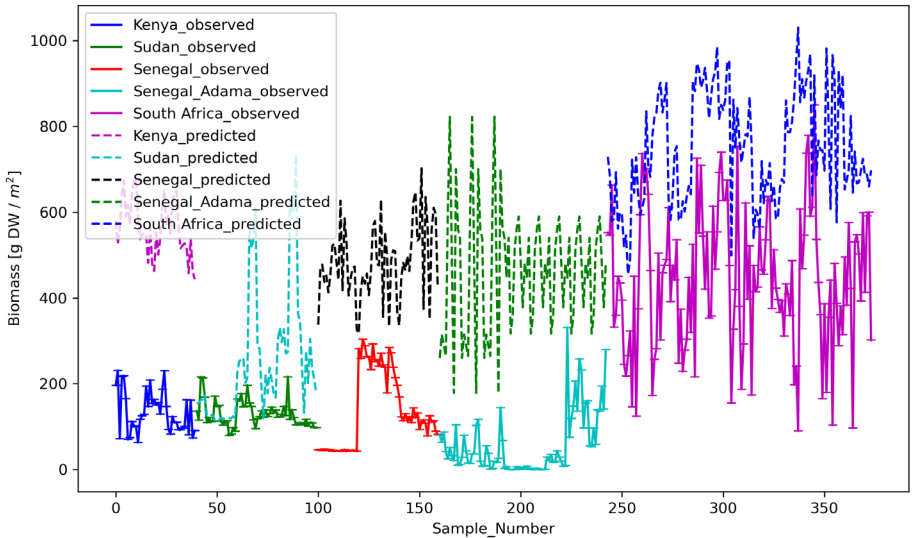


Evaluation using field measured biomass in Senegal, Sudan, Kenya and South Africa

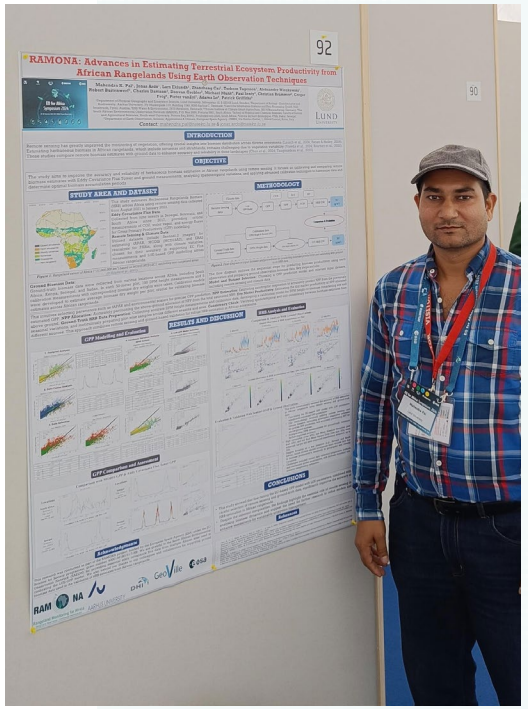






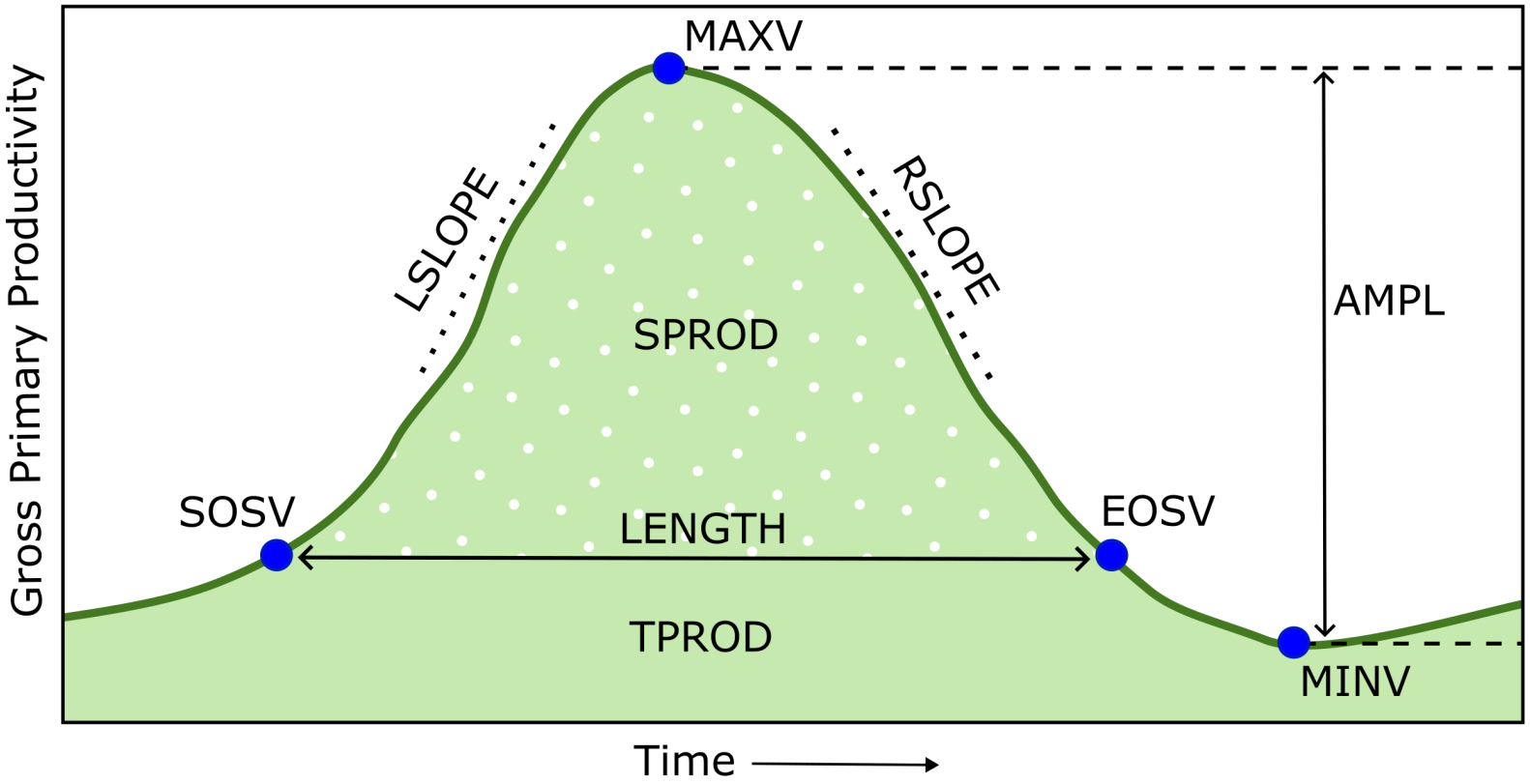


Poster 92



Phenology of herbaceous rangeland vegetation

Herbaceous biomass phenology

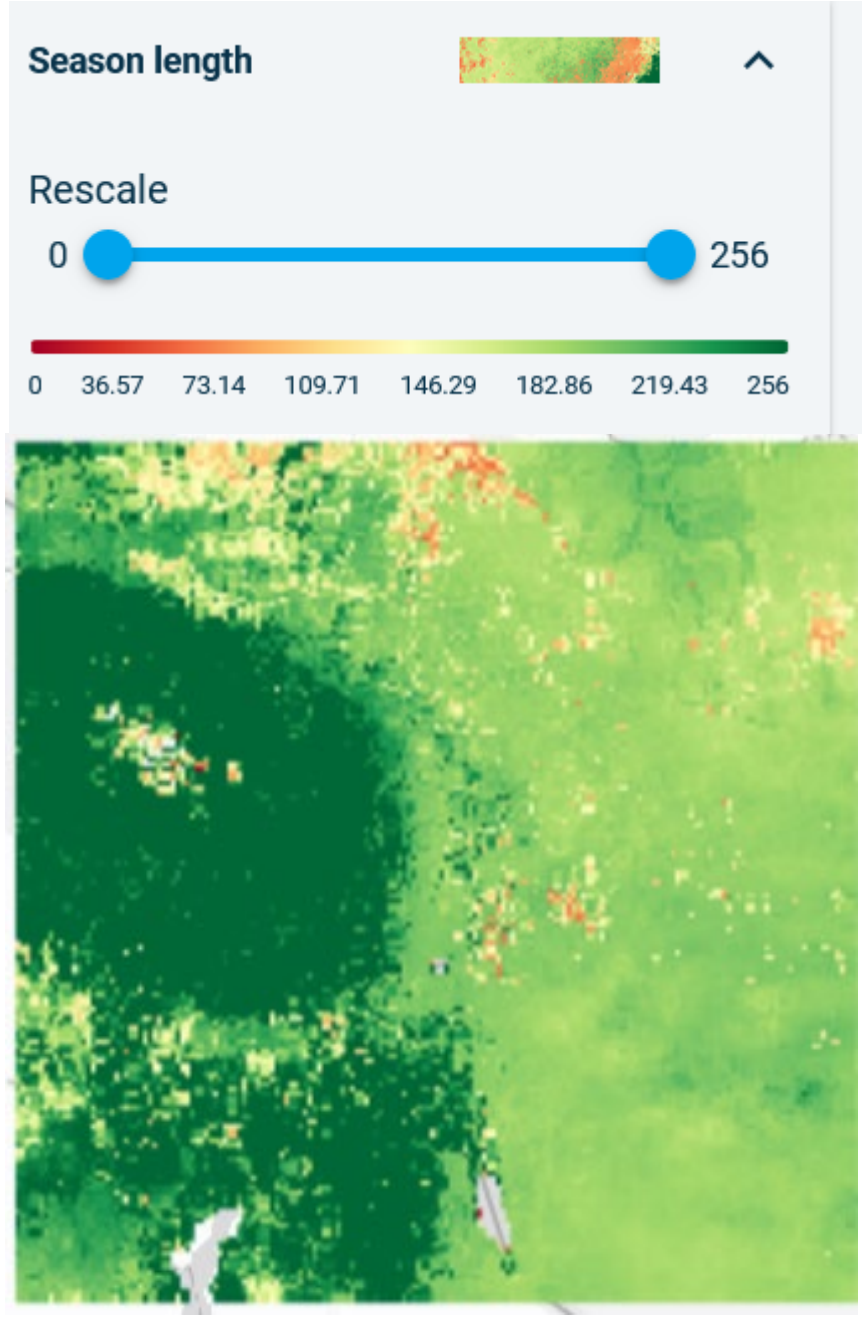


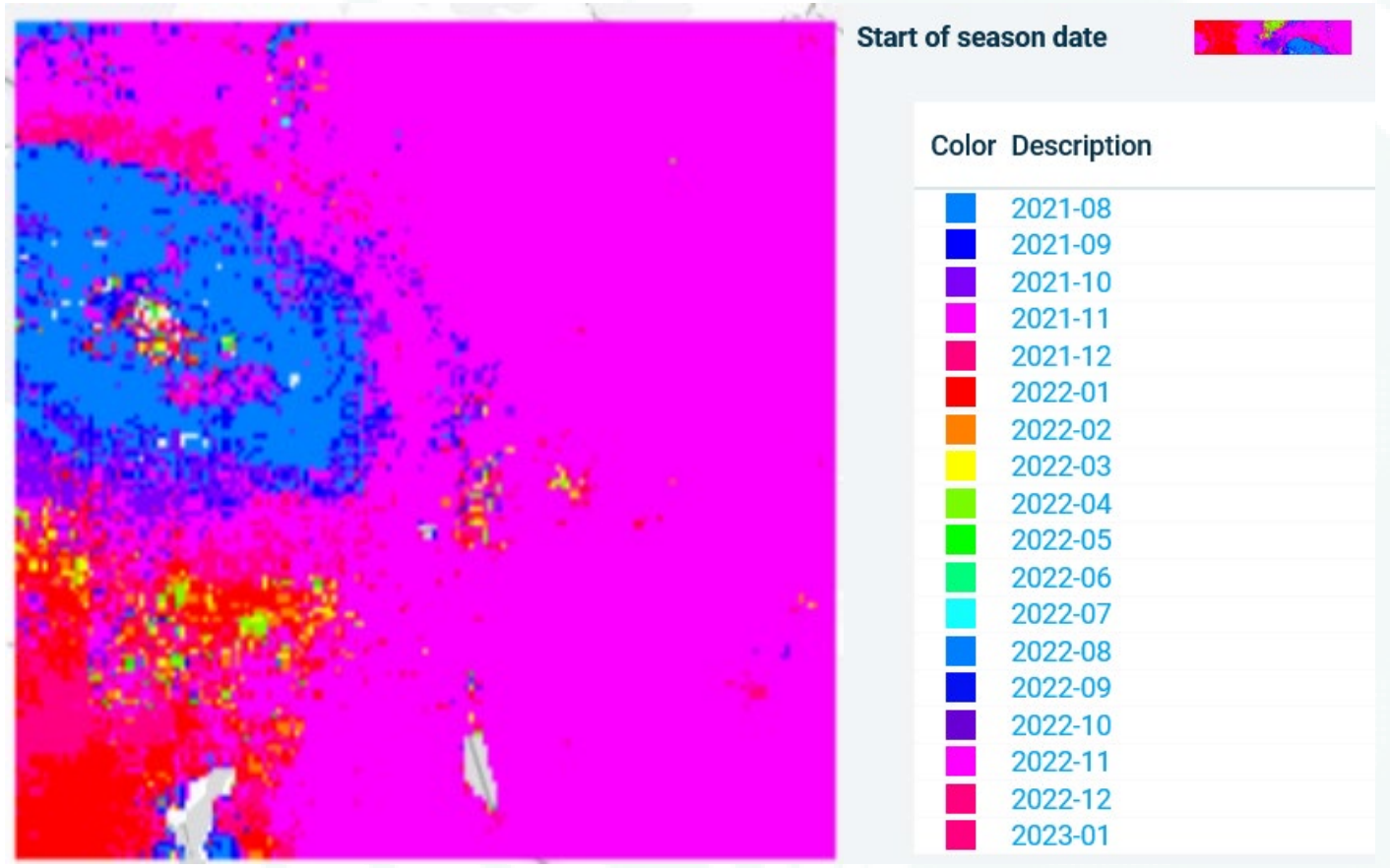
Relevant for

- Livestock grazing
- Fire management
- Wildlife movements
- Ecosystem functioning, e.g. C sequestration

EKLUNDH, L. and JÖNSSON, P (2016). TIMESAT for processing time-series data from satellite sensors for land surface monitoring. In Multitemporal Remote Sensing, eds. Y. Ban , Springer International Publishing, pp. 177-194.

Herbaceous biomass phenology





Rangeland ecosystem functional types

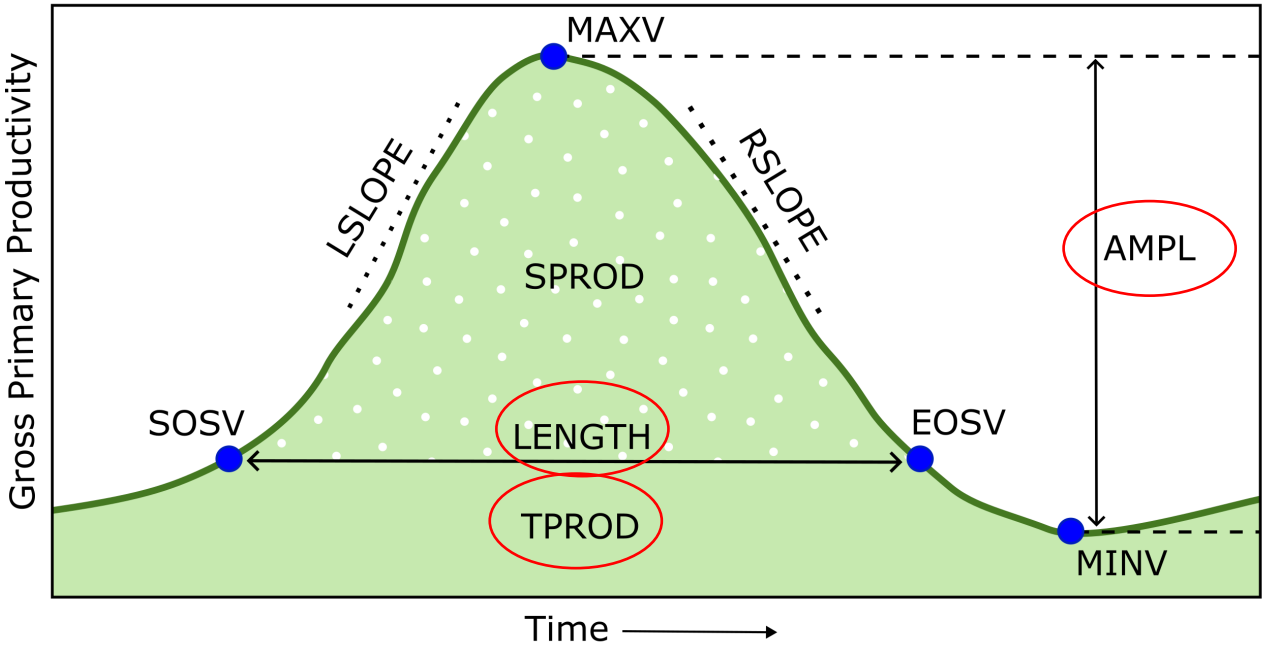
(not a thematic map)

Phenology

Total productivity

Amplitude

Season Length

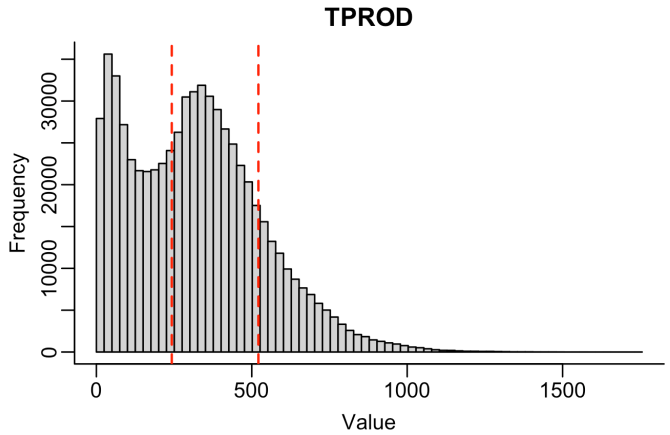


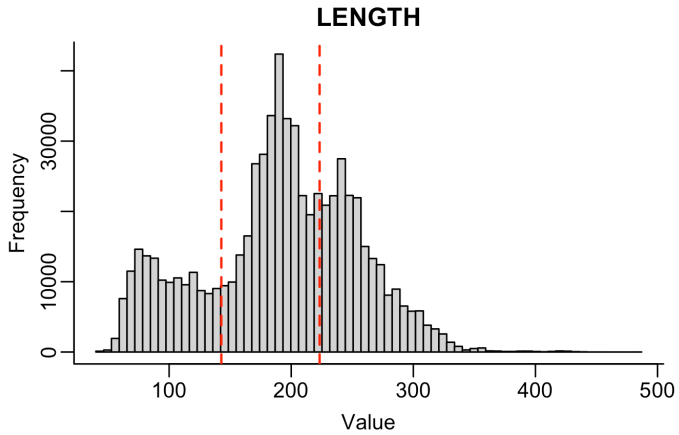
Structure

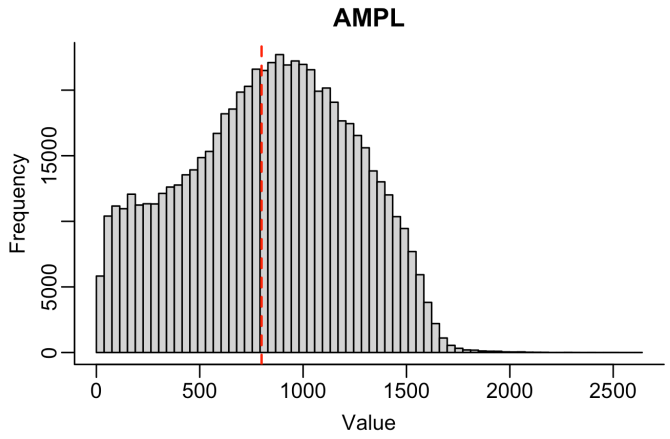
Canopy height

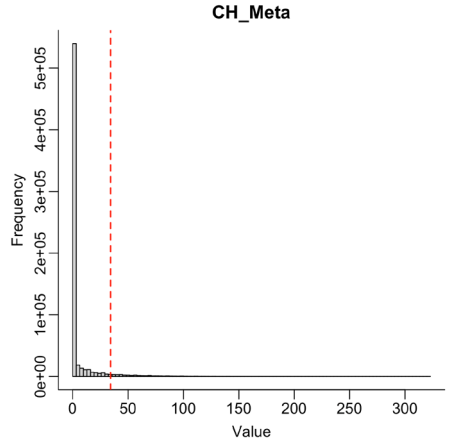
Objective thresholding to create classes

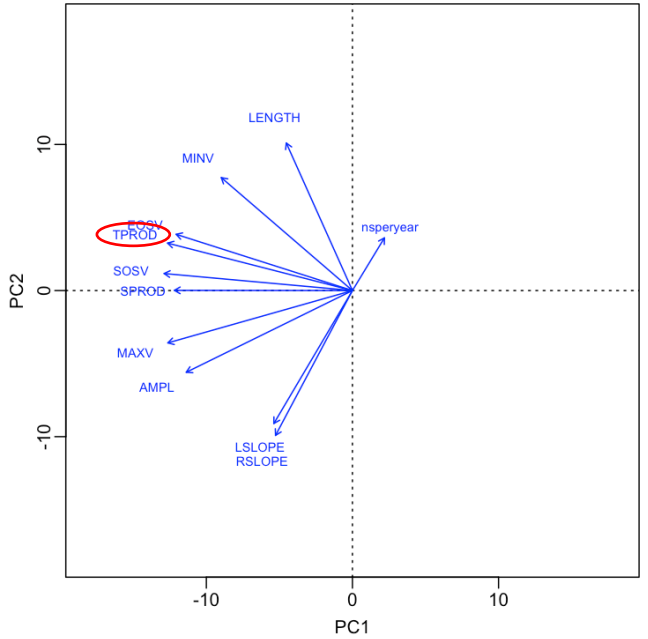
1) **PCA** to identify key variables
2) **K-means** clustering to identify optimal split points

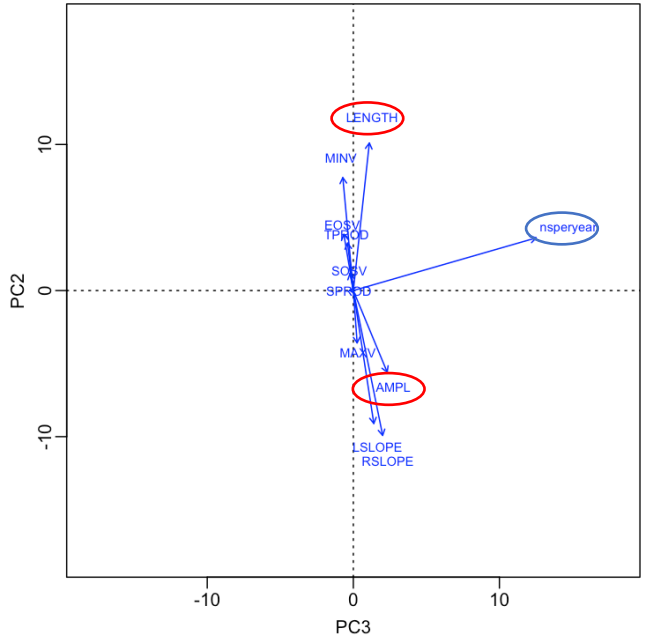












Classification scheme

Class 1 (P1, A1, H1, L1)
Class 2 (P1, A1, H1, L2)
Class 3 (P1, A1, H1, L3)
Class 4 (P1, A1, H2, L1)
Class 5 (P1, A1, H2, L2)
Class 6 (P1, A1, H2, L3)
Class 7 (P1, A2, H1, L1)
Class 8 (P1, A2, H1, L2)
Class 9 (P1, A2, H1, L3)
Class 10 (P1, A2, H2, L1)
Class 11 (P1, A2, H2, L2)
Class 12 (P1, A2, H2, L3)
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Class 30 (P3, A1, H2, L3)
Class 31 (P3, A2, H1, L1)
Class 32 (P3, A2, H1, L2)
Class 33 (P3, A2, H1, L3)
Class 34 (P3, A2, H2, L1)
Class 35 (P3, A2, H2, L2)
Class 36 (P3, A2, H2, L3)

Total productivity:

P1 P2 P3

Amplitude:

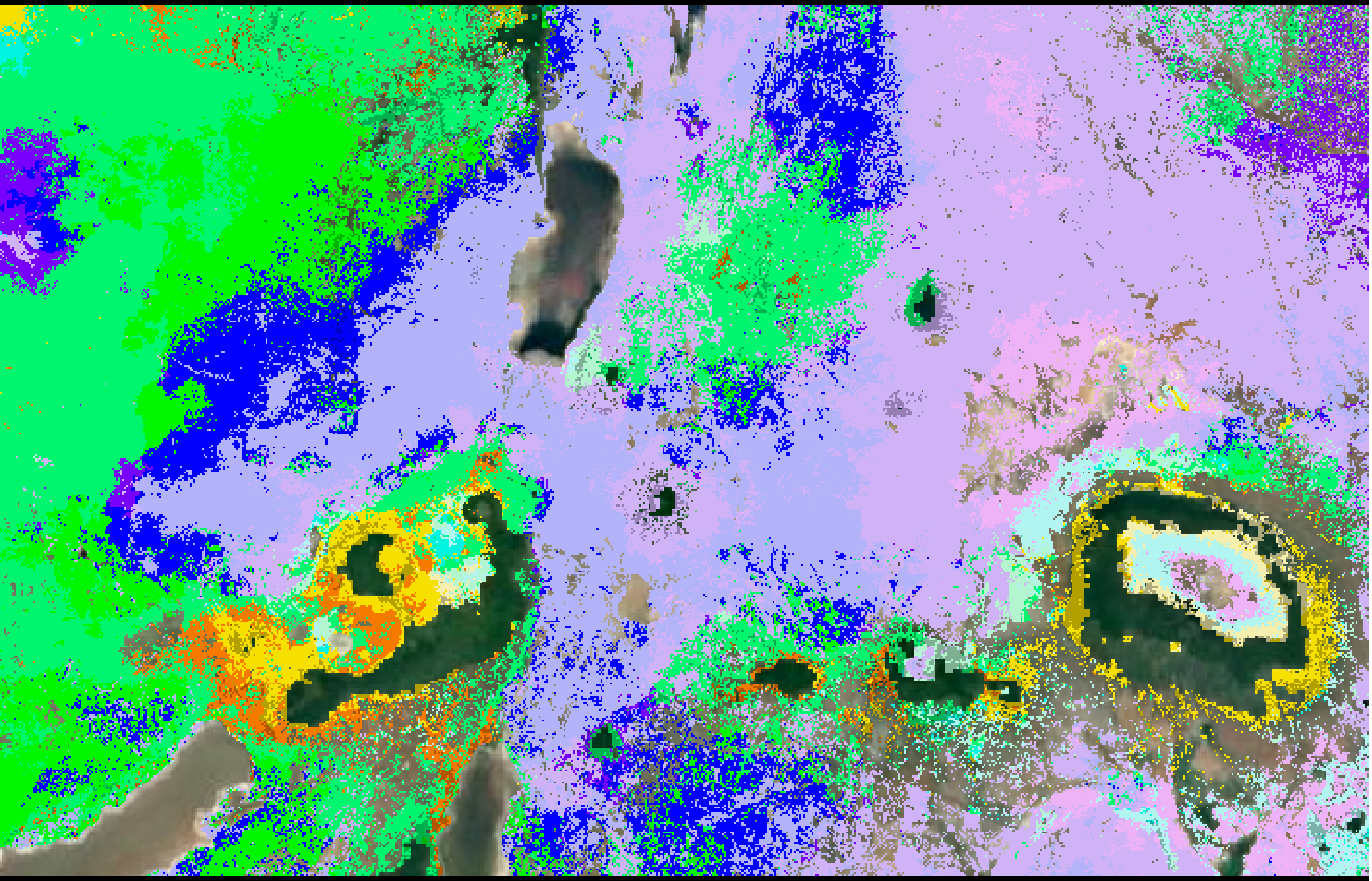
A1 A2

Canopy height:

H1 H2

Season length:

L1 L2 L3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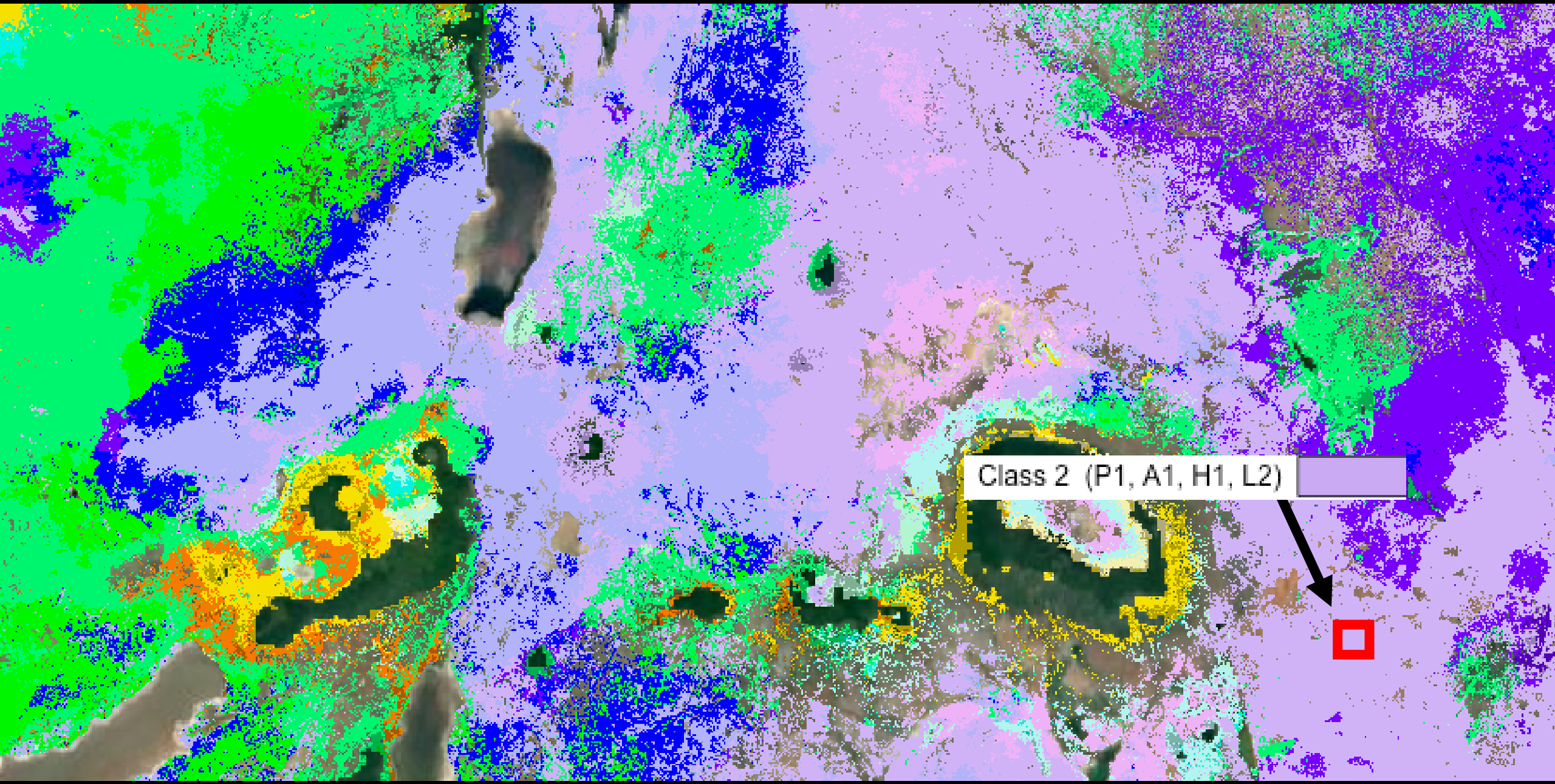
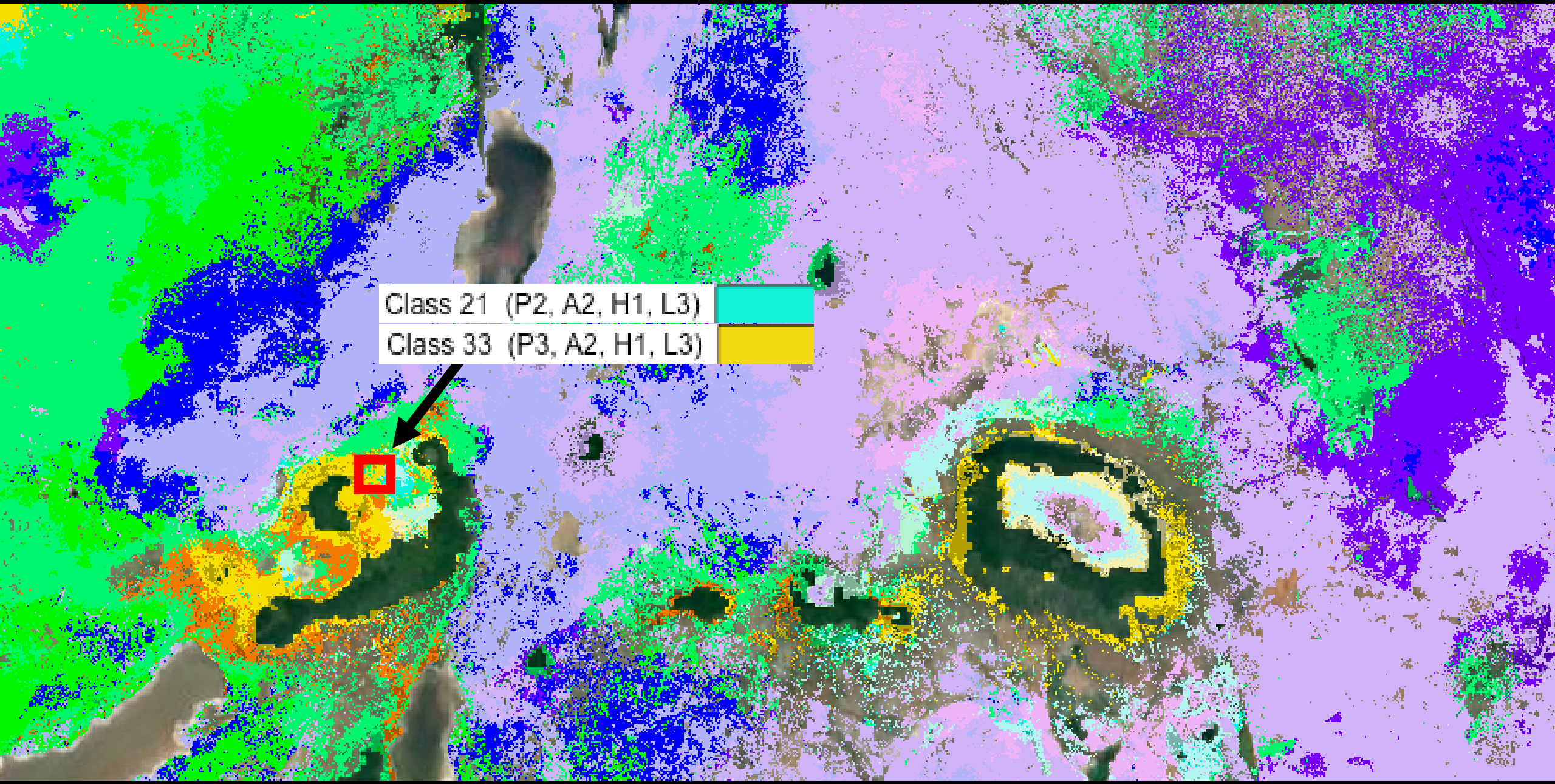
Class 34 (P3, A2, H2, L1)
Class 35 (P3, A2, H2, L2)
Class 36 (P3, A2, H2, L3)

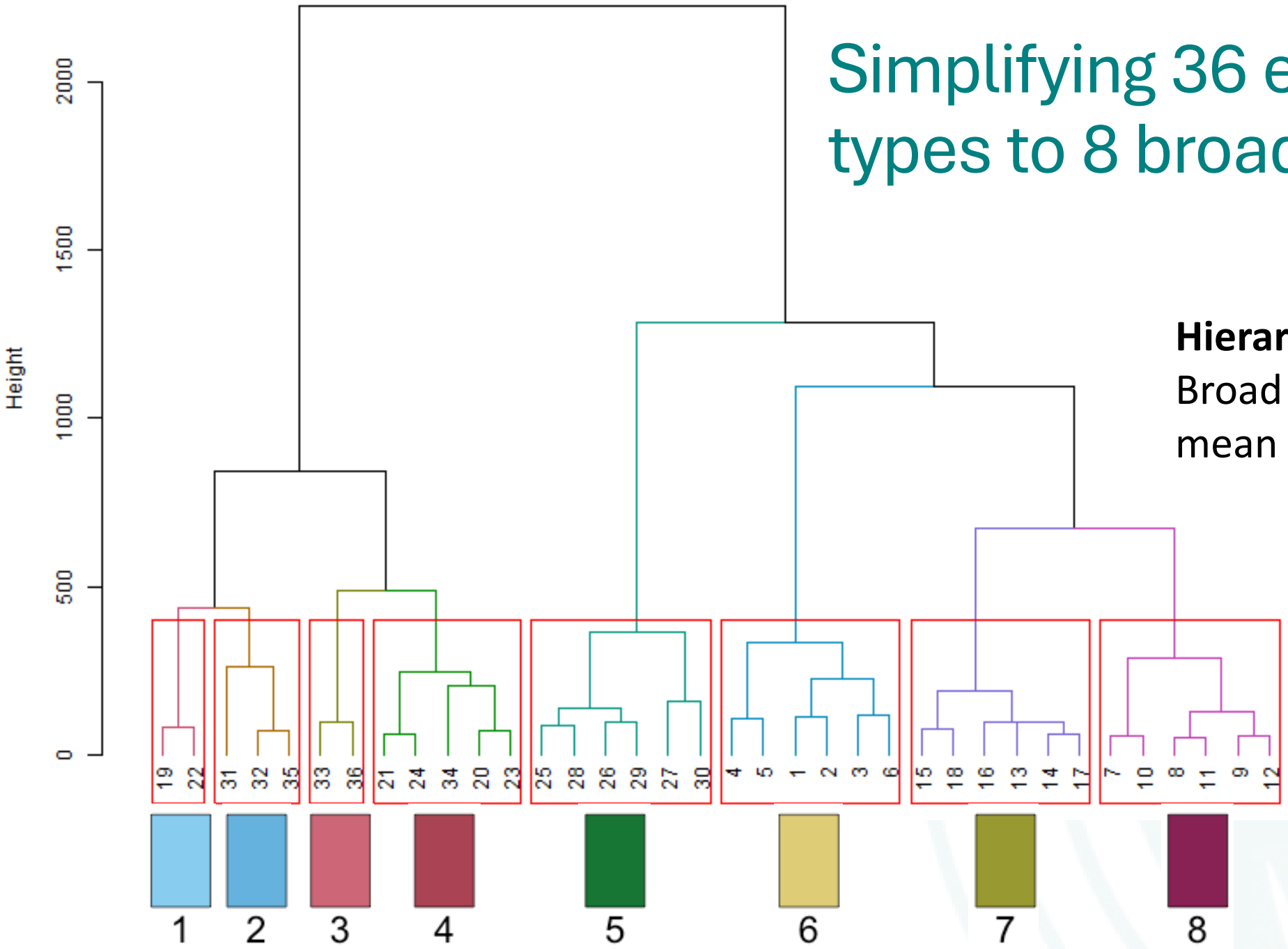

Class 2 (P1, A1, H1, L2)


Class 2 (P1, A1, H1, L2)

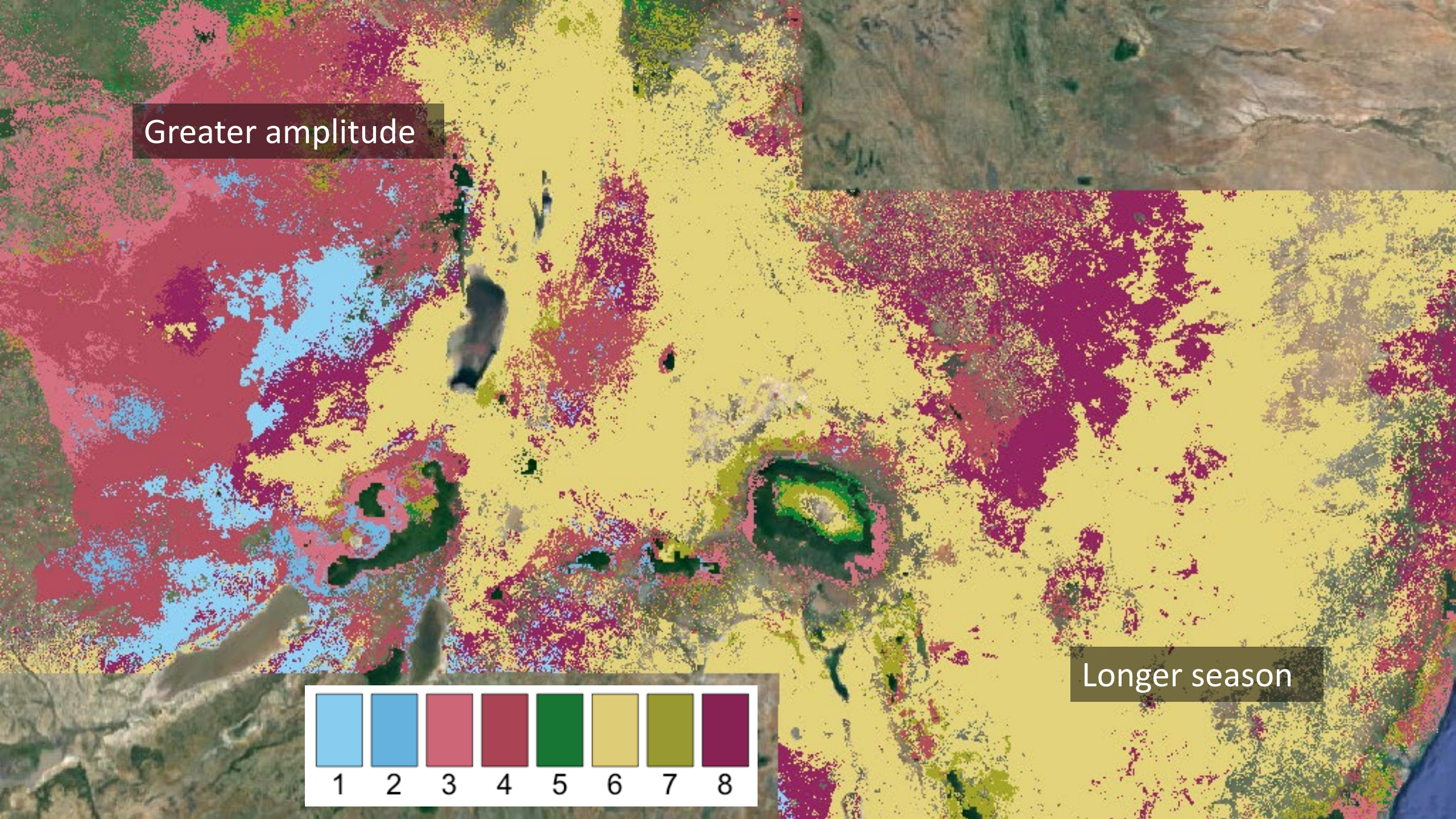

Class 21 (P2, A2, H1, L3)
Class 33 (P3, A2, H1, L3)


Class 21 (P2, A2, H1, L3)
Class 33 (P3, A2, H1, L3)

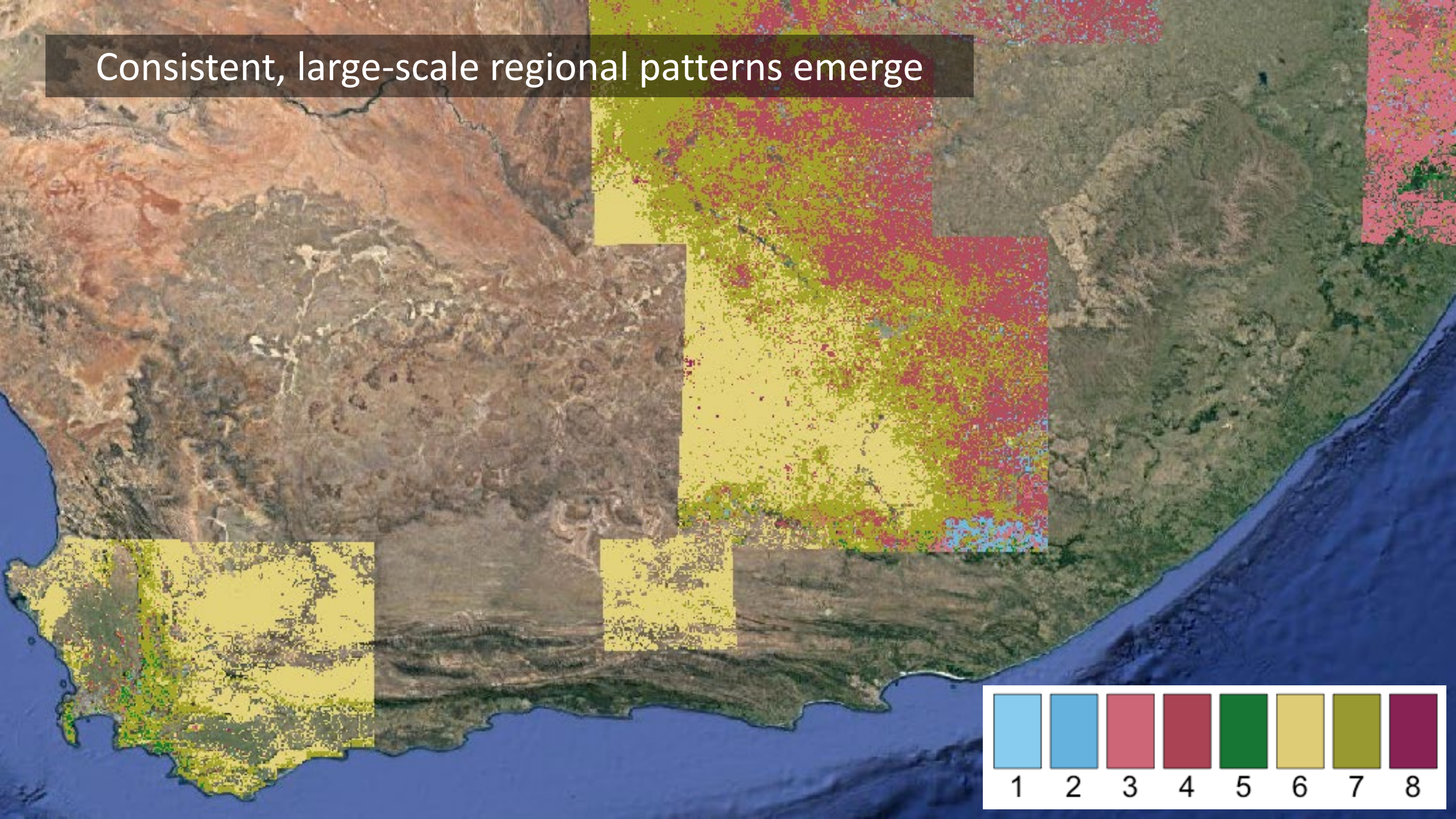
Simplifying 36 ecosystem types to 8 broad classes



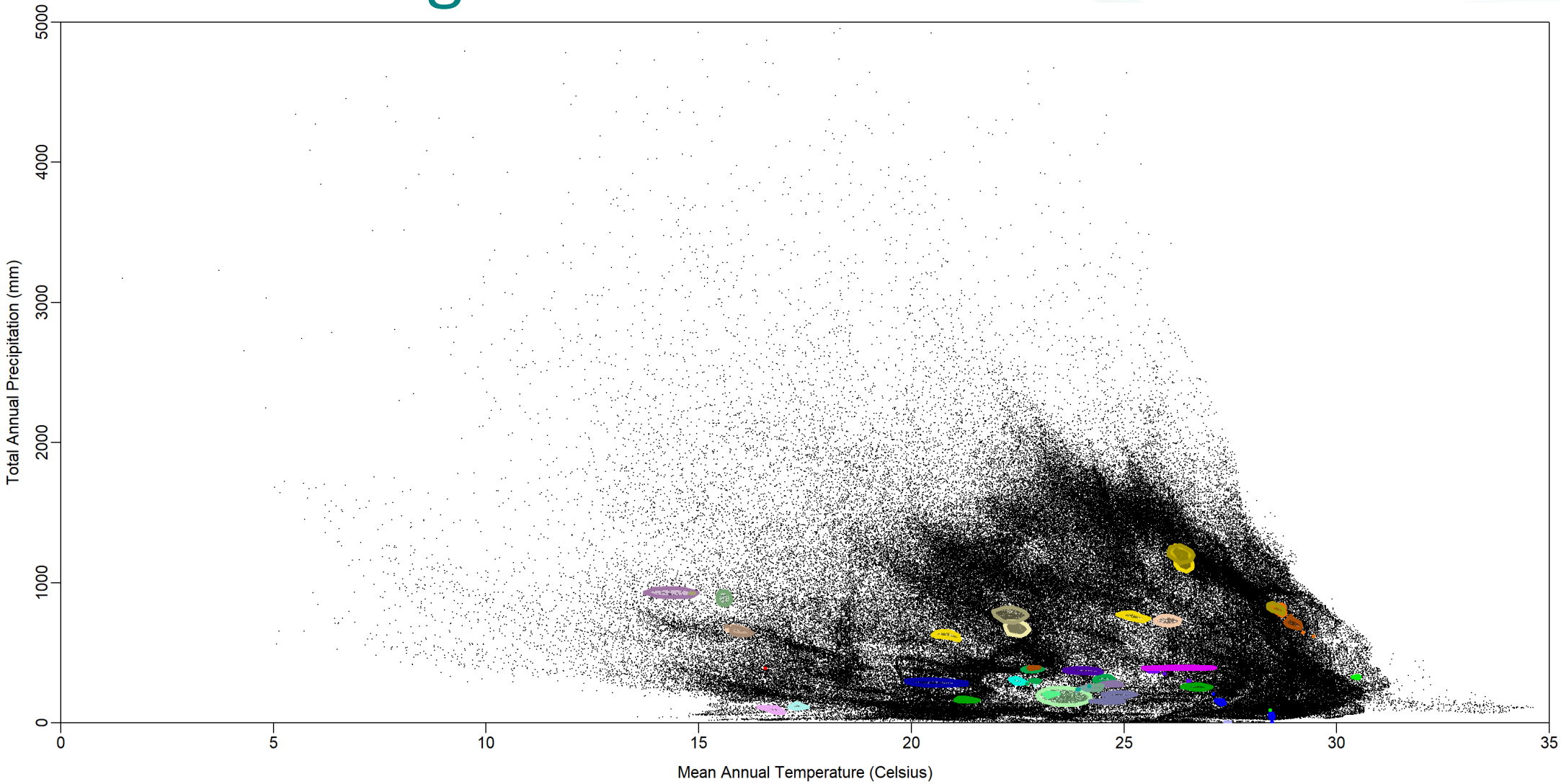
Hierarchical clustering
Broad classes based on mean values


Greater amplitude
Longer season
1
2
3
4
5
6
7
8

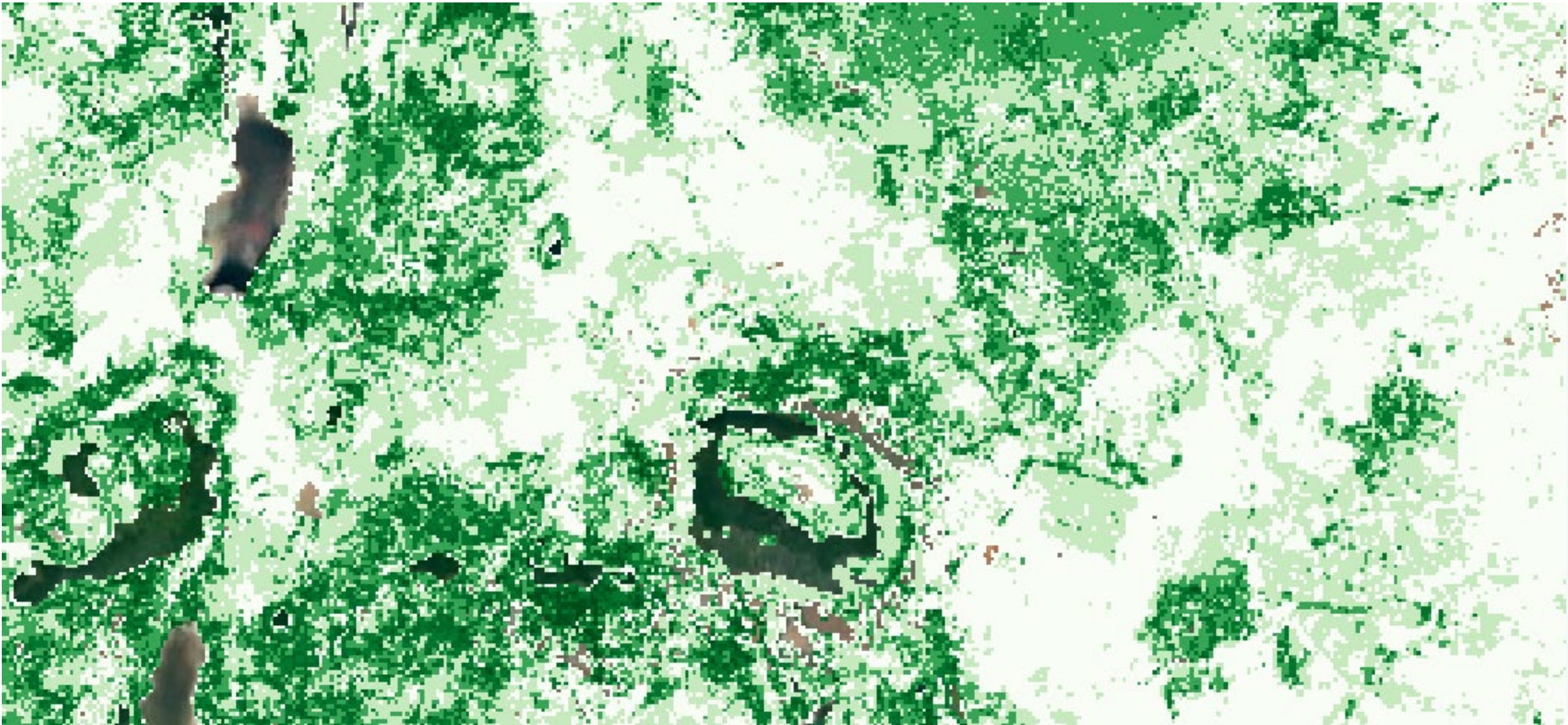
Consistent, large-scale regional patterns emerge



Rangeland types separate in climate space – RAMONA vegetation parameters capture major bioclimatic gradients

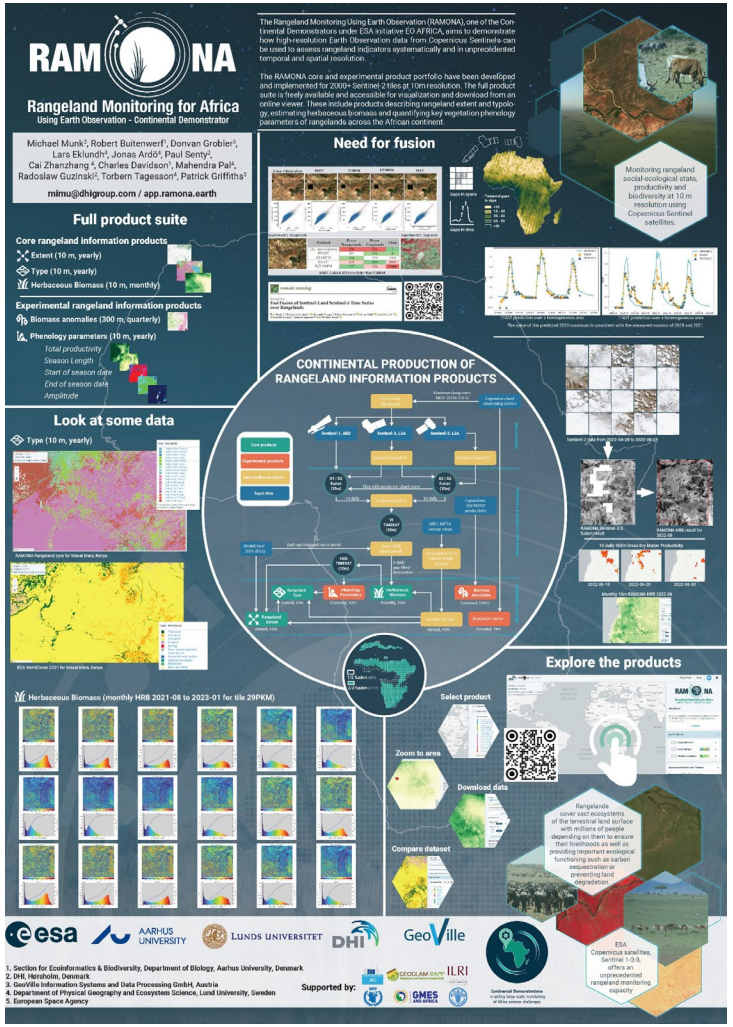


Rangeland type heterogeneity as a biodiversity metric

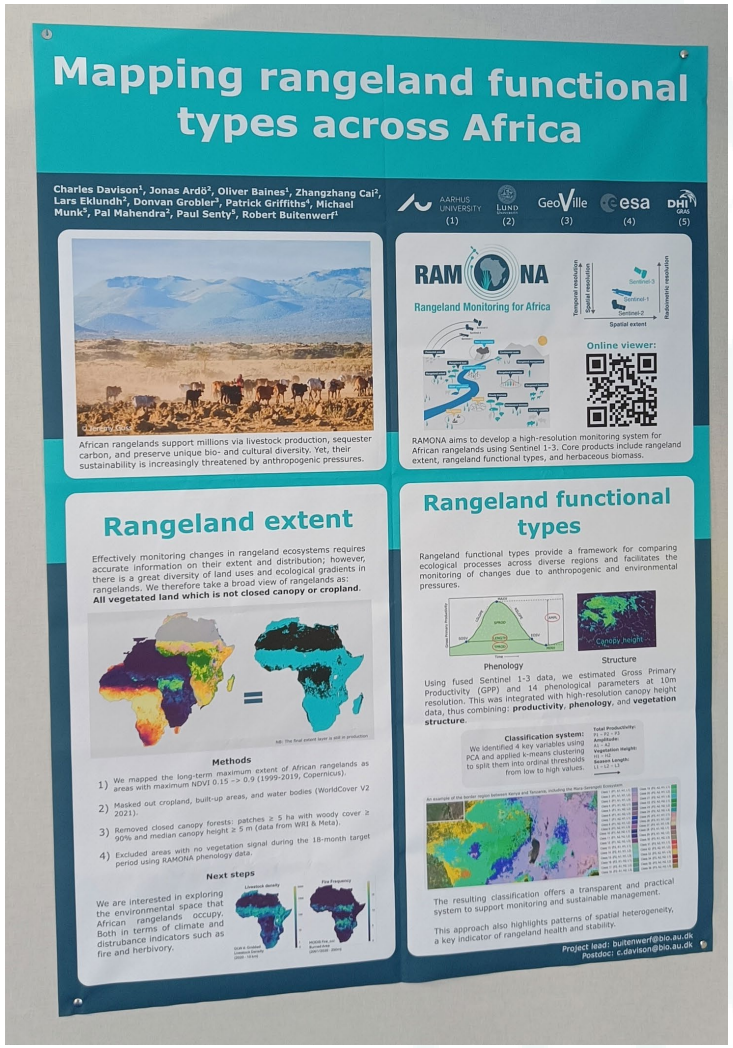


RAMONA posters

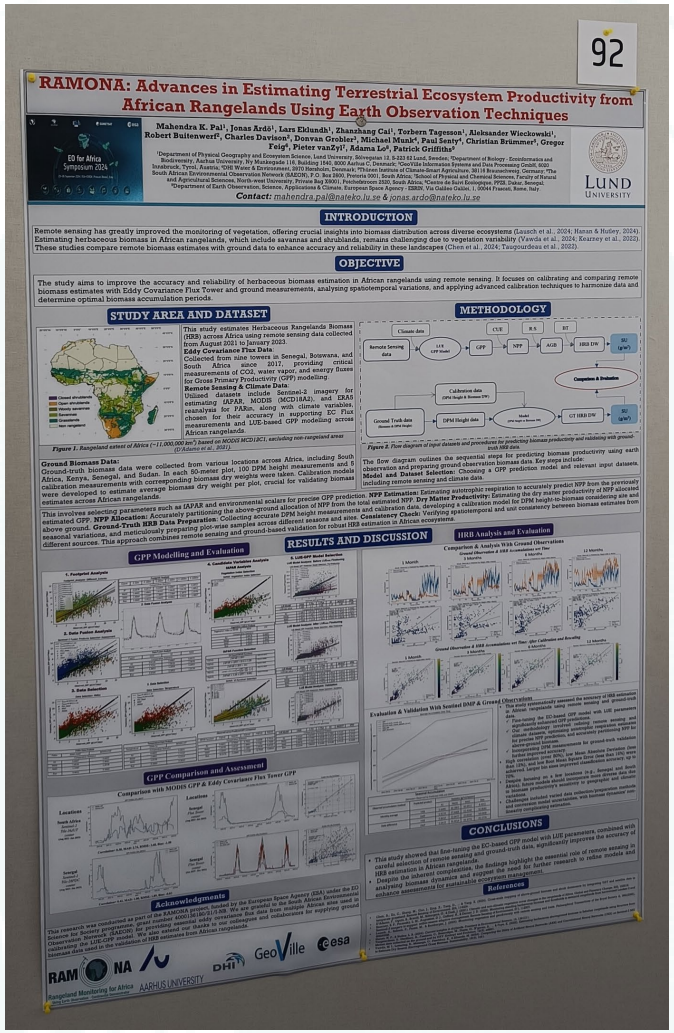
Michael Munk – Poster 79



Charlie Davison – Poster 79



Mahendra Pal – Poster 92



DHI RAMONA Beta version

https://app.ramona.earth/

Project Team

Latitude:
Longitude:
Click on the map to select a value

RAMONA
Rangeland Monitoring for Africa
Using Earth Observation - Continental Demonstrator

Description

Monitoring rangeland social-ecological state, productivity and biodiveristy at 10 m resolution using Copernicus Sentinel satellites.

Expand

Core Products

Rangeland extent

Maximum extent (1km)

Annual extent (10m)

Rangeland type

Herbaceous biomass

he Herbaceous Rangeland Biomass (HRB) productivity describe the amount of biomass