



The LifeWatch ERIC Biodiversity
& Ecosystem eScience Conference
PLOVDIV, BULGARIA 7-10 JULY 2026

Assessing Grassland Productivity Trends

Presenter: Marcos Kavlin Castaneda

09 July 2026





Why PEOPLE-ECCO

■ Conservation organizations have:

- Deep knowledge of areas under management
- Expertise in conservation science and research
- Community network and support
- Policy links

■ ... but **may struggle** with

- Repeated monitoring over long temporal scale
- Assessing effectiveness over large spatial scale
- Identifying high-priority sites outside management area

■ **Earth Observation** can **support** conservation actions by:

- Covering large geographic areas
- Over long and regular time series



Source: Reef Check Malaysia



Source: Reef Check Malaysia



Source: Lebanon Reforestation Initiative



Why PEOPLE-ECCO

■ EO can support conservation actions:

- Mapping and monitoring of key habitats
- Track deforestation, forest degradation and fragmentation
- Monitor water quality, detect Harmful Algal Blooms
- Support rapid response after disasters (flood, fire)
- Regulatory compliance
- ... and many more



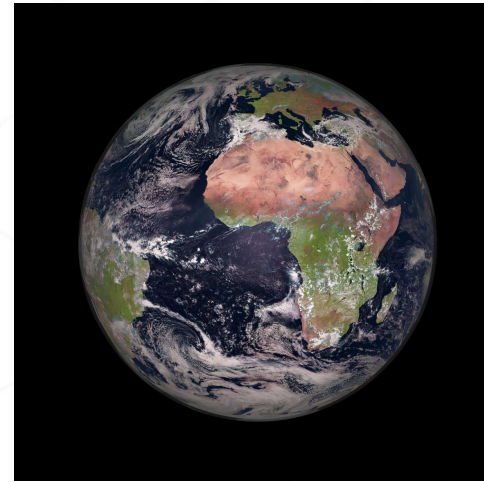


Why PEOPLE-ECCO

■ ... but

- Requires understanding of surface processes
- Needs in situ data for calibration and validation
- Can not replace on-the-ground actions and observations
- Is limited by sensor characteristics (e.g., spatial resolution) and atmospheric processes (e.g., clouds)

- → **Clear value of linking EO expertise with CSO/NGO conservation expertise**





What is PEOPLE-ECCO?

Enhancing Ecosystems Conservation through Earth observation solutions, Capacity development and Co-design

- Project of ESA's PEOPLE series (Pioneering Earth Observation Applications for the Environment)
- Response to community needs identified by CSOs/NGOs active in ecosystems conservation
- 2-year project: October 2024 – September 2026

Goals:

1. Engage CSOs/NGOs through co-design and capacity development
2. Develop tools and methods for
 - a) Monitoring conditions and management effectiveness of existing conservation actions
 - b) Identify high-priority areas for new conservation actions





Who are PEOPLE-ECCO?



▲ Project Consortium

UNIVERSITY
OF TWENTE.

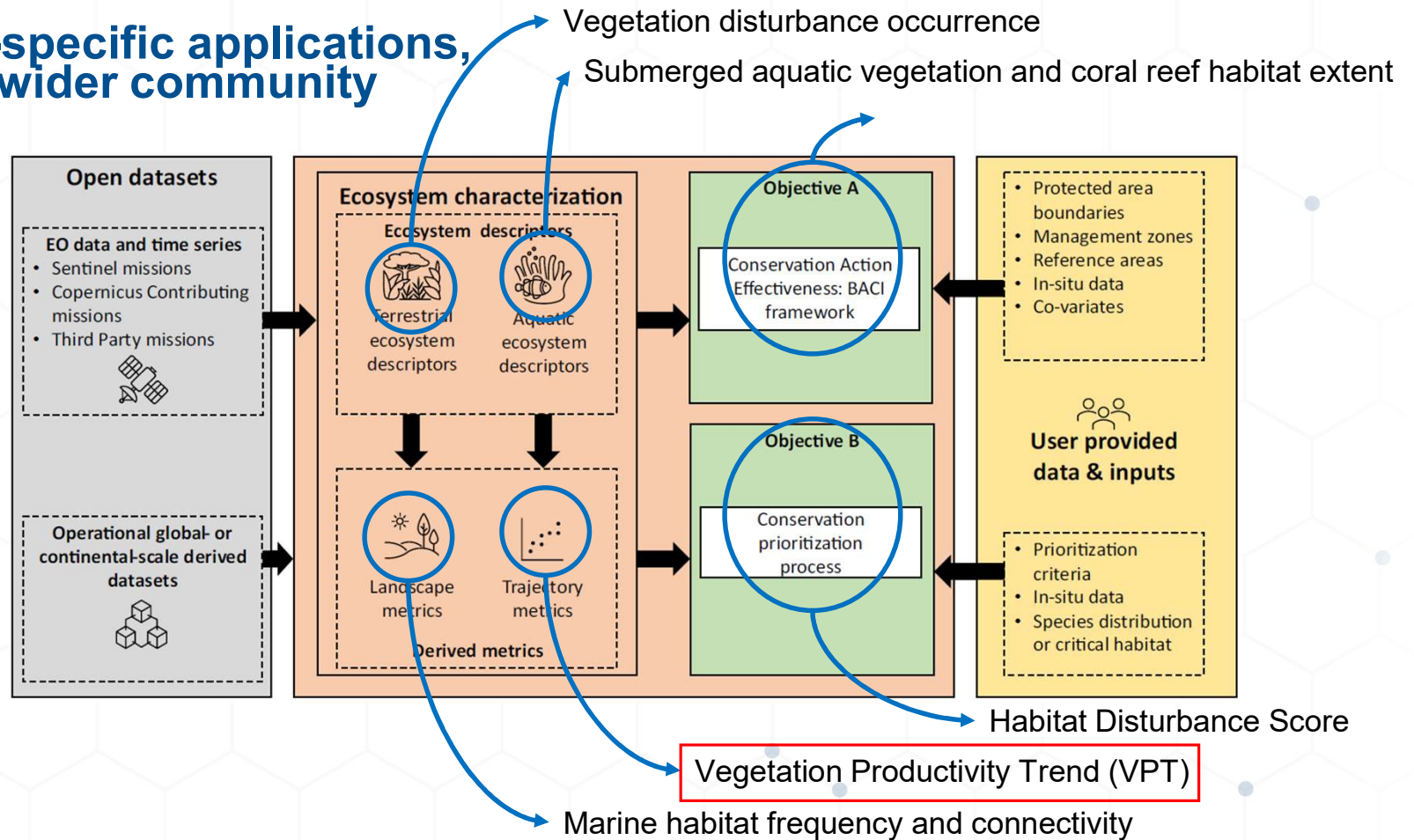


Advisory Board:

- WWF Italy
- IUCN
- SYKE
- WCS Uganda

Overall Approach to PEOPLE-ECCO

Early Adopter-specific applications, framed within wider community needs



Vegetation Productivity Trend (VPT) in Grasslands



VPT Background

- Vegetation productivity is a key indicator of grassland condition and function often linked to:
 - Biomass production
 - Grazing capacity
 - Biodiversity support
 - Carbon sequestration
- Can be affected by:
 - Overgrazing
 - Abandonment
 - Invasive species
 - Management practices (mowing, controlled grazing, ploughing)



Sakar region, Bulgaria. Source: Endangered Landscapes and Seascapes Programme



VPT Background

- In grasslands ecosystems VPT can:
 - Provide pixel-level spatially explicit data across large areas
 - Detect long-term productivity trends (increase, stability, decline)
 - Account for seasonality and phenology
- Sentinel-2 monthly time series
- Scalable for regional assessment
- Flexible - user defined time period and vegetation index (e.g., SAVI for grasslands)
- Complements EU Grassland Watch (N2K sites)
- Integrates into:
 - Conservation effectiveness
 - Prioritization and planning



Sakar region, Bulgaria. Source: Endangered Landscapes and Seascapes Programme

VPT Background

- SAVI = "**Soil Adjusted Vegetation Index**" is a modification on the NDVI remote sensing index that aims to improve vegetation monitoring in areas where soil brightness can significantly affect reflectance measurements.



Sakar region, Bulgaria. Source: Endangered Landscapes and Seascapes Programme

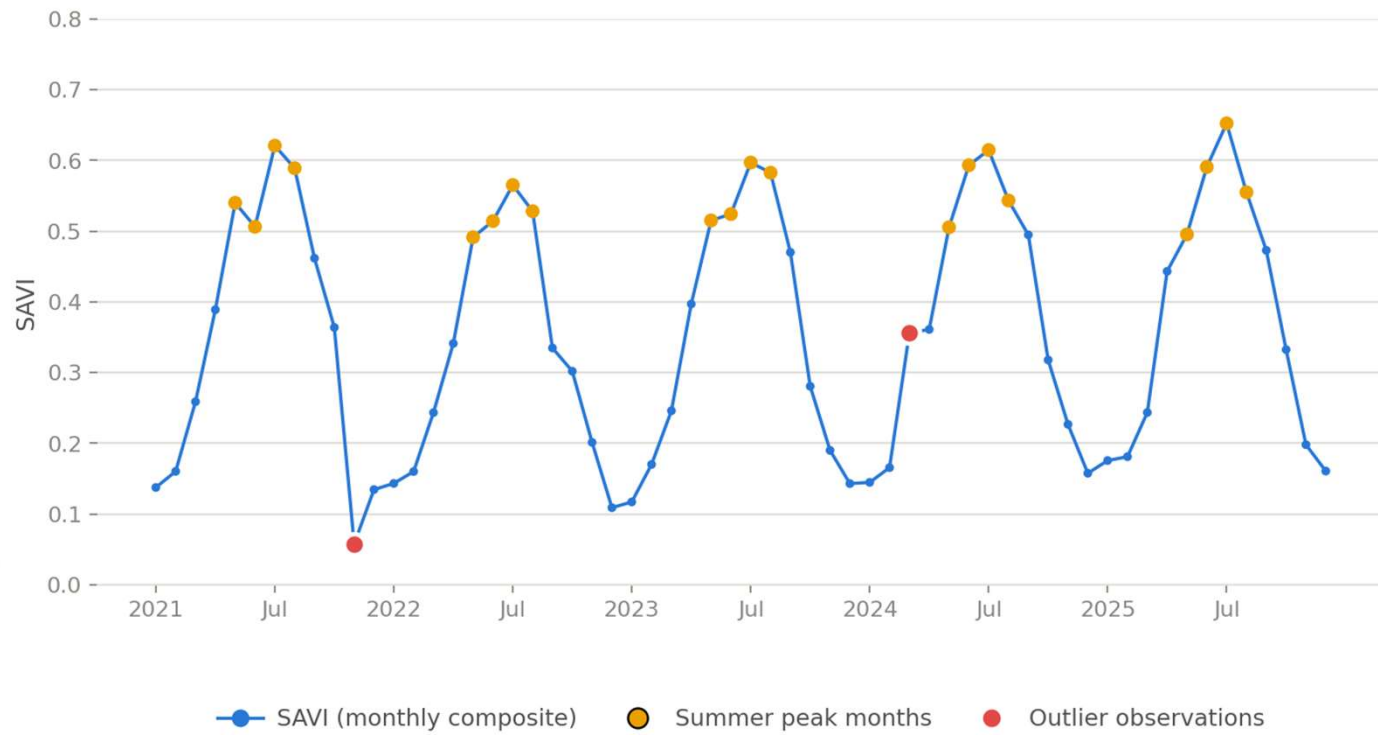
VPT Methods

1. Raw
Time
Series

2. Same-
month
pairing

3. Slope
distribution

4. Sen's
slope
result



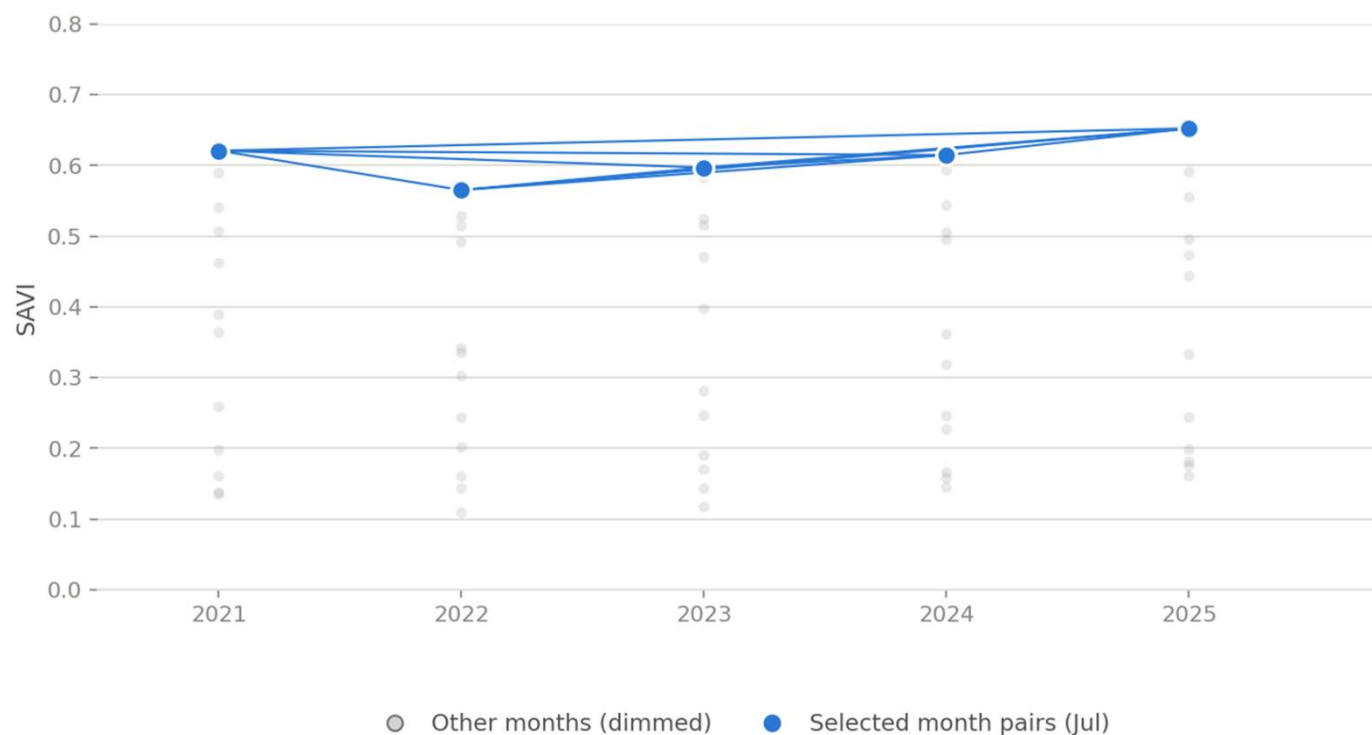
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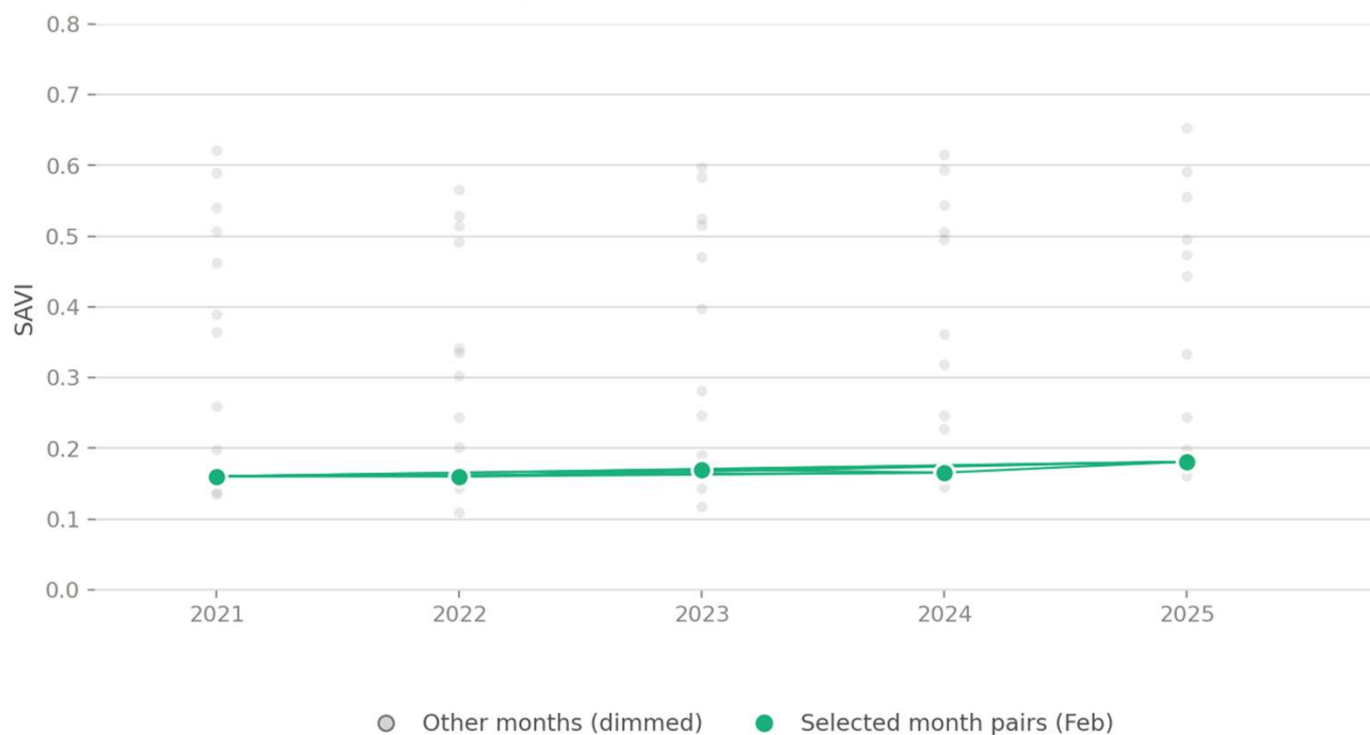
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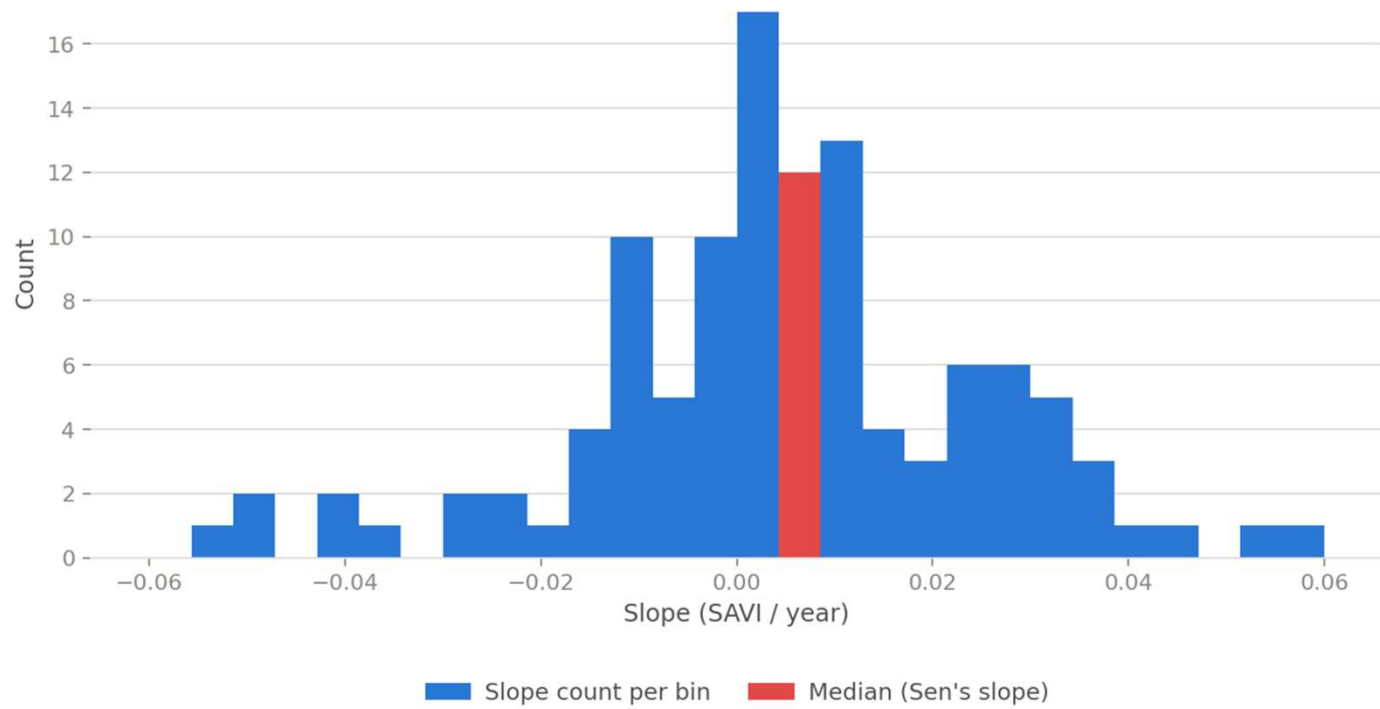
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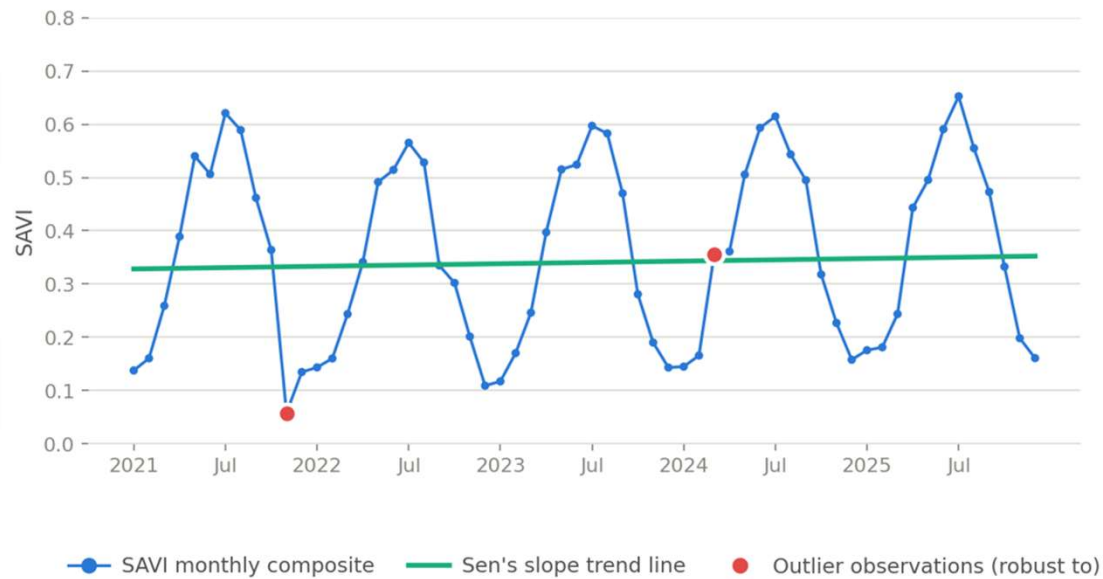
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Sen's slope	Total change (4 yr)	Trend direction	Pairs computed
+0.0049 SAVI/yr	+0.020 SAVI	Increasing ↑	120 slopes
+1.30% of 2021 baseline per year	+5.2% of 2021 baseline over 4 yr	64.2% of slopes positive	12 months × 10 pairs each

$$\text{DeltaIR} = \frac{\text{Total Change}}{\text{Percent Change}}$$



Input Data

VPT - Best Available Pixel

1. Scene acquisition

2. Cloud masking

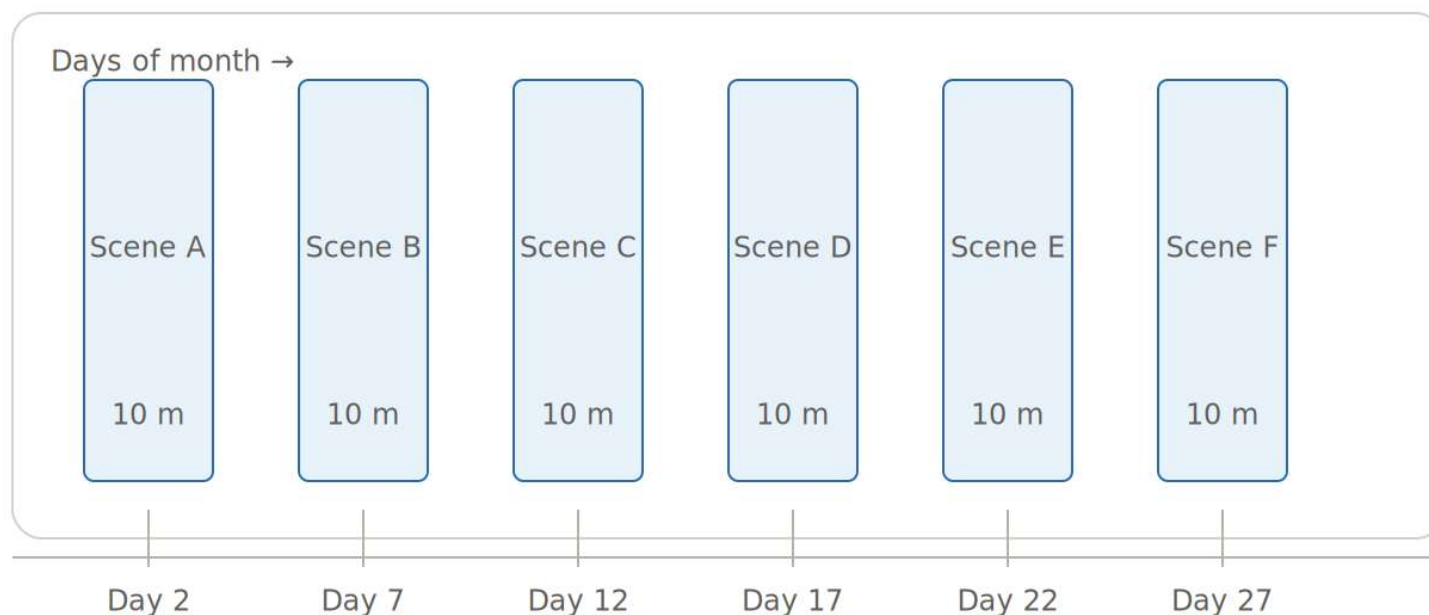
3. SAVI computation

4. Pixel scoring

5. Monthly composite

6. Year stack

Sentinel-2 acquisitions — one month example



~5-day revisit · 6 scenes/month · bands: B4 (red), B8 (NIR), SCL (cloud mask)

Sentinel-2 L2A surface reflectance, 10 m resolution

VPT - Best Available Pixel

1. Scene acquisition

2. Cloud masking

3. SAVI computation

4. Pixel scoring

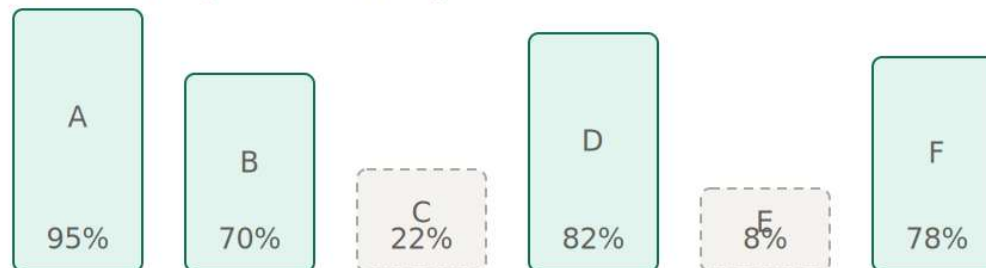
5. Monthly composite

6. Year stack

Scene Classification Layer (SCL) masking



Scene coverage after masking



Dashed = heavily clouded scene, low valid coverage

VPT - Best Available Pixel

1. Scene acquisition

2. Cloud masking

3. SAVI computation

4. Pixel scoring

5. Monthly composite

6. Year stack

Per-pixel SAVI calculation

B4 — Red
665 nm band

B8 — NIR
842 nm band

SAVI formula

$$\frac{(NIR - Red)}{(NIR + Red + L)} \times (1 + L), L = 0.5$$

SAVI image
 per scene, per pixel
 range: -1 to +1

SAVI interpretation for grassland

0.05-0.15

0.15-0.30

0.30-0.45

0.45-0.60

0.60+

Bare / dormant

Sparse cover

Moderate cover

Dense grass

Peak productivity

VPT - Best Available Pixel

1. Scene acquisition

2. Cloud masking

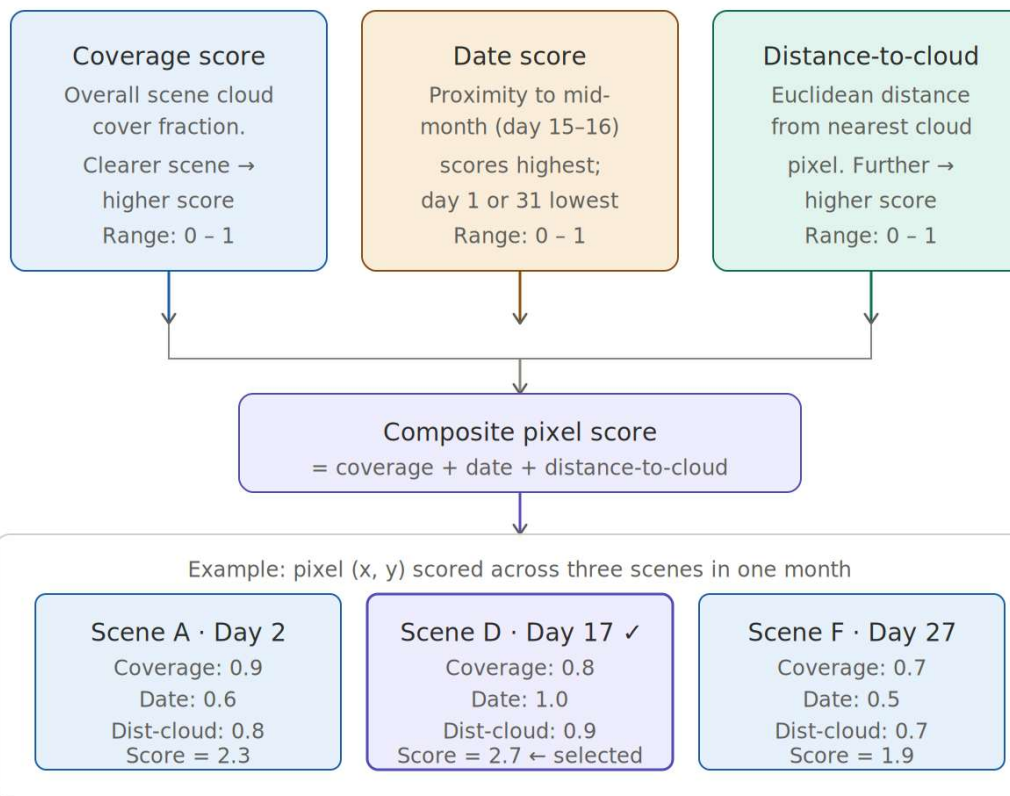
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Per-pixel quality score — three criteria



VPT - Best Available Pixel

1. Scene acquisition

2. Cloud masking

3. SAVI computation

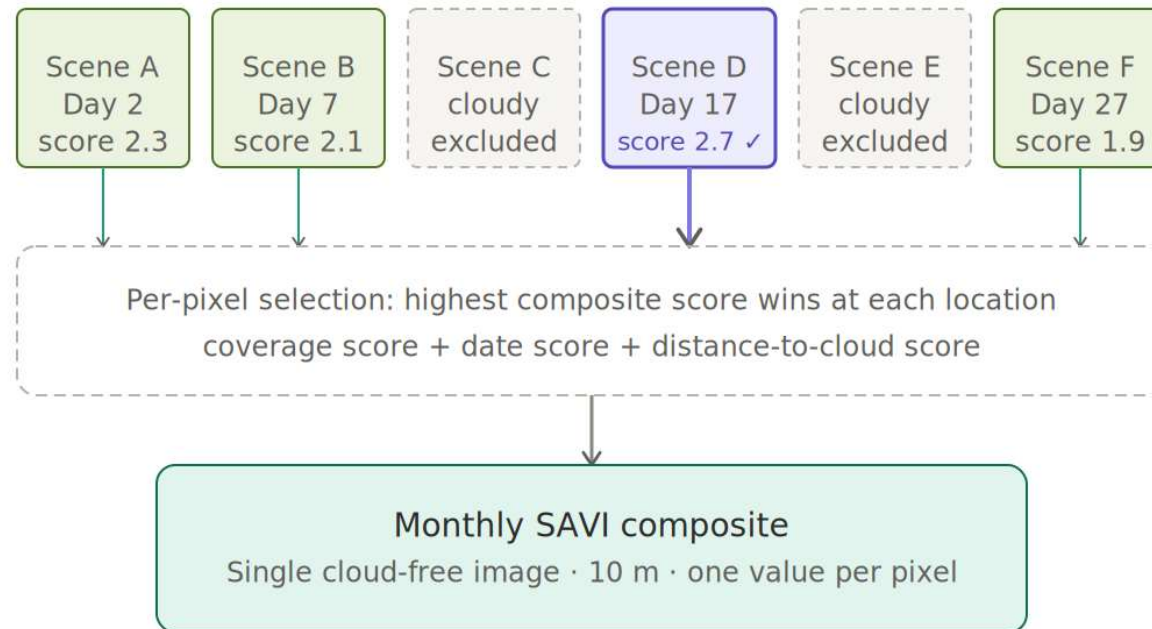
4. Pixel scoring

5. Monthly composite

6. Year stack

Best-available pixel compositing — one month

Valid SAVI scenes with per-pixel composite scores



Repeat for every month, 2021-2025 → 60 monthly composite images



VPT - Best Available Pixel

1. Scene acquisition

2. Cloud masking

3. SAVI computation

4. Pixel scoring

5. Monthly composite

6. Year stack

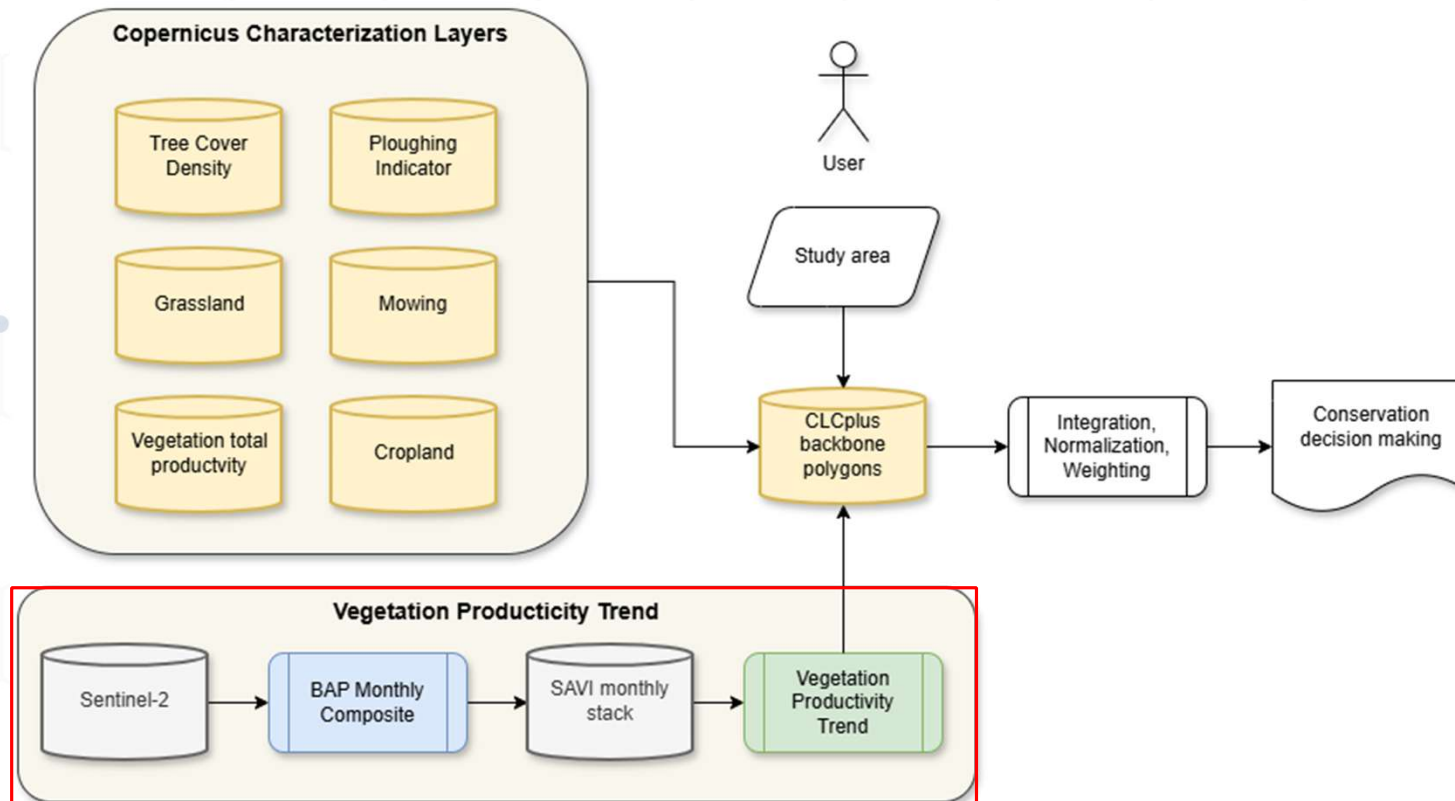
60 monthly SAVI composites → Seasonal Sen's Slope

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2021	0.15	0.17	0.29	0.42	0.61	0.47	0.66	0.63	0.49	0.42	0.21	0.14
2022	0.14	0.16	0.25	0.32	0.51	0.47	0.54	0.51	0.24	0.29	0.21	0.09
2023	0.11	0.17	0.25	0.42	0.55	0.49	0.59	0.60	0.49	0.25	0.18	0.14
2024	0.14	0.16	0.24	0.34	0.52	0.60	0.62	0.52	0.52	0.31	0.23	0.15
2025	0.18	0.18	0.23	0.49	0.49	0.59	0.68	0.53	0.47	0.32	0.18	0.15

Seasonal Sen's Slope analysis

60 composites · same-month pairs · median slope

Grassland Prioritization Workflow

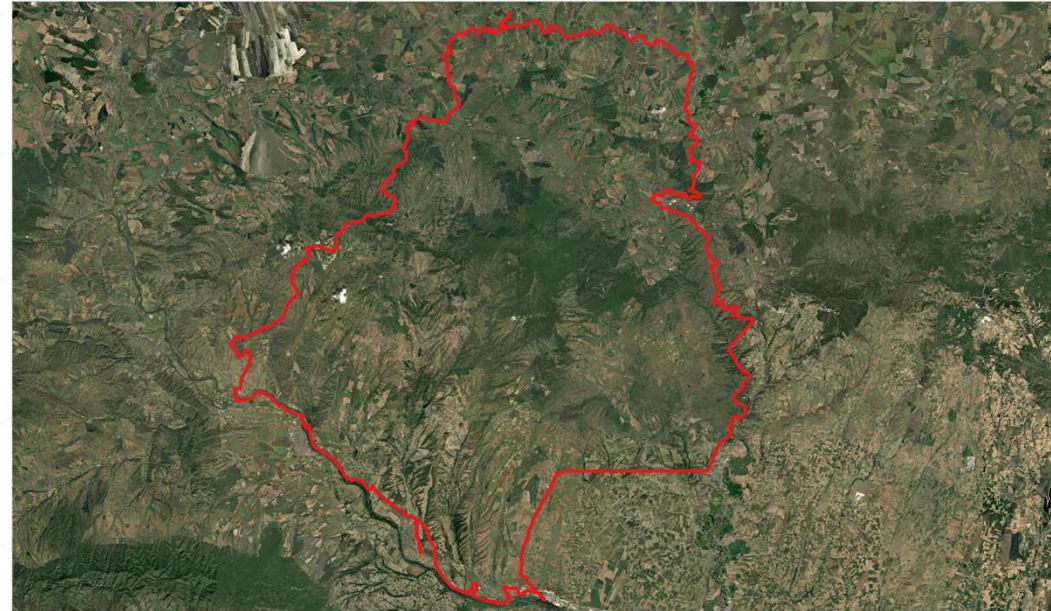




Grassland Prioritization Workflow

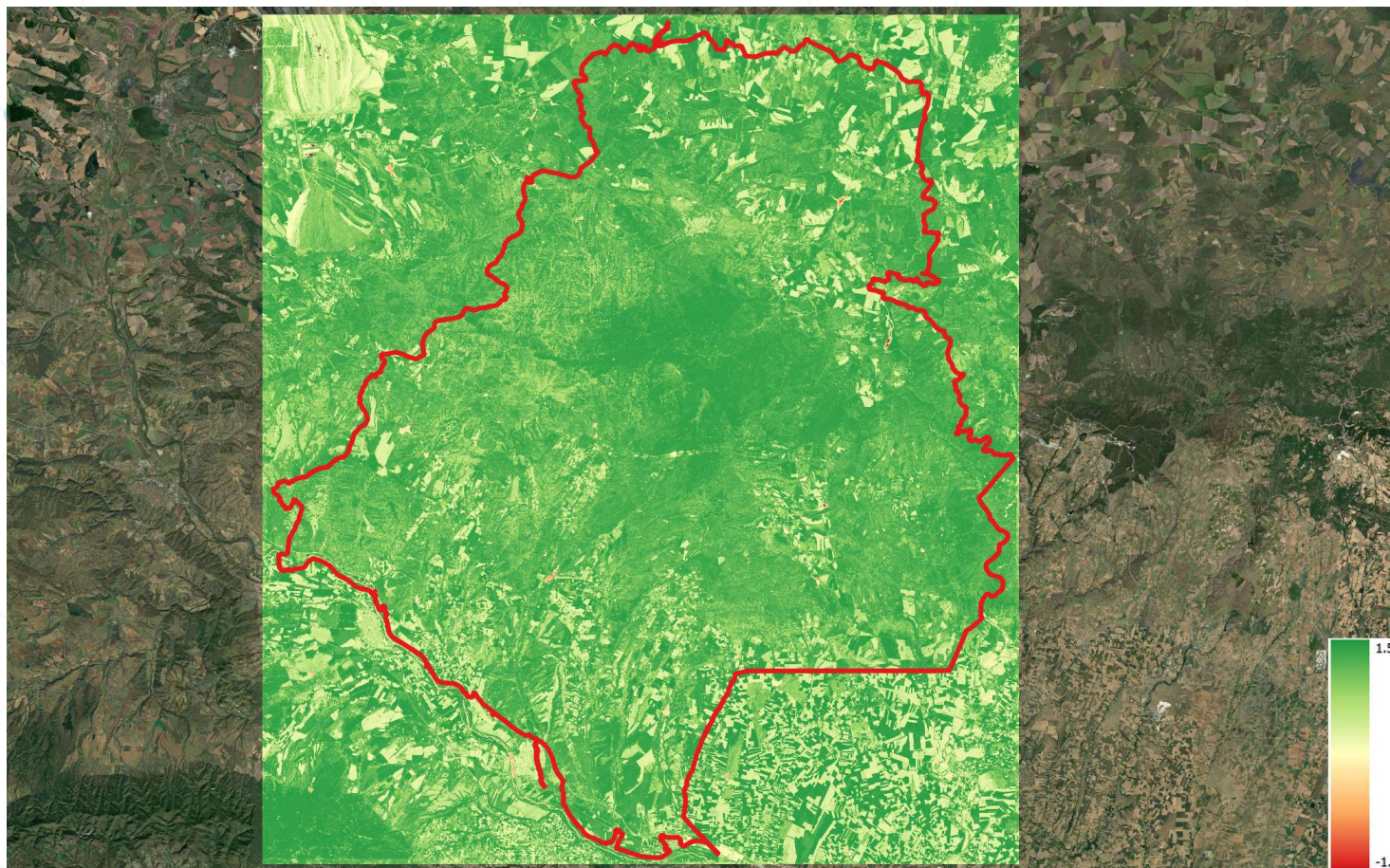
Demonstration Steps:

- Production of SAVI BAPs for 2021-2025
- Large scale Vegetation Productivity Trend execution for the Sakar region



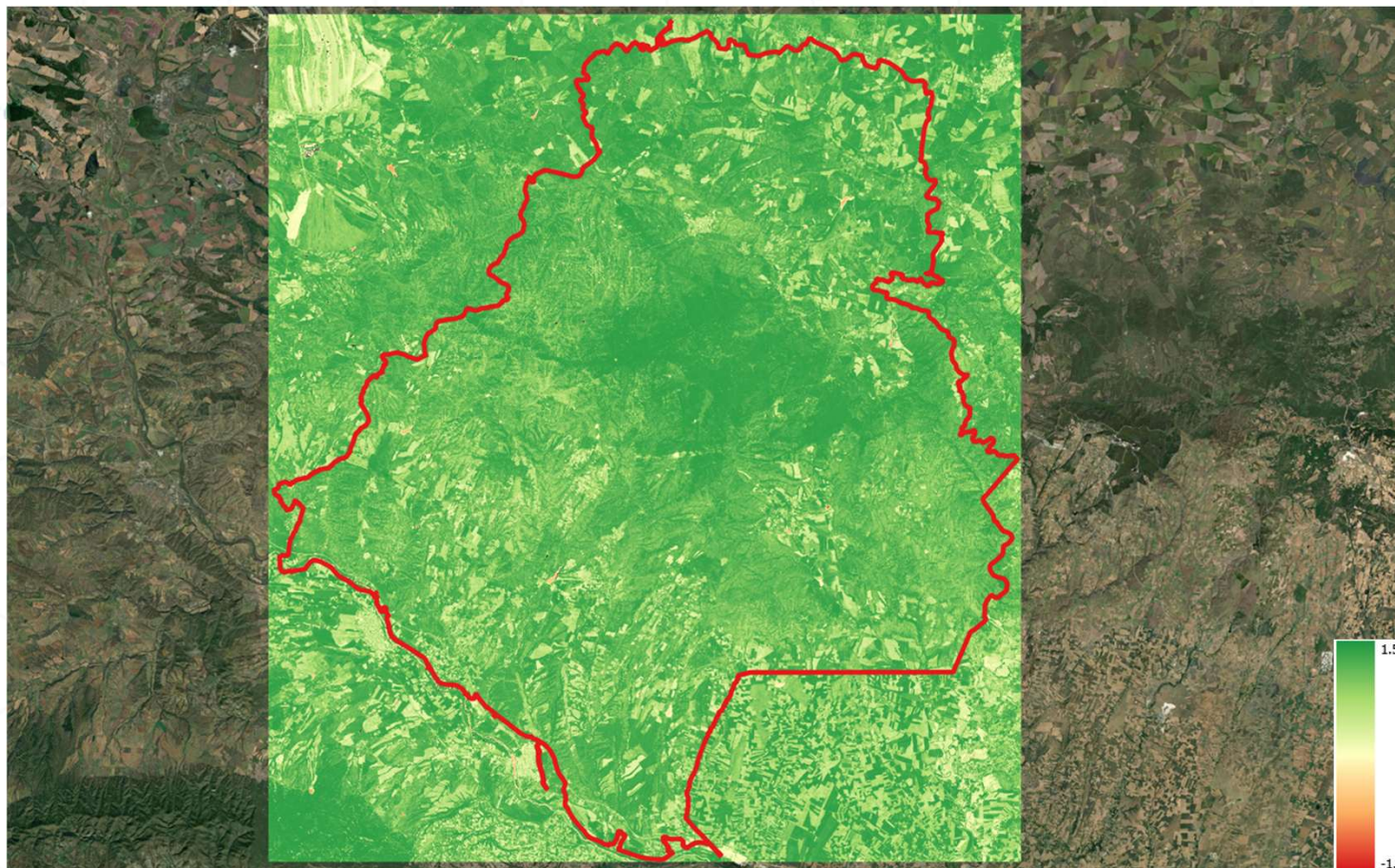


SAKAR BAPS





SAKAR BAPS

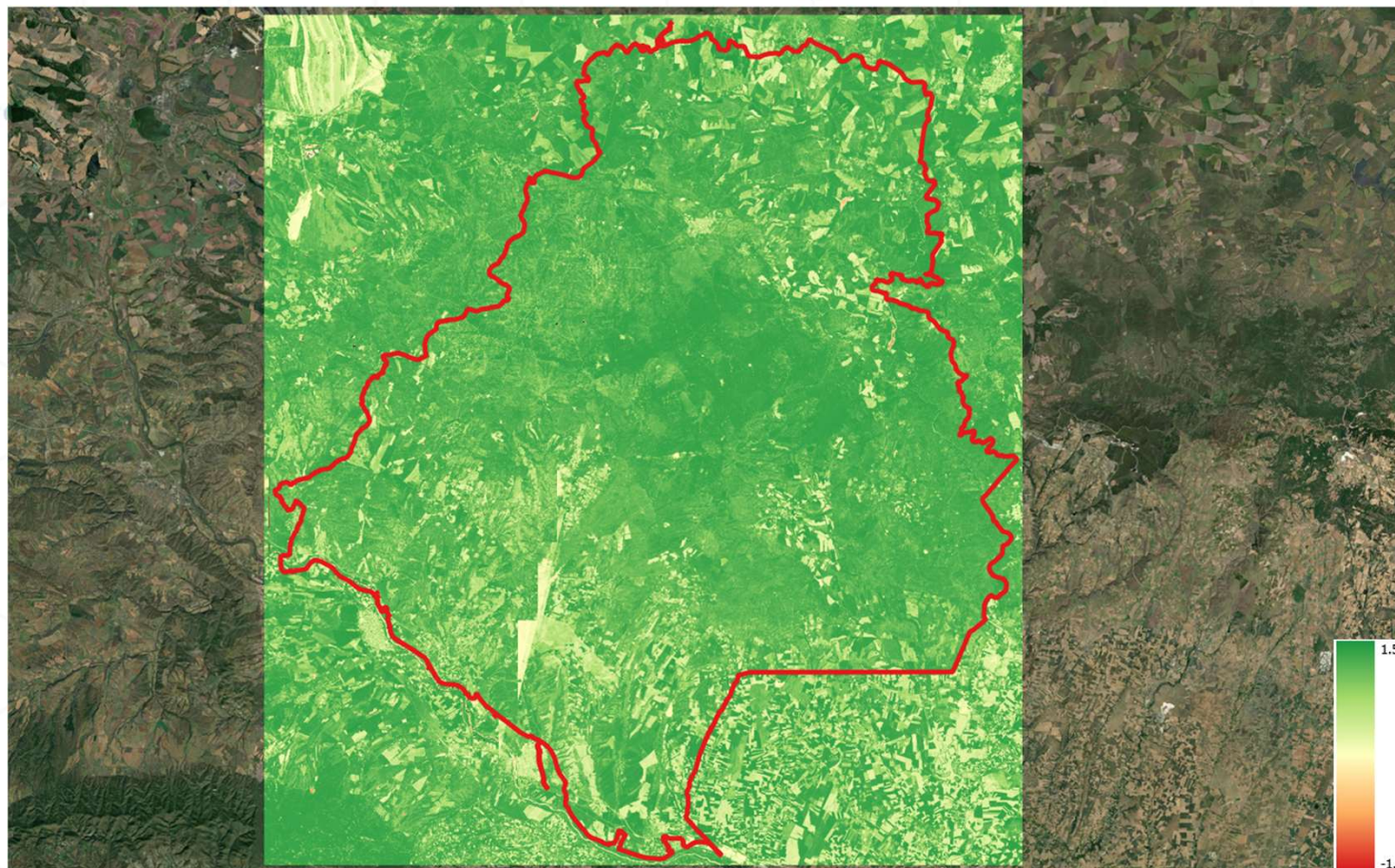


2022

SAVI

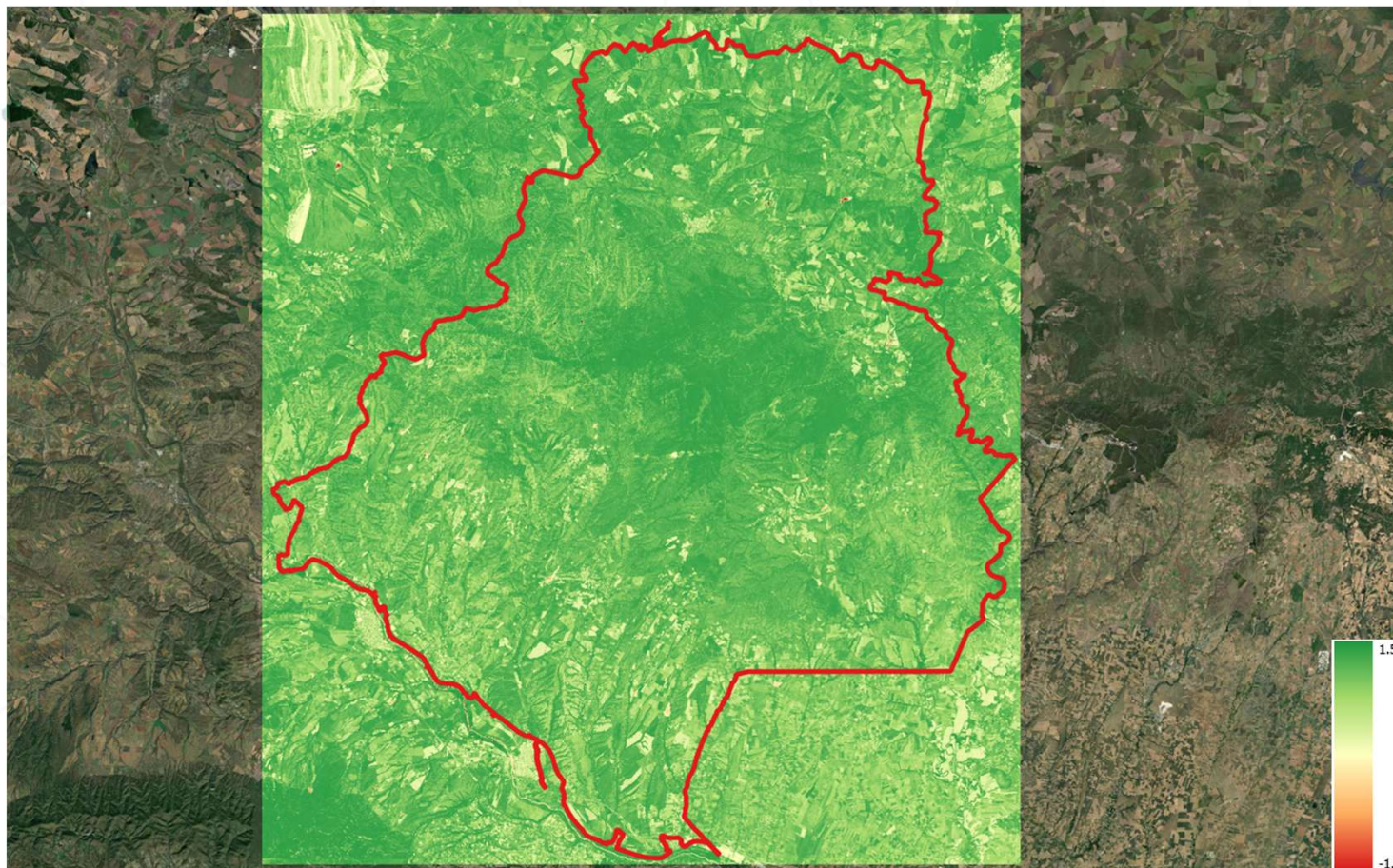


SAKAR BAPS



2023

SAVI



2024

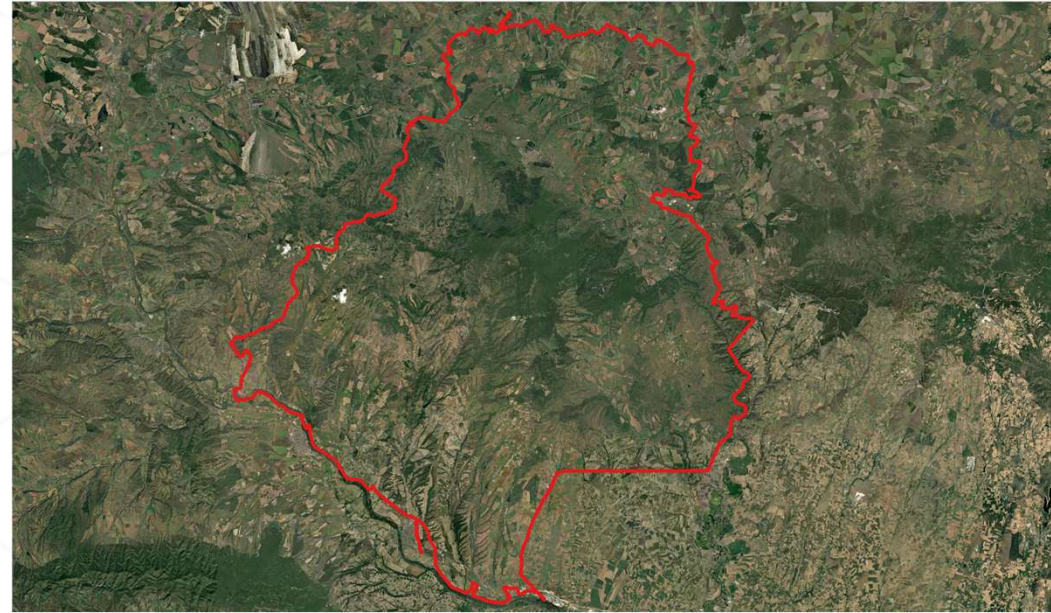
SAVI



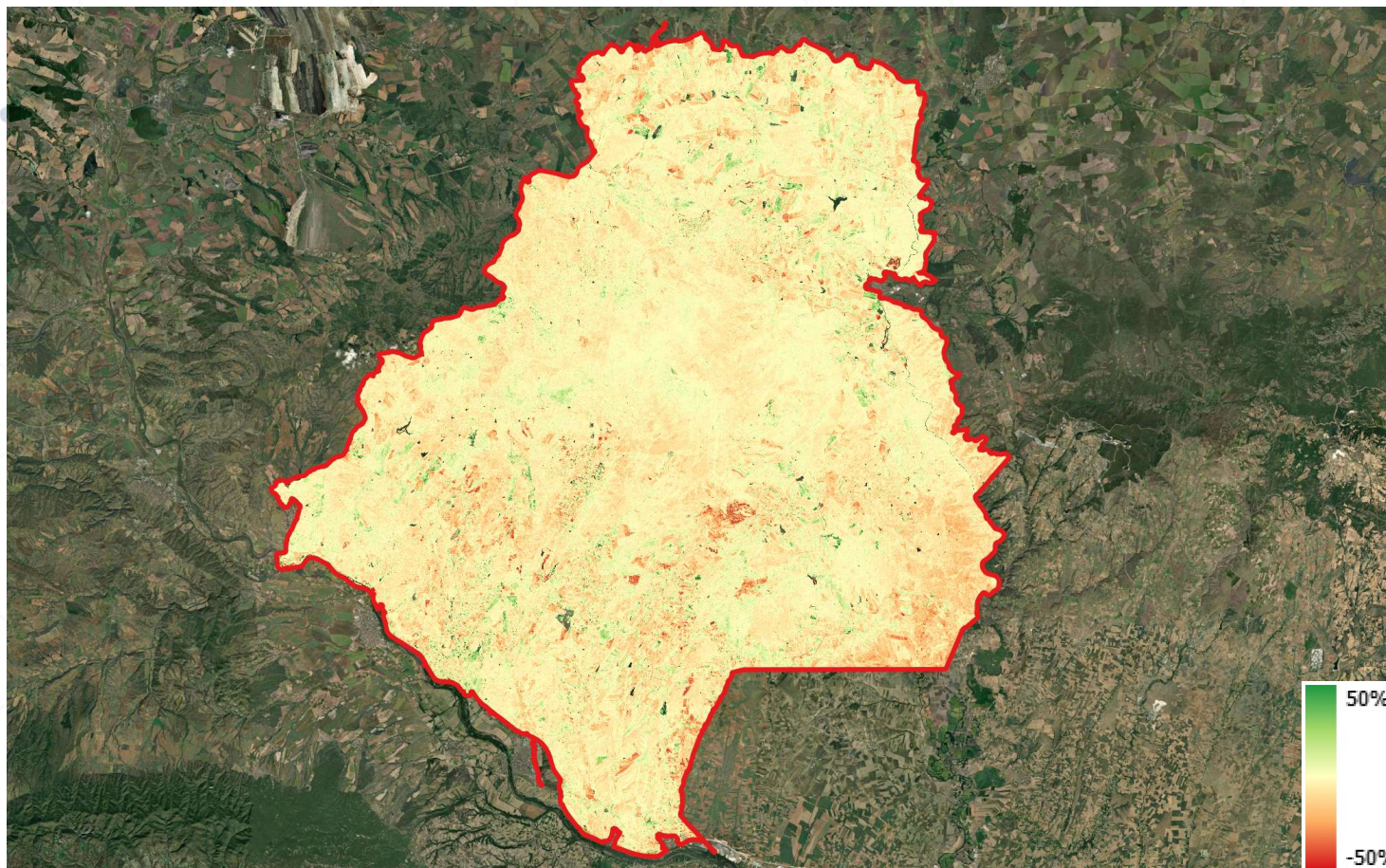
Grassland Prioritization Workflow

Demonstration Steps:

- Production of SAVI BAPs for 2021-2025
- Large scale Vegetation Productivity Trend execution for the Sakar region



VPT - SAVI % Change



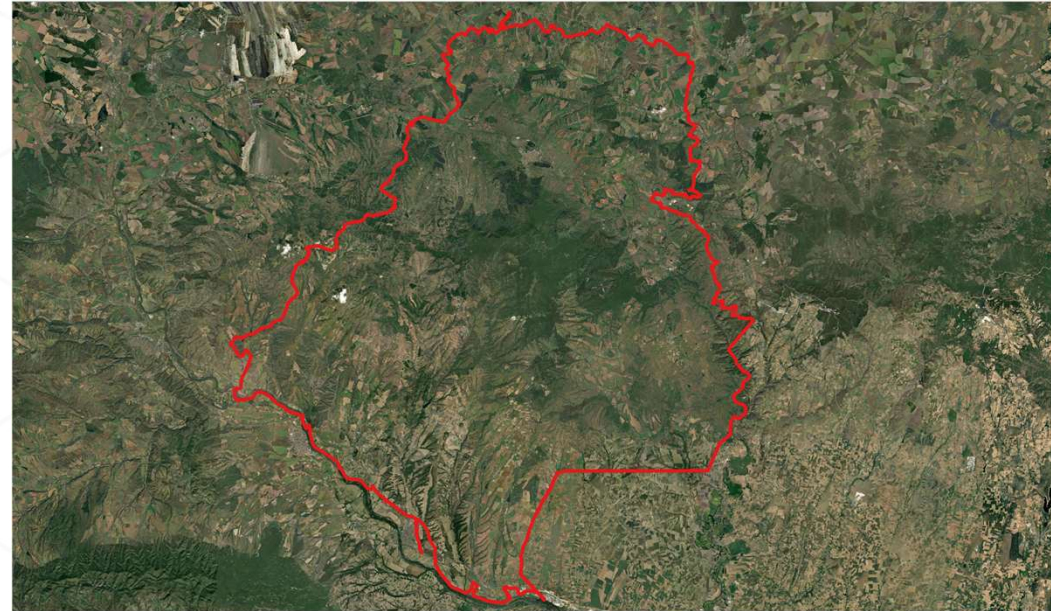
How can this be used?



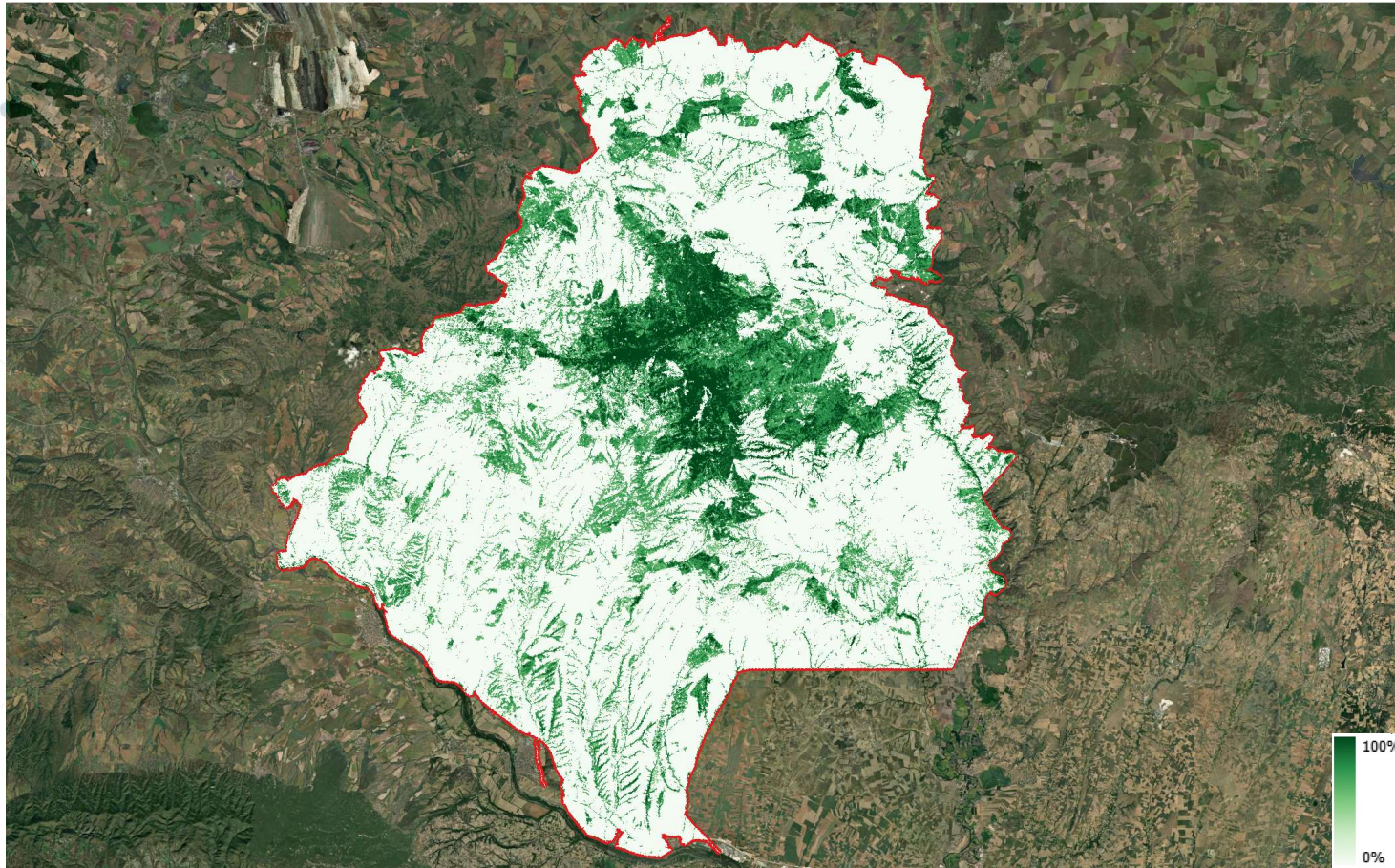
Grassland Prioritization Workflow

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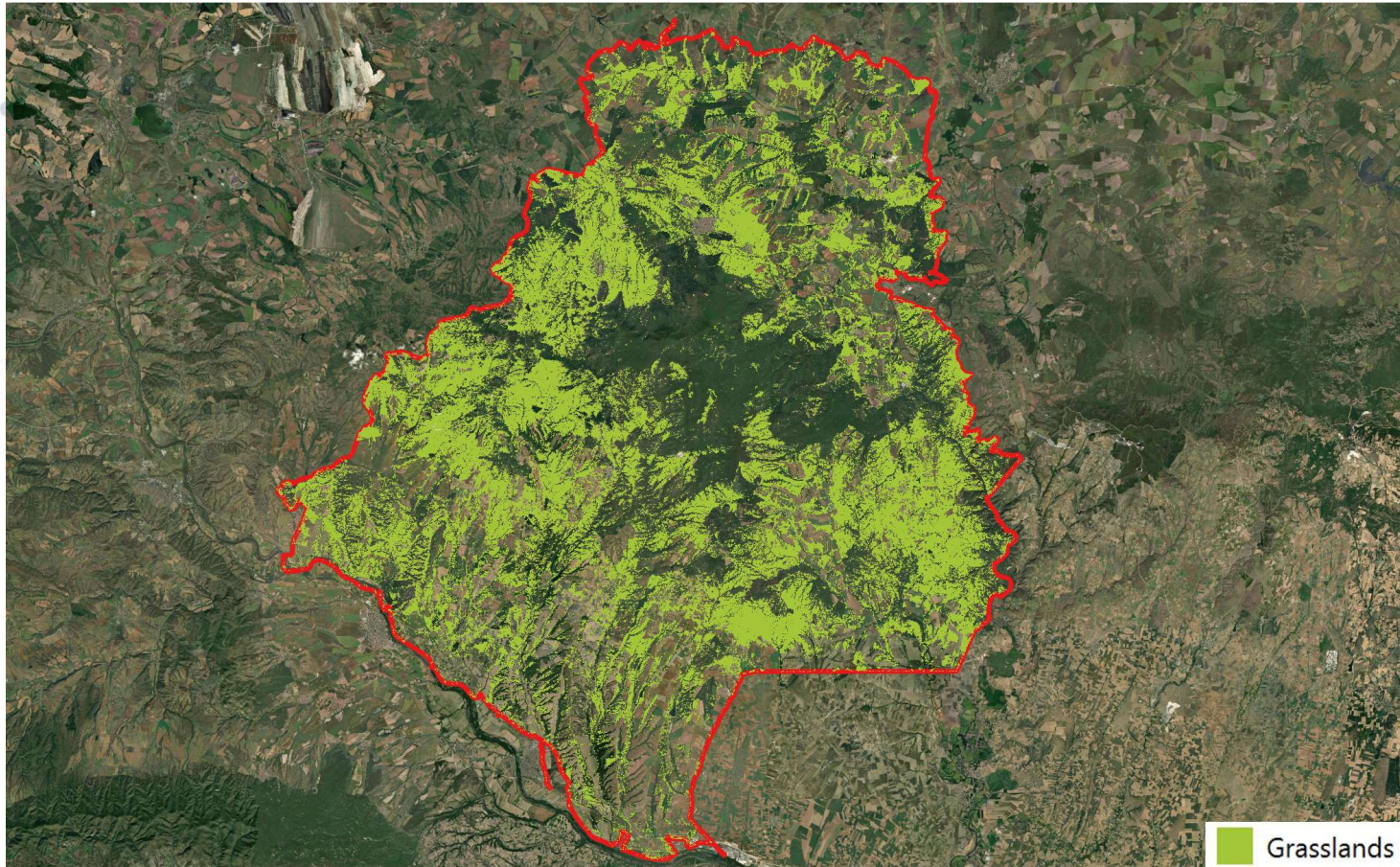
- Production of SAVI BAPs for 2021-2025
- Large scale Vegetation Productivity Trend execution for the Sakar region
- Integration of ancillary datasets using a spatial framework (can use land parcel data if available)
- Apply weights to then prioritize conservation needs of the landscape



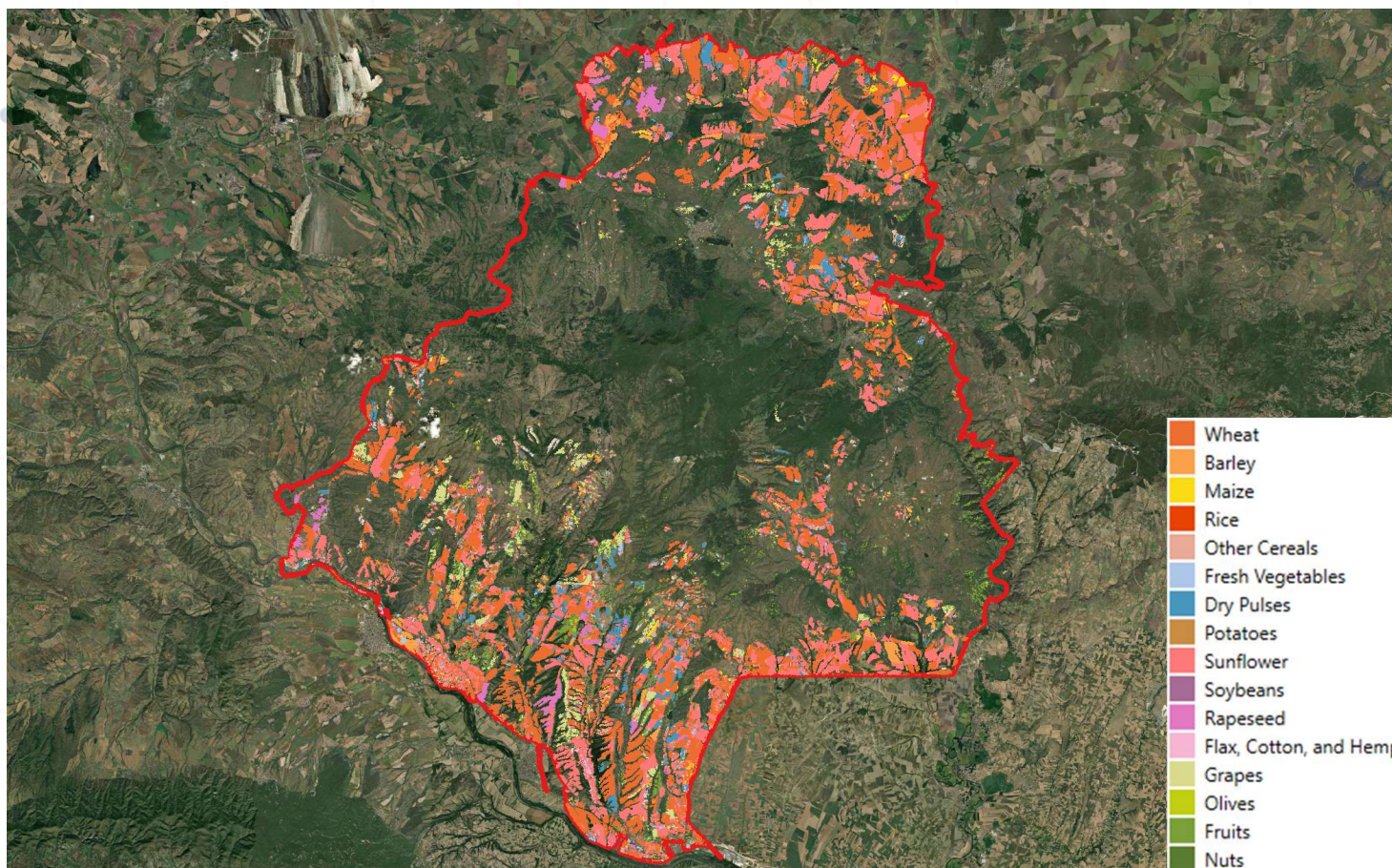
CLMS Tree Cover Density (2021)



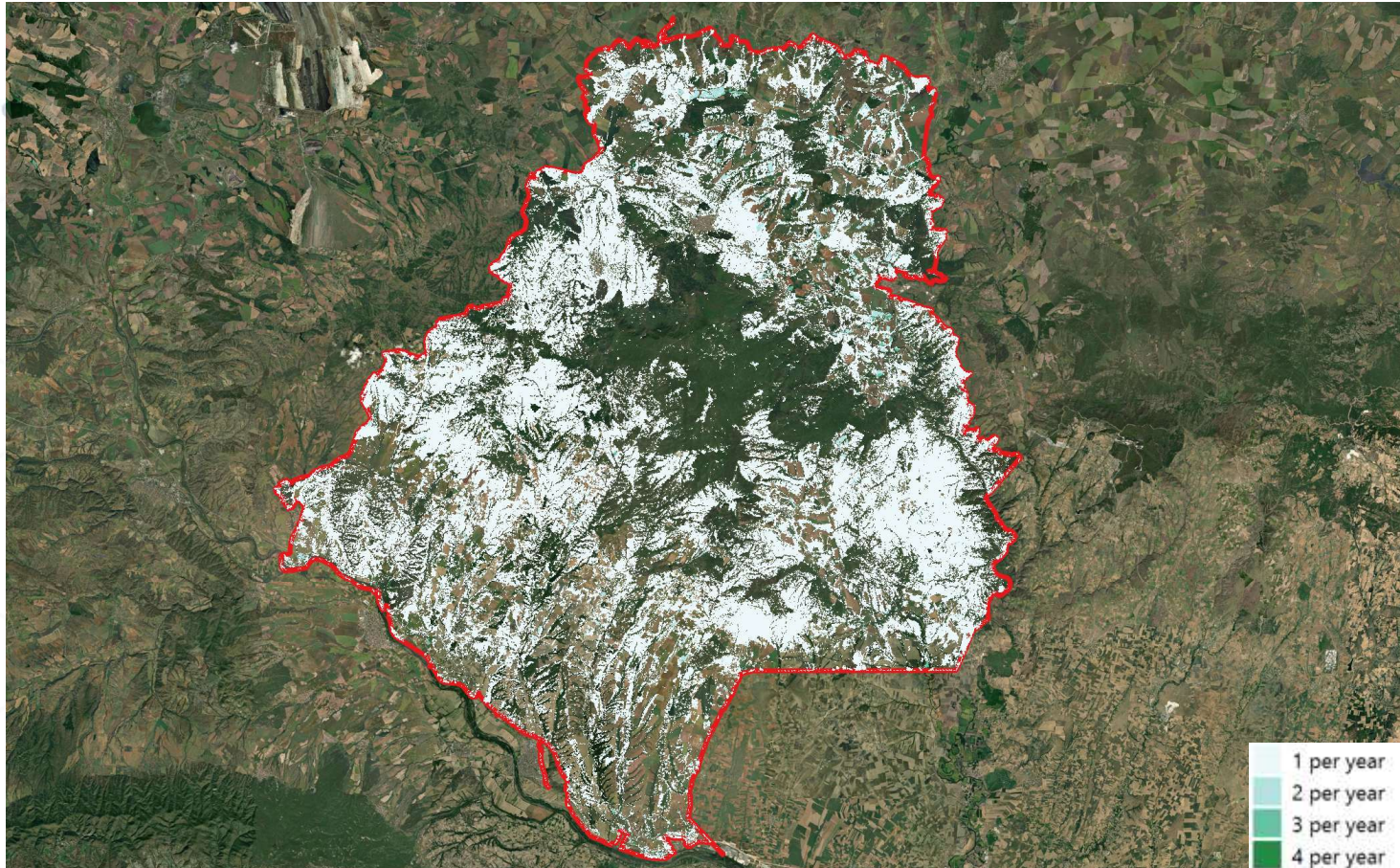
CLMS Grasslands (2024)



CLMS Crop Type (2023)

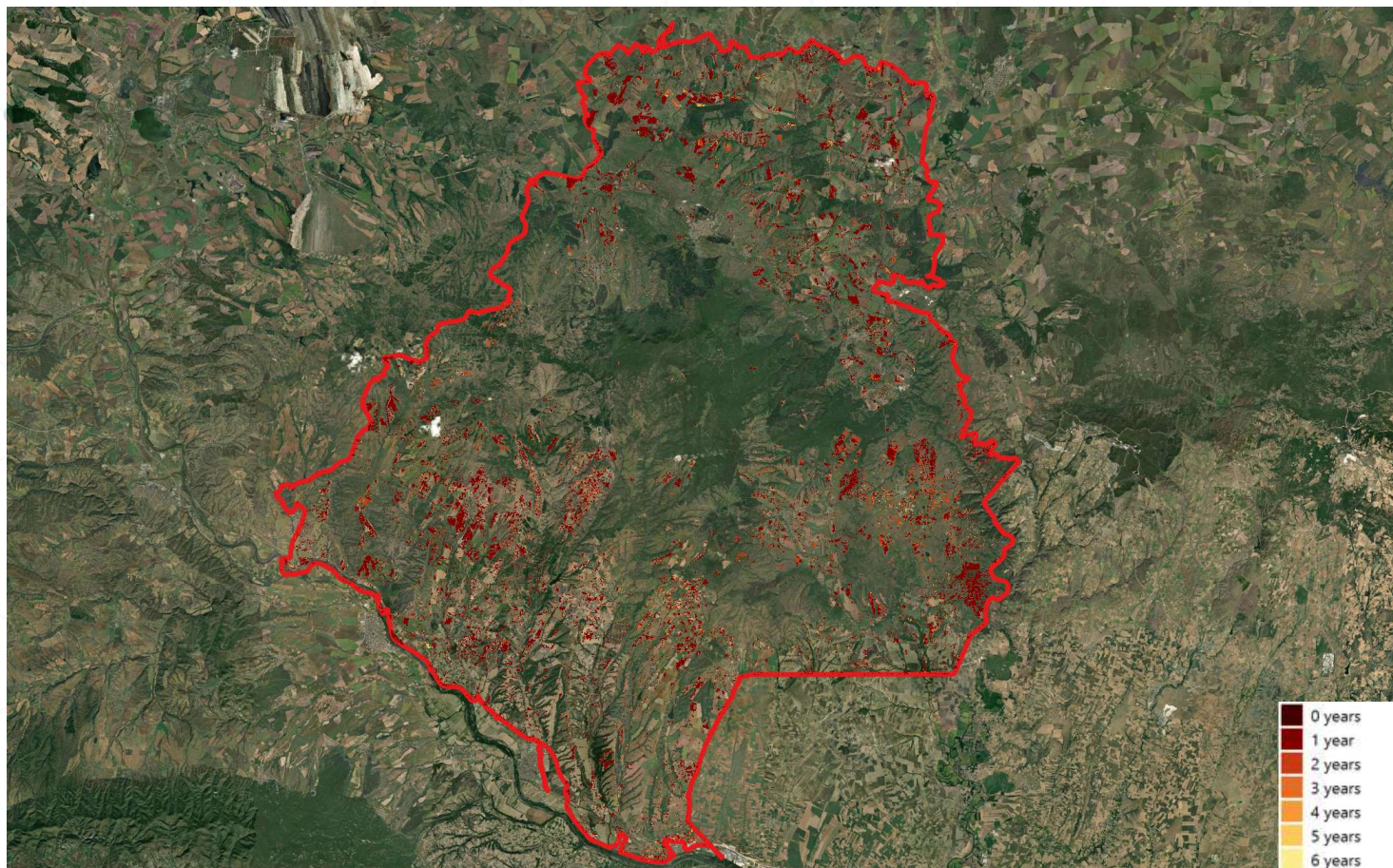


CLMS Mowing Events (2023)



Mowing
Events

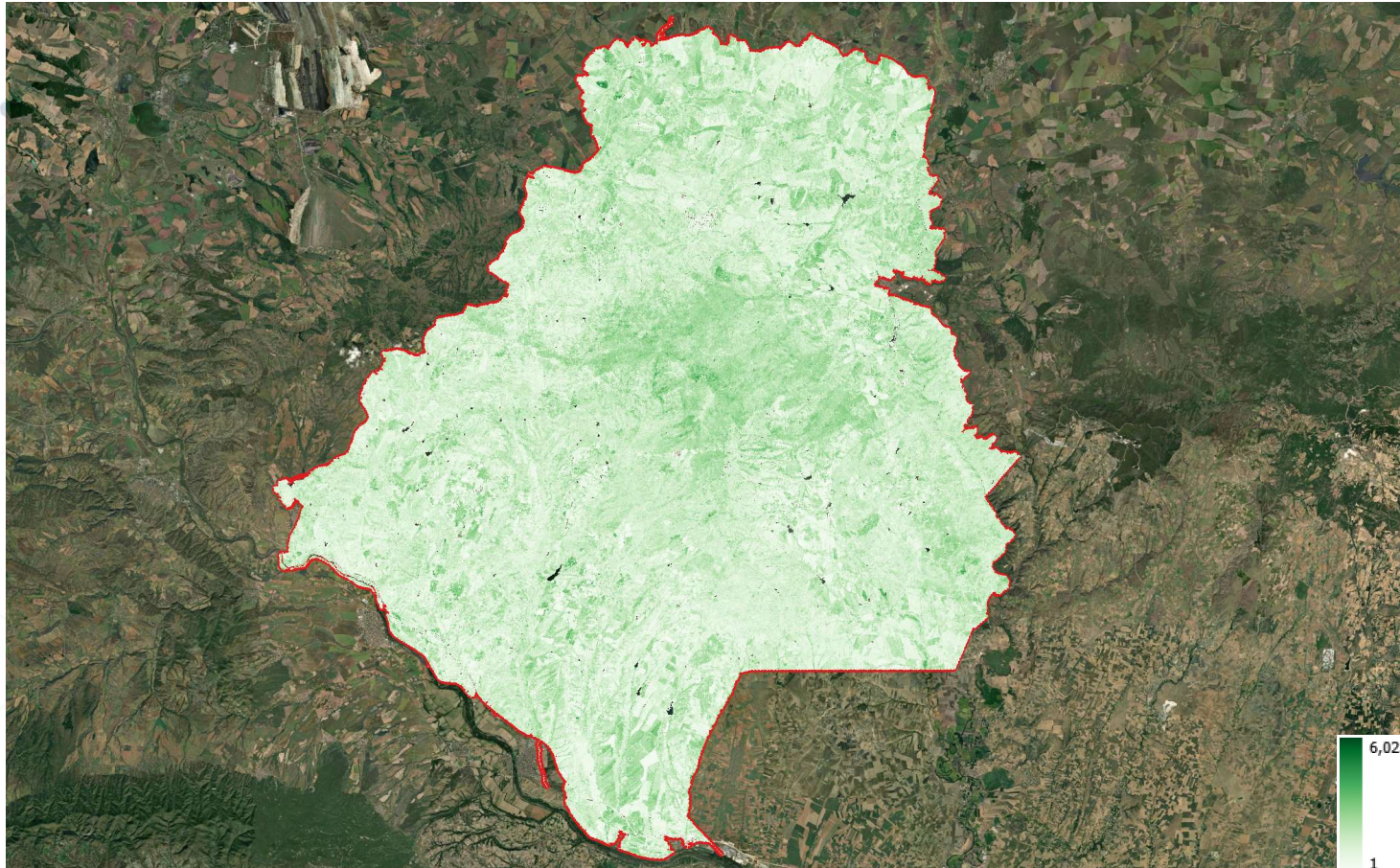
CLMS Ploughing Indicator (2023)



Years
since
ploughing



CLMS Total Productivity (2024)



Sum of
Growing
Season
PPI values



CLMS Parcel-level Statistics

Statistic	Value
Mean tree cover density for parcel (0 to 100%)	2.83 %
Percent of parcel covered with cropland (0 to 100%)	2.97 %
Majority crop type	Fruits
Percent of parcel covered with grassland (0 to 100%)	85.72 %
Mean vegetation productivity (mean of total productivity).	913.03
Land parcel ploughing or seasonal senescence of grassland: - Ploughing/senesce occurrence (Yes or No) - Percent of polygon with ploughing/senescence in 2021, 2022, 2023 (0 to 100%) - Years since last ploughing	- Ploughing/senescence occurrence: <u>Yes</u> - Percent of polygon with ploughing/senescence in 2021, 2022, and 2023: <u>0.94 %</u> - Median years since last ploughing/senescence: <u>0</u>
Land parcel number of mowing events: - Mowing occurrence (Yes or No) - Percent of polygon with mowing in 2021, 2022, or 2023 (0 to 100%) - Mowing events per year	- Mowing occurrence: <u>Yes</u> - Percent of polygon with mowing in 2021, 2022, or 2023: <u>9.9 %</u> - Median mowing events per year: <u>1</u>
Median percent change of the parcel (% change SAVI)	0.77 %
Average minimum distance to a nest (metres)	4442 m

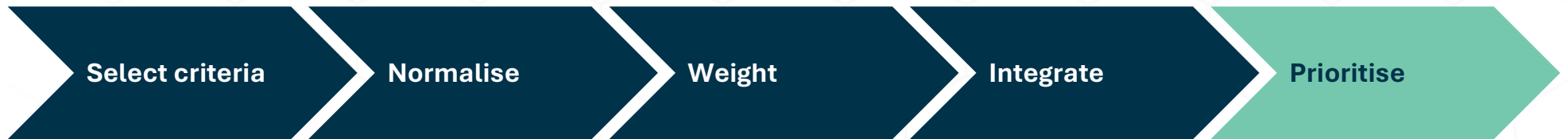
Multi Criteria Analysis



Multi-Criteria Prioritization

- A structured decision-support method that combines several spatial data layers into a single composite score, used to rank and prioritise areas.
- In conservation prioritisation it integrates factors such as habitat quality, species presence/proximity, threats — no single layer tells the whole story.
- Each criterion is placed on a common scale, weighted by importance, then combined into one priority surface.

The MCA workflow





Why Normalise the Input Data?

- Criteria are measured in different units and span very different numerical ranges.
- Combined directly, layers with large ranges (e.g. distance, elevation) dominate the result and swamp those with small ranges (slope, density).

Input layer	Unit	Typical raw range
Tree cover density	%	0 – 100
Distance to eagle nest	m	0 – 23,180
Total vegetation productivity	n/a	0 – 4,180
Mowing	count	0 – 4

Distance to nest spans 5,000
Tree cover density spans 100
— without rescaling, distance alone would drive the result.

Normalization puts every layer on a common 0–1 scale so each criterion contributes fairly.



MCA Key Assumptions



Approximately normal

Methods such as z-score standardization assume each layer is roughly normally distributed.



Monotonic relationship

Suitability changes consistently in one direction as a criterion increases or decreases.



Comparable & independent

Criteria capture distinct factors; strongly correlated layers would double-count the same effect.



Clean, complete data

Outliers and gaps are handled first — they distort the min, max, mean and standard deviation.

Normalization Methods

Min-max scaling

$$x' = (x - \min) / (\max - \min)$$

Rescales values to a fixed 0–1 range using known bounds. Keeps relative spacing but is sensitive to outliers.

Z-score standardisation

$$z = (x - \mu) / \sigma$$

Centres data on the mean in units of standard deviation. Suits roughly normal data; not bounded to 0–1.

Inverse min-max

$$x' = (\max - x) / (\max - \min)$$

For 'lower is better' criteria — e.g. land nearer the eagle nest receives a higher score.



Integration & Weighting

- Normalised layers are combined into a single composite priority score for every location.
- Weighted Linear Combination is the most common rule; each criterion is multiplied by a weight, then summed.
- Weights express relative importance and must sum to 1; they come from expert judgement or other methods.

$$S = \sum (w_i \times x_i) \quad \text{with} \quad \sum w_i = 1$$

Example weighting (must total 100%)

Total vegetation productivity
40%

Distance to nest
30%

Positive VPT
20%

Grassland
10%



Integration & Weighting

As a first try we'll use the following weights:

- grassland percentage = 0.2
- cropland percentage = 0.12
- ploughed percentage = 0.12
- years since ploughing = 0.1
- tree cover density = 0.1
- productivity = 0.1
- percent change in productivity = 0.08
- mowed percentage = 0.06
- mowing events per year = 0.04
- total area = 0.05
- distance to eagles nest = 0.03

CLC_zonal_stats_v4 — Field Calculator

☐ Only update 0 selected feature(s)

☐ Create a new field ☒ Update existing field

☐ Create virtual field

Output field name:

Output field type: 1.2 Decimal number (real)

Output field length: Precision:

1.2 Conservation_Score

Expression Function Editor

`("normalized_grassland_pct" *0.2)+("normalized_pct_crop" *0.12) + ("normalized_pct_ploughed" *0.12) + ("normalized_years_since_ploughing" *0.1) + ("normalized_tcd" *0.1) + ("normalized_productivity" *0.1) + ("normalized_pct_change" *0.08) + ("normalized_pct_mowing" *0.06) + ("normalized_mowing_amounts" *0.04) + ("normalized_area"*0.05) + ("normalized_dist_eagles_nest" *0.03)`

Feature: Preview: 0.886102358629014

Search... Show Values

group field

Double-click to add field name to expression string.
Right-Click on field name to open context menu sample value loading options.

Notes

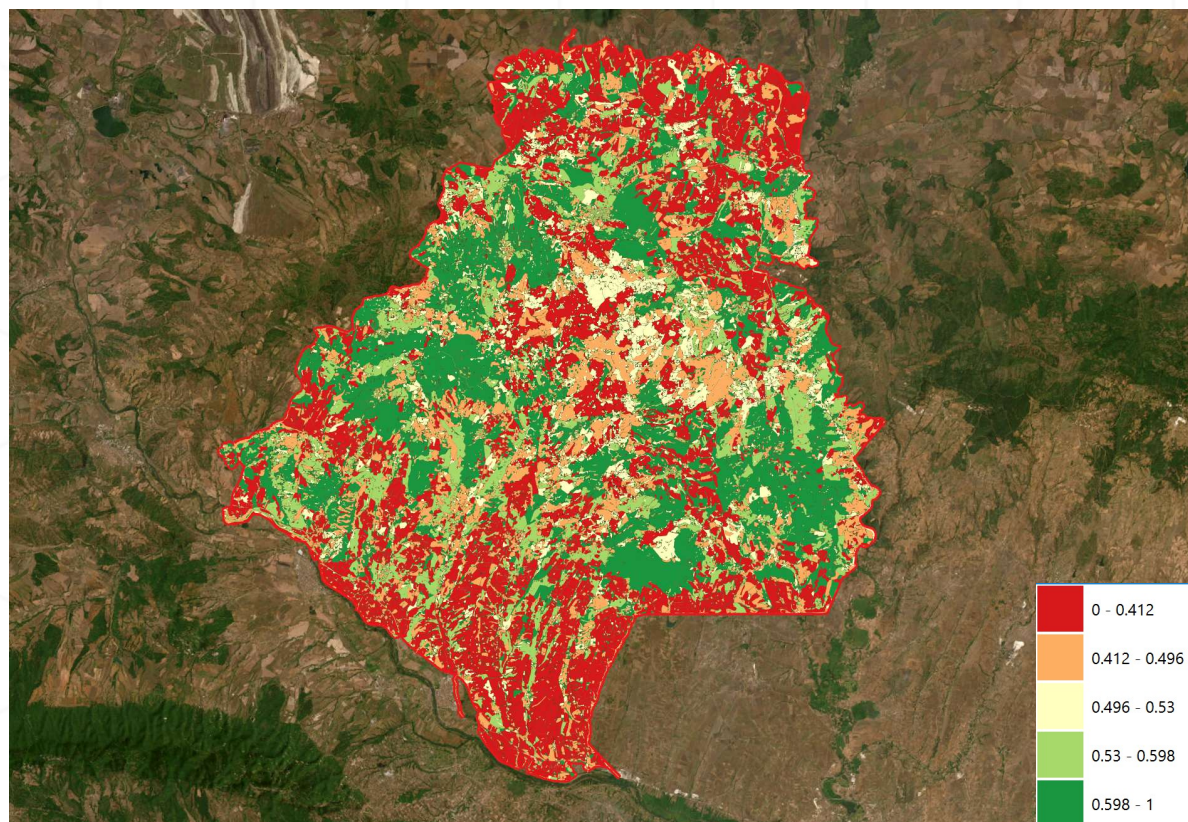
Loading field values from online sources isn't supported before the layer is actually inserted, ie. when building queries.

Values Search...

All Unique 10 Samples

OK Cancel Apply Help

Conservation Score Example





Questions?



The LifeWatch ERIC Biodiversity
& Ecosystem eScience Conference
PLOVDIV, BULGARIA 7-10 JULY 2026

THANK YOU!

Questions?

mkavlin@hatfieldgroup.com

