A3.10.1 Novel in-situ collection for agricultural and forest structure applications

DataCAP: Sentinel datacubes, crowdsourced street-level images and annotated benchmark datasets for the monitoring of the CAP

Wed, 25 May, 2022

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BEYOND Centre for EO Research & Satellite Remote Sensing

National Observatory of Athens Institute of Astronomy Astrophysics, Space Applications & Remote Sensing

living planet symposium BONN 23–27 May 2022

esa

New CAP – Steering towards exhaustive monitoring

Checks for cultivated crop types and compliance with CAP guidelines
Random Sampling → Smart Sampling[1]

- AI models trained with satellite data (Sentinels)
- Crop Classification outcomes compared with LPIS
- On-The-Spot-Checks (OTSCs) out of the disagreement pool
- Scalability: X – Regularity: X

SCAN ME

Smart Sampling	
Classification vs Declaration	Action
Agreement	No further action required – Pay subsidies
Disagreement	Sample from this pool for OTSCs

[1] Rousi, Maria and Sitokonstantinou, Vasileios et al. "Semantically enriched crop type classification and Linked Earth Observation Data to support the Common Agricultural Policy monitoring." IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing 14 (2020): 529-552.

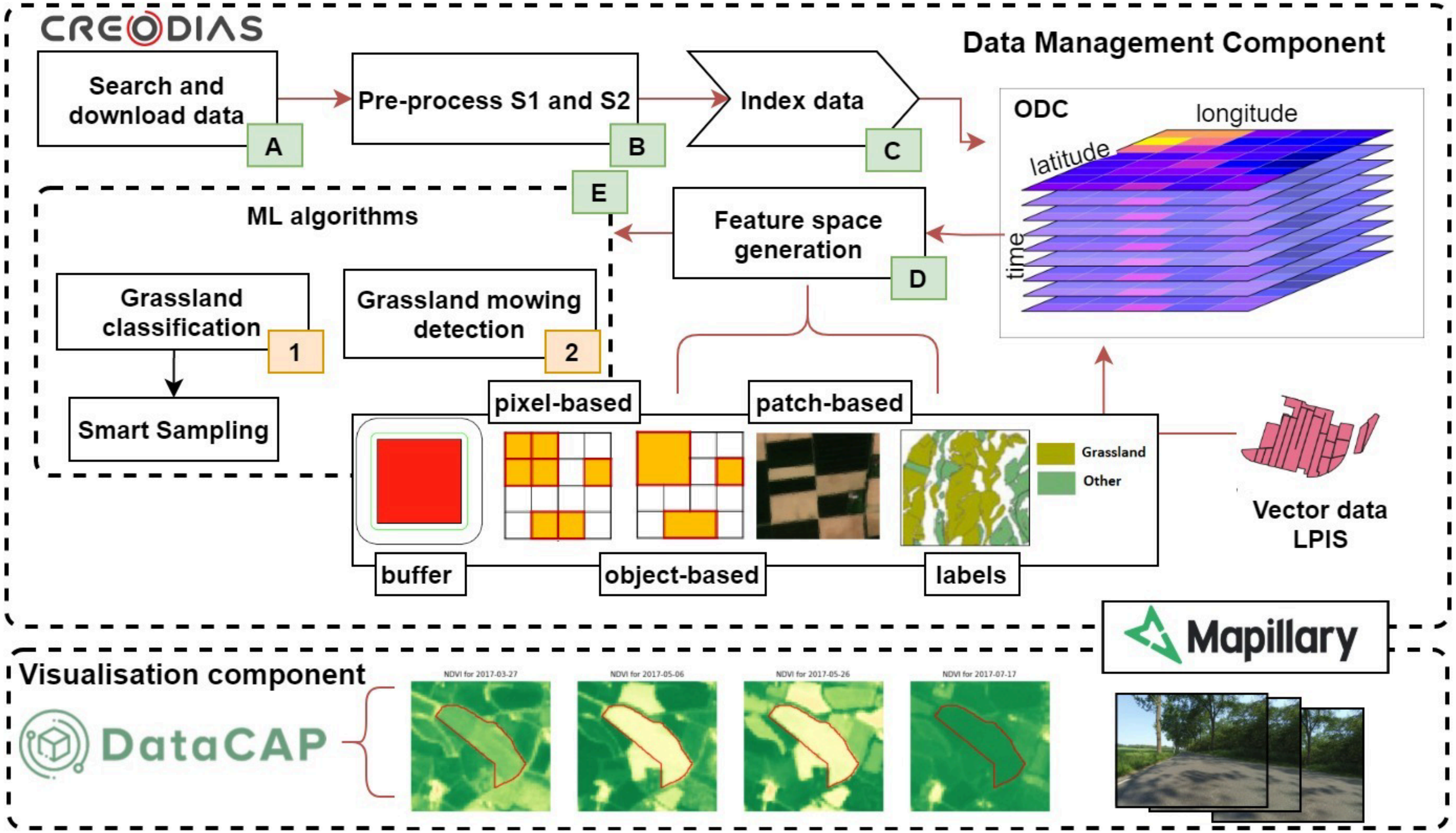
New CAP – Steering towards exhaustive monitoring

Smart Sampling → Wall-to-wall Monitoring (Exhaustive monitoring)

- Post-2020 CAP
- Incorporation of heterogeneous data sources for Space-to-Ground coverage
  - Very High-Resolution satellite data
  - Unmanned Aerial Vehicles
  - Street-level and in-field geo-tagged photos

Towards Exhaustive Monitoring	
Classification vs Declaration	Action
Strong Agreement	No further action required – Pay subsidies
Weak (Dis)agreement	Check street-level images
Weak (Dis)agreement	If not enough – Fly UAVs
Weak (Di)sagreement	If not enough - OTSCs
Strong Disagreement	Correct declaration

A comprehensive data solution for monitoring the CAP



in the office

SCAN ME

envision

CALLISTO

[2] DataCAP: A Satellite Datacube and Crowdsourced Street-Level Images for the Monitoring of the Common Agricultural Policy. In International Conference on Multimedia Modeling (pp. 473-478). Springer.

DataCAP GUI

DataCAP

SMART SAMPLING

GRASSLAND EVENTS

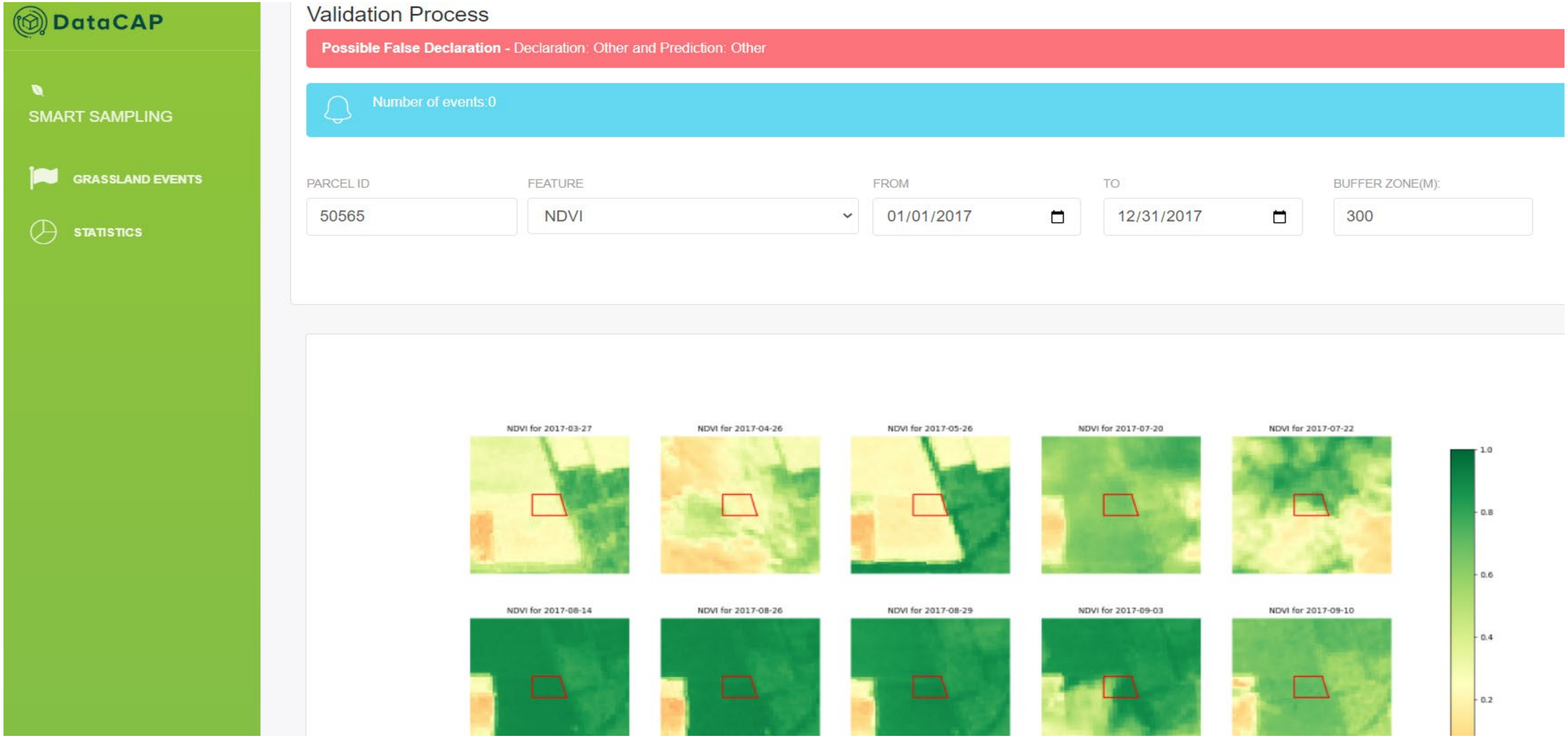
STATISTICS

PARCEL ID	ONLY ALERTS	CONFIDENCE LEVEL OF PREDICTION(%)
Parcel ID	Yes	No Selection

Show

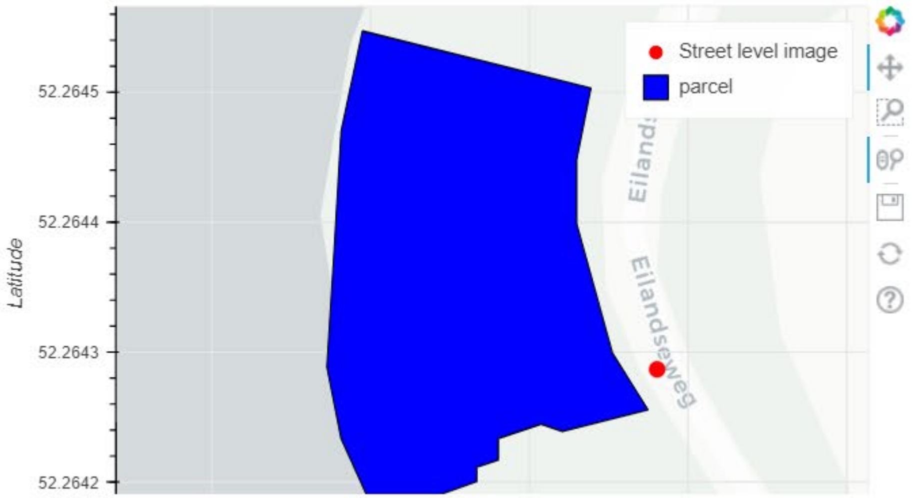
PARCEL ID	DECISION CONFIDENCE(%)	DECLARED CROP TYPE	PREDICTED CROP TYPE	ACTION	STREET LEVEL IMAGE
6080	100.0	Grassland	Grassland	Verify	Not available
13176	100.0	Grassland	Grassland	Verify	Show
8628	100.0	Grassland	Grassland	Verify	Not available
50566	100.0	Grassland	Other	Verify	Not available
50565	100.0	Sumer Barley	Other	Verify	Not available
4051	100.0	Grassland	Grassland	Verify	Not available
4677	100.0	Grassland	Grassland	Verify	Not available
16006	100.0	Grassland	Grassland	Verify	Not available
12979	100.0	Grassland	Grassland	Verify	Not available

DataCAP GUI

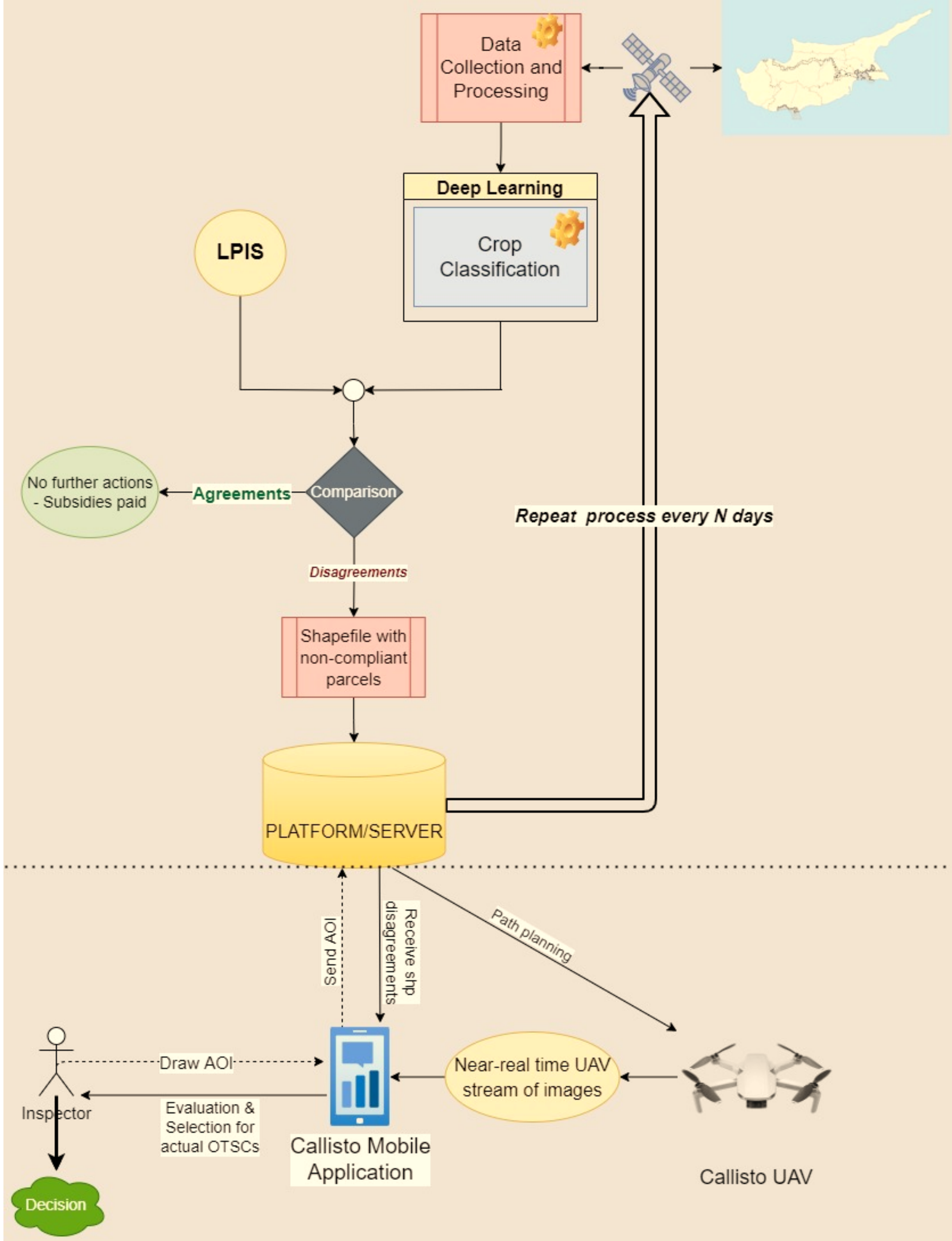

DataCAP
SMART SAMPLING
GRASSLAND EVENTS
STATISTICS
Validation Process
Possible False Declaration - Declaration: Other and Prediction: Other
Number of events:0
PARCEL ID
50565
FEATURE
NDVI
FROM
01/01/2017
TO
12/31/2017
BUFFER ZONE(M):
300
NDVI for 2017-03-27
NDVI for 2017-04-26
NDVI for 2017-05-26
NDVI for 2017-07-20
NDVI for 2017-07-22
NDVI for 2017-08-14
NDVI for 2017-08-26
NDVI for 2017-08-29
NDVI for 2017-09-03
NDVI for 2017-09-10
1.0
0.8
0.6
0.4
0.2

DataCAP GUI

May 15, 2017
(Parcel On The **left**)



DataCAP



near the field

CALLISTO

Collection of street-level images

Street-Level Images

•Campaigns

- Acquisition methodology
  - Cost-efficient, easy to set up by inspectors & using existing operational framework
- ▪ Mapillary platform analysis
- ▪ Action cam (better results than smartphone)
- ▪ Giving back to the community – **Mapillary crowdsourcing platform**
  - ✓ **300 k street-level images** already uploaded - Top contributors in Cyprus

•Annotation through LPIS matching – *"DataCAP"* - publication on MMM – Callisto generated dataset

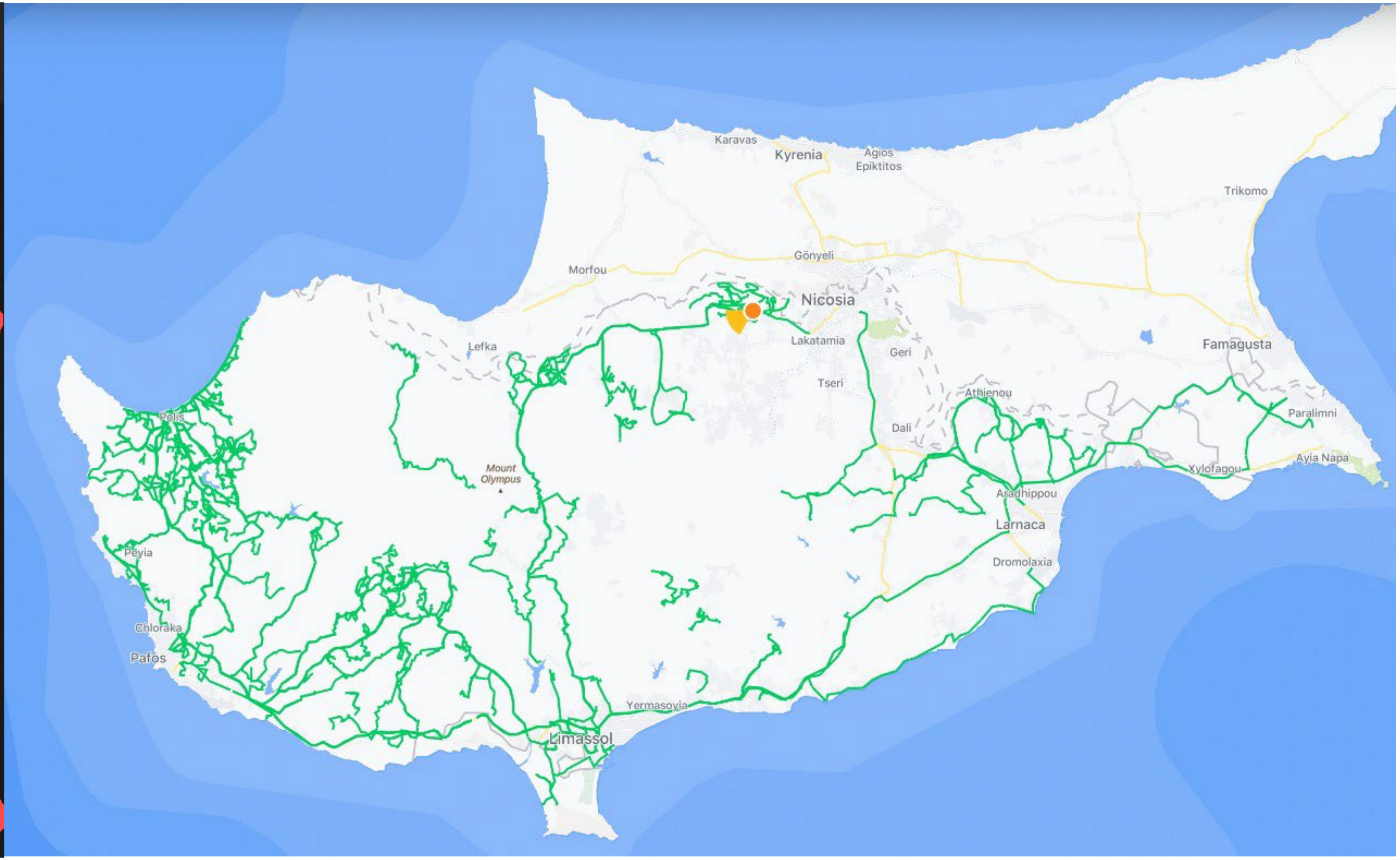
Sitokonstantinou, V., et al. (2022).DataCAP: A Satellite Datacube and Crowdsourced Street-Level Images for the Monitoring of the Common Agricultural Policy. In International Conference on Multimedia

Street-level image from Cyprus (Mapillary)

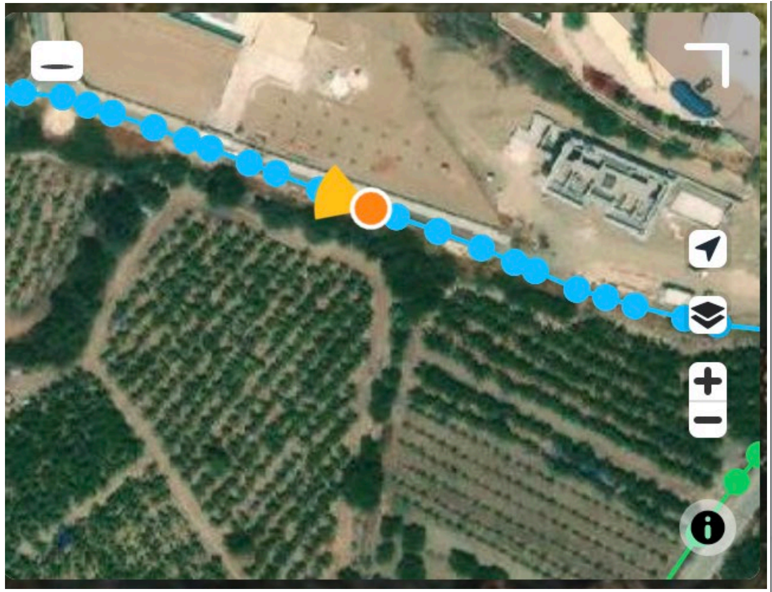
Cyprus

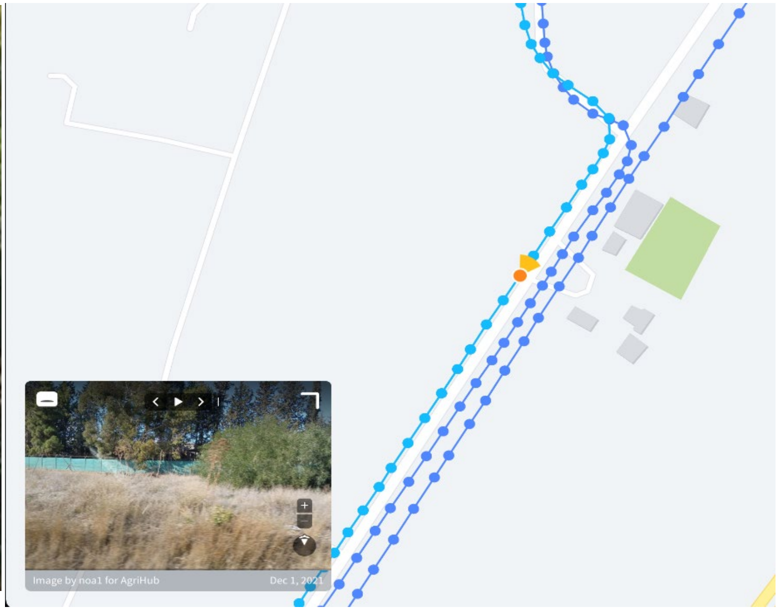
All time | This month | This week

		no. of images
#1	noa1	218.0 K
#2	stpkyriakou	164.2 K
#3	healixx	85.3 K
#4	ozkanilyasaksu	67.5 K
#5	WhanTwo	63.8 K
#6	noa2	38.0 K



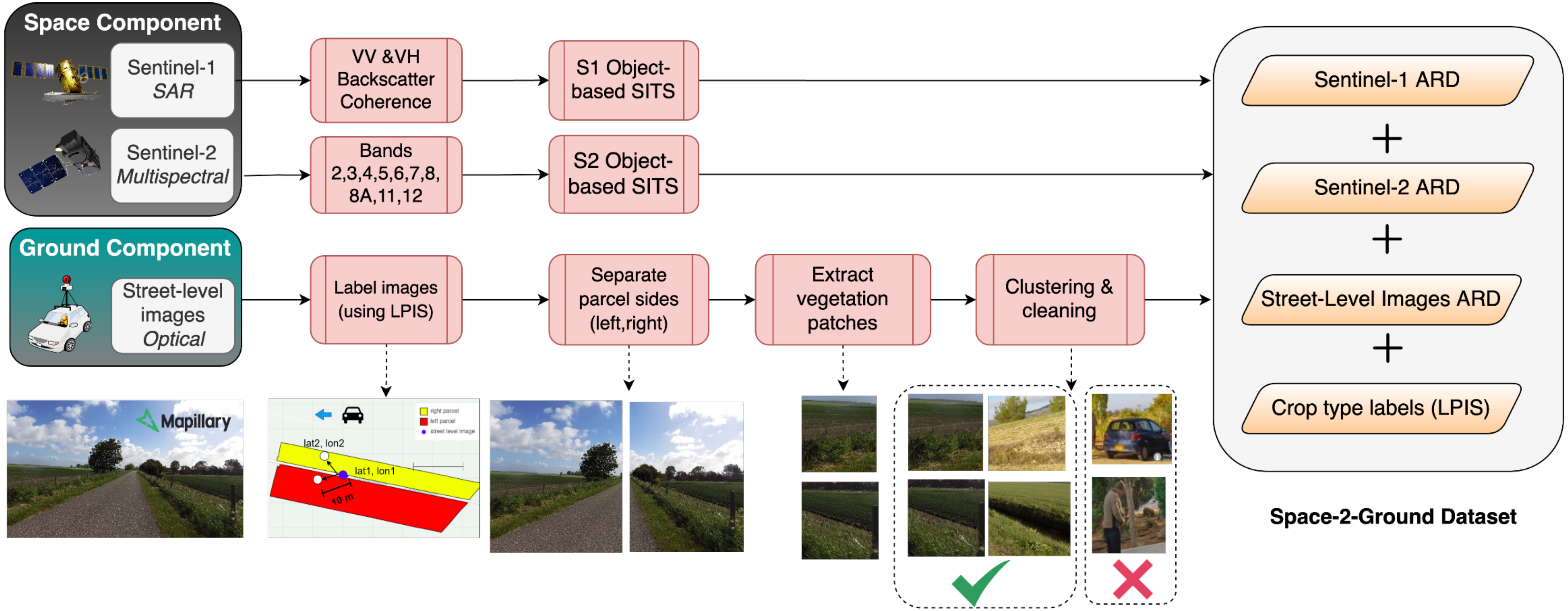
Visiting multiple times within season





Space-to-ground data availability

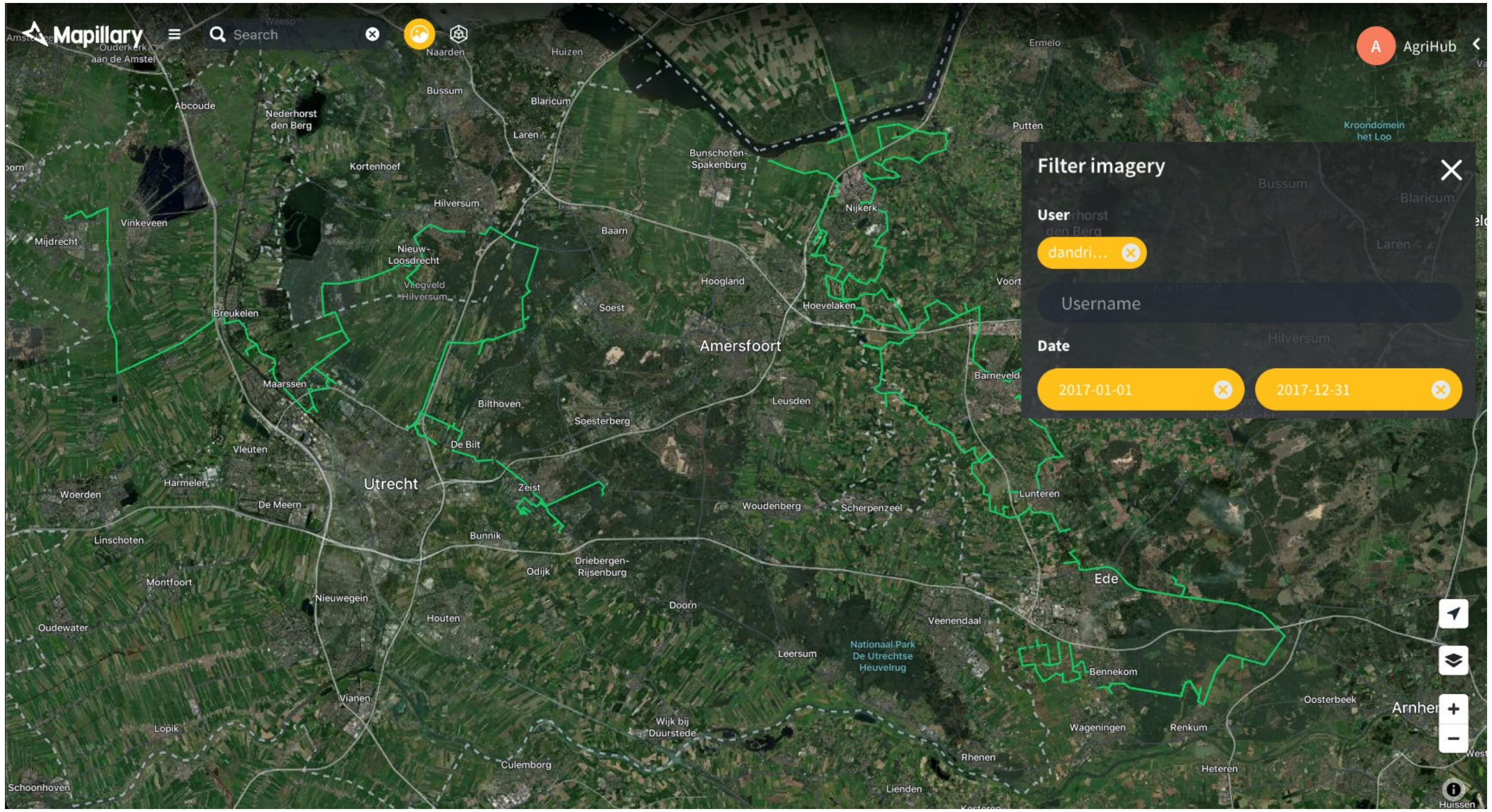
Choumos, G.*, Koukos, A.*, Sitokonstantinou, V. and Kontoes, C. (2022). Towards space-to-ground data availability for agriculture monitoring.In 2022 IEEE 14th Image, Video, and Multidimensional Signal Processing Workshop,IVMSP.



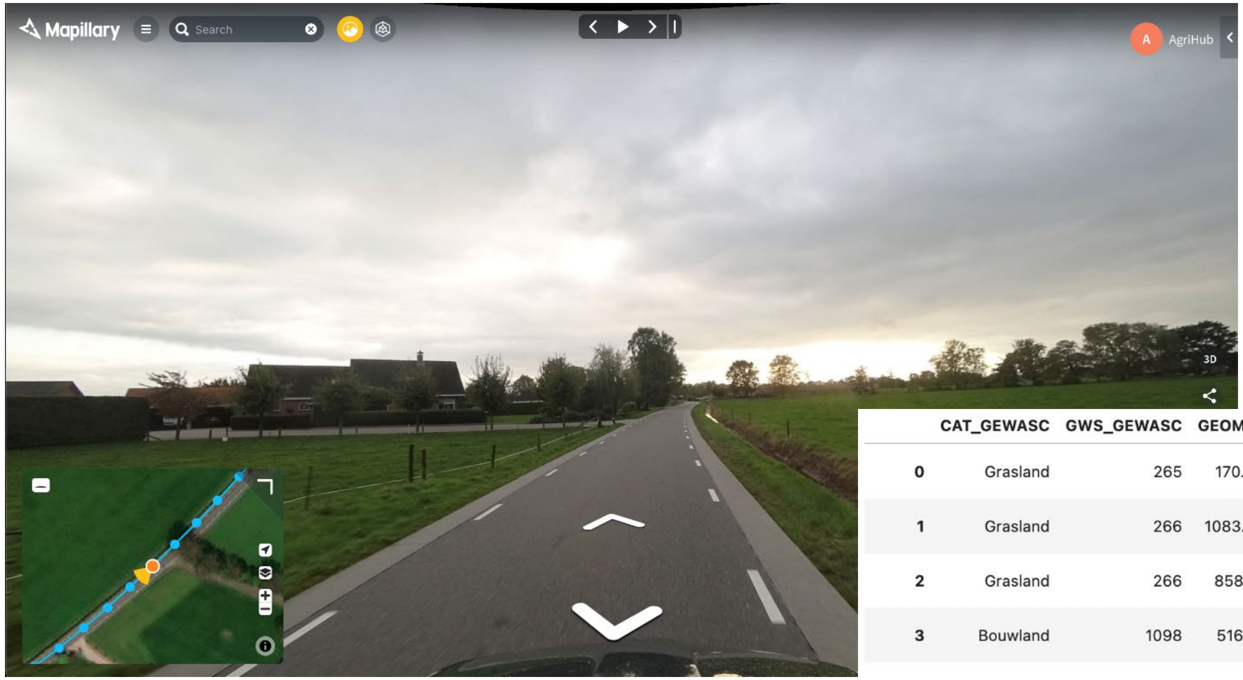
SCAN ME

Campaign for collecting street-level images of grasslands in the Netherlands

d'Andrimont, R., Lemoine, G. and Van der Velde, M., 2018. Targeted grassland monitoring at parcel level using sentinels, street-level images and field observations. Remote Sensing, 10(8), p.1300.




Mapillary
Search
A
AgriHub
3D
Image by dandrimont
Oct 10, 2017

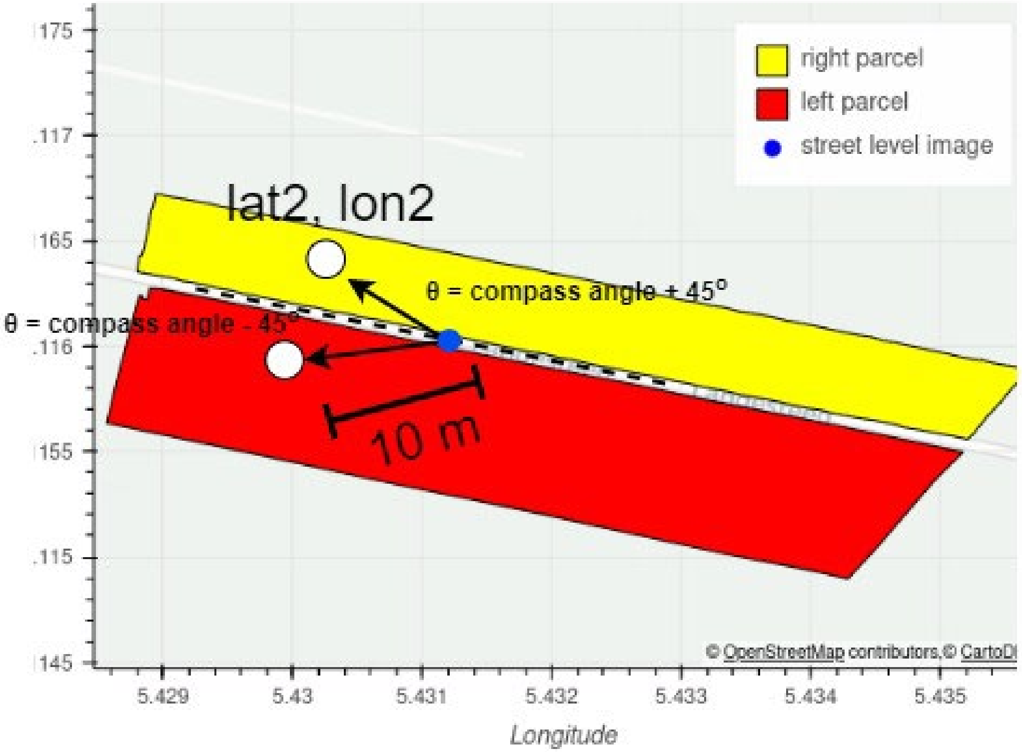


Combining Street-level images in the Netherlands with Dutch LPIS labels openly available.

	CAT_GEWASC	GWS_GEWASC	GEOMETRIE_	GEOMETRI_1	GWS_GEWAS	id	geometry
0	Grasland	265	170.704927	1472.436561	Grasland, blijvend	1	POLYGON ((607260.186 6850944.822, 607260.491 6...
1	Grasland	266	1083.416239	26008.169650	Grasland, tijdelijk	2	POLYGON ((607589.261 6849674.646, 607588.788 6...
2	Grasland	266	858.443121	28843.493760	Grasland, tijdelijk	3	POLYGON ((607937.264 6851070.654, 607394.081 6...
3	Bouwland	1098	516.104951	2783.437687	Peren. Aangeplant voorafgaande aan lopende sei...	4	POLYGON ((551847.903 6809201.124, 551847.749 6...
4	Grasland	265	911.993567	20414.915207	Grasland, blijvend	5	POLYGON ((551371.731 6827869.920, 551370.198 6...
...	...	...	...	...	...	...	...
55034	Grasland	265	100.022431	504.525746	Grasland, blijvend	55035	POLYGON ((589995.209 6841226.222, 590003.944 6...
55035	Grasland	265	400.141629	3930.653695	Grasland, blijvend	55036	POLYGON ((548720.576 6843754.469, 548700.911 6...
55036	Grasland	265	558.913736	11432.118162	Grasland, blijvend	55037	POLYGON ((620079.799 6847006.063, 620093.376 6...
55037	Grasland	265	168.449401	1558.859561	Grasland, blijvend	55038	POLYGON ((618496.803 6847468.779, 618466.965 6...
55038	Grasland	265	574.773859	9801.745443	Grasland, blijvend	55039	POLYGON ((545679.407 6822762.192, 545573.445 6...

$$lat_2 = \arcsin\left(\sin lat_1 \cdot \cos \frac{d}{R}\right) + \cos lat_1 \cdot \sin \frac{d}{R} \cdot \cos \theta)$$

$$lon_2 = lon_1 + \arctan\left(\sin \theta \cdot \sin \frac{d}{R} \cdot \cos lat_1, \cos \frac{R}{d} - \sin lat_1 \cdot \sin lat_2\right)$$

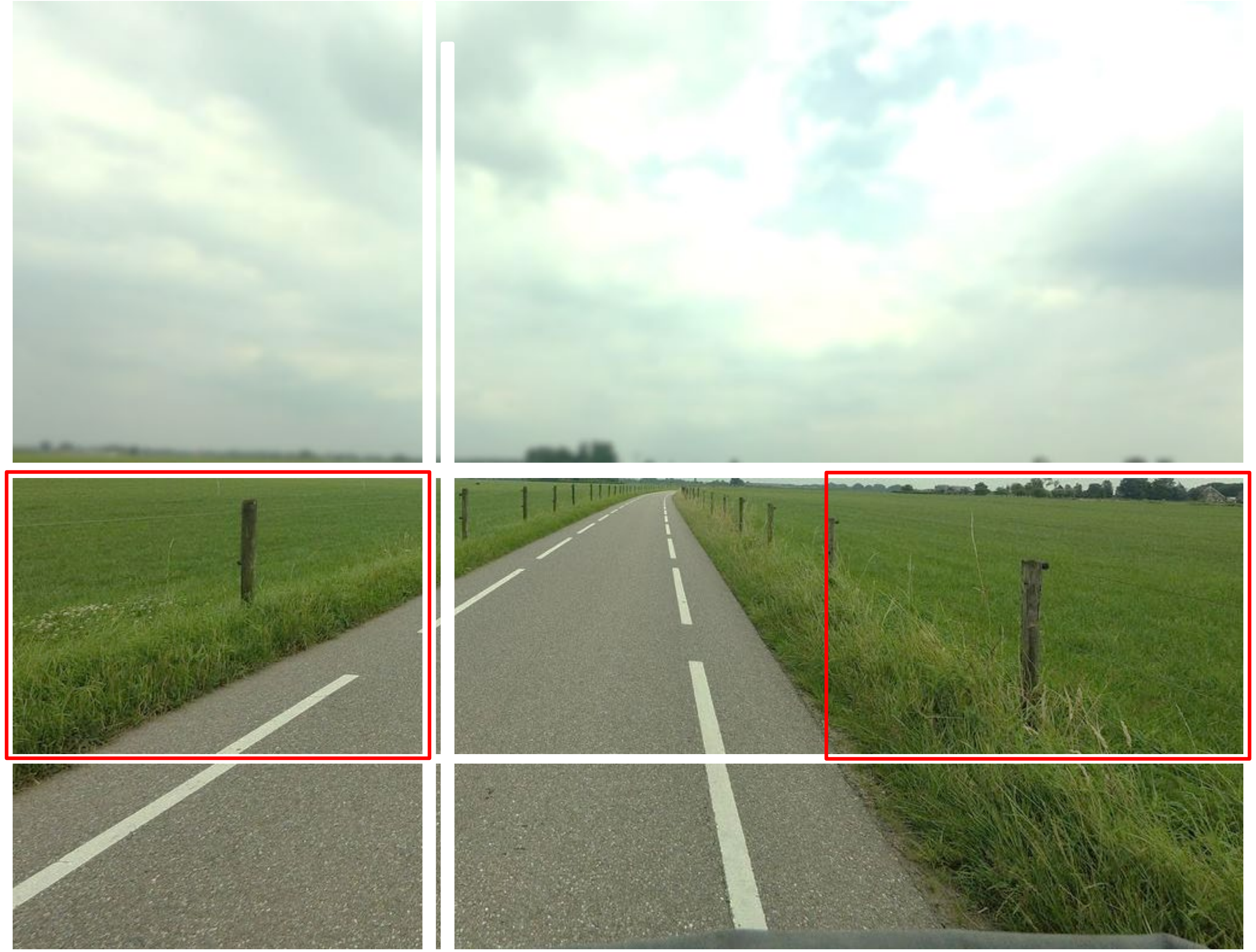


Initial Image

Split image in half

Vegetation patches

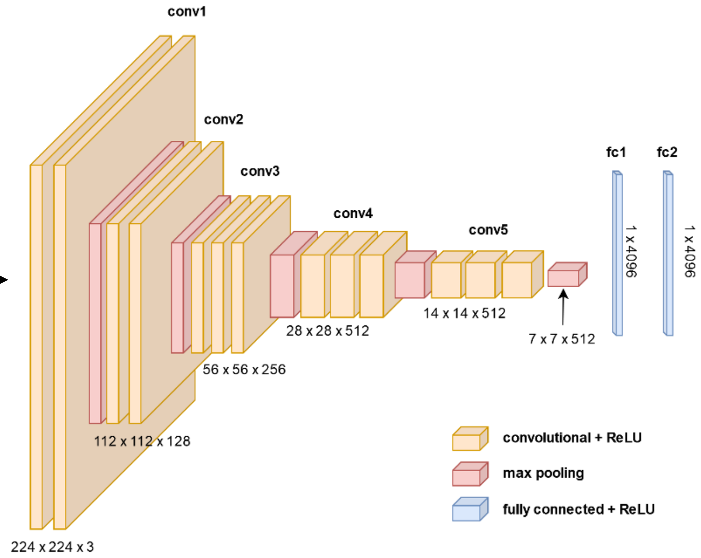
20%-50% of height



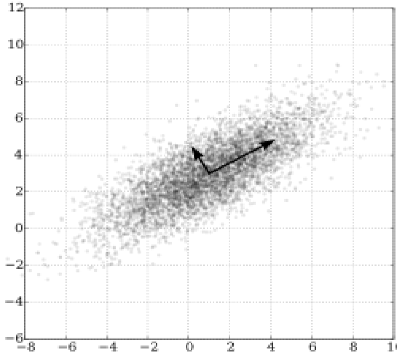
0%-30%
70%-100%
of width

Clustering and Cleaning

VGG19 representation

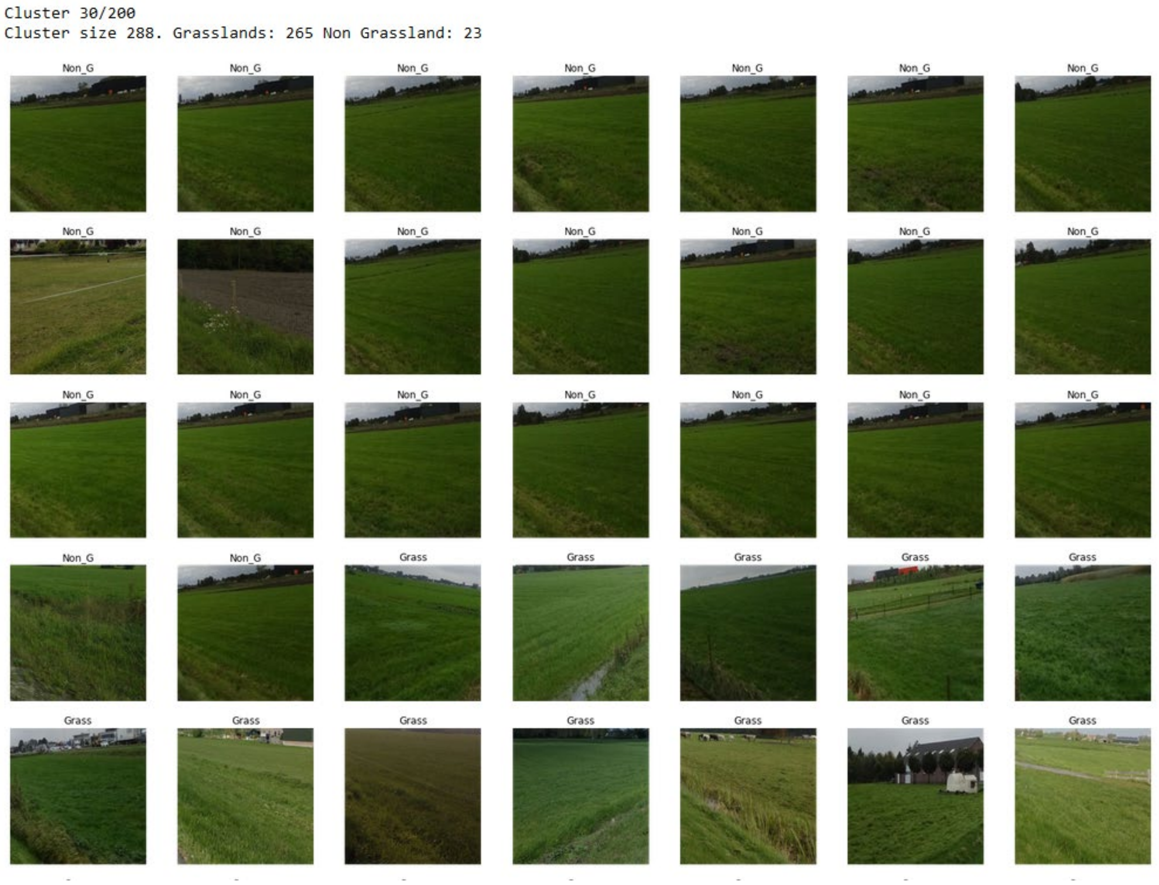


PCA



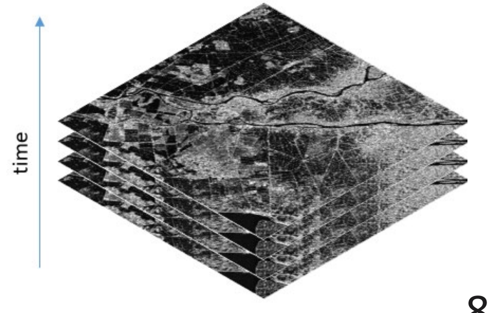
K-means

Clustering and Cleaning



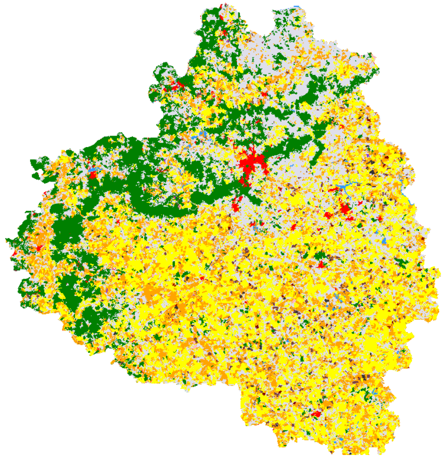
sentinel-2

Model fusion



8,875 Grasslands
1,227 Non Grasslands

Crop classification
RF, SVM, TempCNN,
LSTM, LSTM + Attention

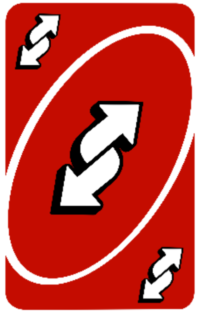


Street-level images

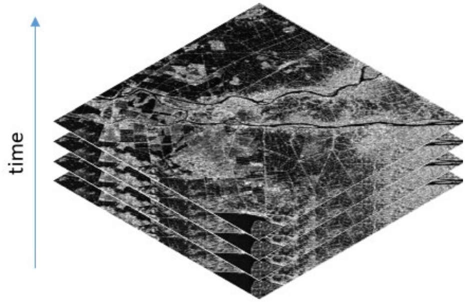
Crop classification
Pre-trained on Imagenet
- ResNet, EfficientNet,
VGG, **Inception v3**

Low confidence decisions

Reverse decision



Model fusion



Crop classification
RF, SVM, TempCNN,
LSTM, LSTM + Attention

Method	SVM	RF	TempCNN	LSTM	LSTM+Attention
Accuracy	93.69%	94.68%	95.22%	95.14%	95.20%
F1 score	85.22%	88.08%	89.96%	89.85%	90.05%

Street-level images

Inception v3 = 85%

Low confidence decisions

Space-to-ground dataset

Uses
Train, Validate and Test AI models
Photo-interpretation
Dispute resolution

Fusion tasks
Measurement fusion
Feature fusion
Late fusion (decision fusion)

Other tasks
Inference at the edge
Domain adaptation
Synthetic data generation

Downstream tasks
Crop classification
Phenology classification
Damage detection etc.

AI for EO data repository

https://github.com/Agri-Hub/Callisto-Dataset-Collection

README.md

AI for Copernicus - a data repository by CALLISTO

A list of datasets aiming to enable Artificial Intelligence applications that use Copernicus data.

Callisto Generated Datasets

- Annotated Street Level Images from Mapillary (published in MMM22)
  Crop type labels from the freely available Land Parcel Identification System (LPIS) of the Netherlands are matched with all available Mapillary street-level images for the year 2017.

id	label	image_date	image_id	direction
1890	Grassland	2017-08-02	527903208225456	right
28235	Grassland	2017-08-05	485698512854670	left
28235	Grassland	2017-08-05	108543031310984	left
28235	Grassland	2017-08-05	457662825313831	left
28235	Grassland	2017-08-05	473988820482591	left
28235	Grassland	2017-08-05	203930774712867	left
28235	Grassland	2017-08-05	4539489152727750	left
28235	Grassland	2017-08-05	317311680013031	left
28235	Grassland	2017-08-05	478570490029705	left
28235	Grassland	2017-08-05	455695235499217	left

Data Source	Type	Area	Task	Paper	Code	Relevant implementations
Street level images	Image	Netherlands	Crop Classification	(2022)	GitHub	Street2Sat, DenseASPP, Crop Phenology, Scene Segmentation

data-repository

machine-learning-datasets

Readme

36 stars

3 watching

2 forks

Releases

No releases published

Create a new release

Packages

No packages published

Publish your first package

Contributors 4

alkiskk

gchoumos George Choumos

vsitokonstantinou

ggiannarakis Yorgos

AI for EO data repository

https://github.com/Agri-Hub/Callisto-Dataset-Collection

Thematic domains
Agriculture
Land change
Water quality
Air quality
Other

Types of datasets
EO with labels
EO without labels
In-situ and ground-level datasets
Geo-referenced labels

Information per entry
Available code
Available paper
Available model (git repo)
Other appropriate models (manual matching)
Other appropriate labels (manual matching)

Remarks & Future work

- Experiment with architectures for No Reference Image Quality Assessment of street-level images

- Identify the agriculture part of the image using Semantic Segmentation and apply on side captures

- Create analysis ready benchmark dataset from the campaigns in Cyprus containing 100s of thousands of images → enhance street-level image based crop classification

- Explore DL models for early and late fusion of space and ground data

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Thank you!

Smart sampling of OTSCs

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DataCAP

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Space-to-Ground dataset

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AI for EO repo

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