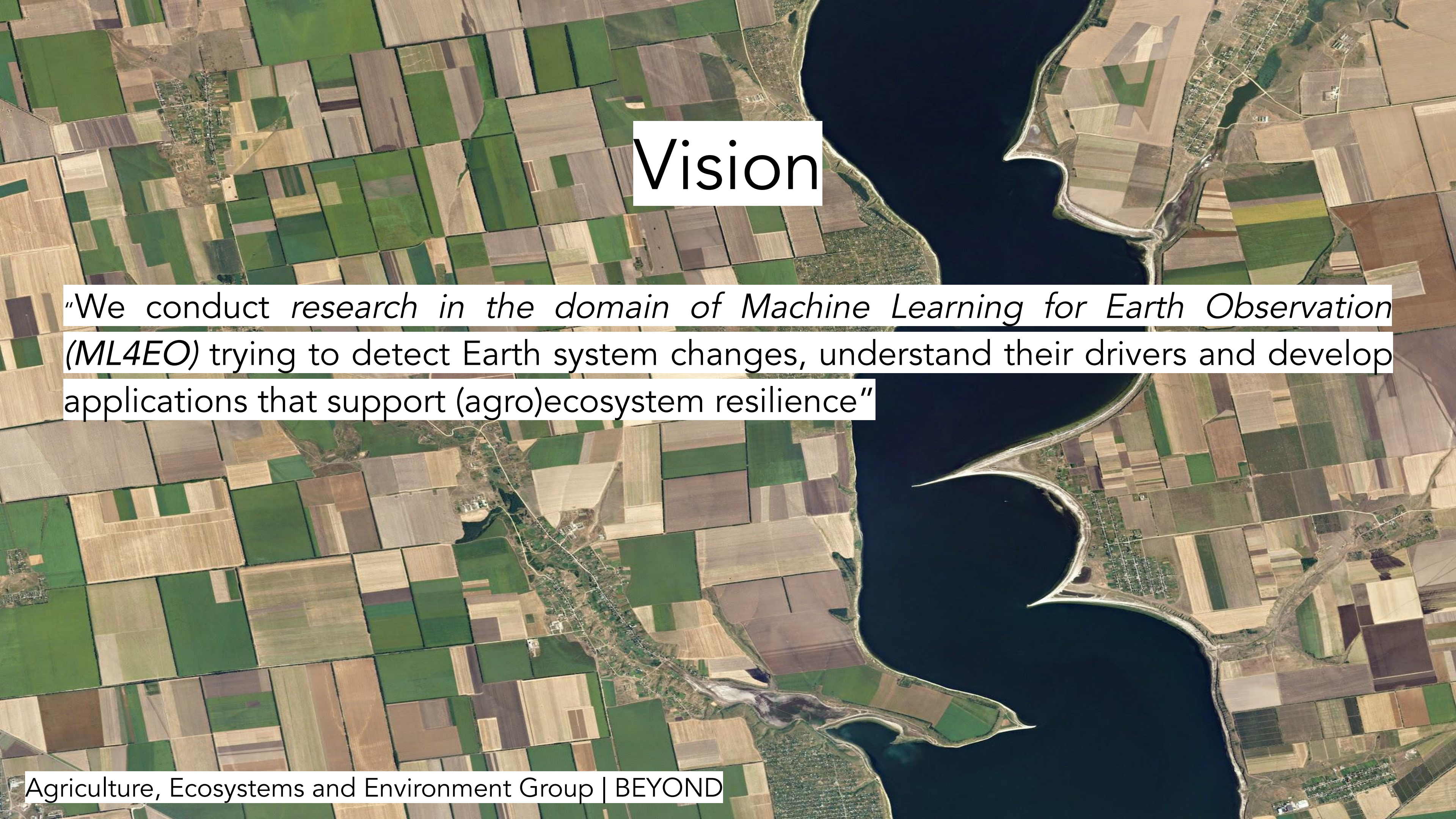
Agriculture, Ecosystems and Environment Group

BEYOND

Big Earth data and Machine Learning for Resilient Ecosystems

BEYOND
Centre of EO Research
and Satellite Remote Sensing

Roxanne S. Lorilla, Ilias Tsoumas, Alkis Koukos, George Choumos, George Giannarakis, Iason Tsardanidis, Ornela Nanushi, Thanassis Drivas, Alexandros Marantos, Nikos Bartsotas, Anastasis Katsos, Dimitris Vallianatos, Mariza Kaskara, Haris Kontoes, Vassilia Karathanassi and Vassilis Sitokonstantinou



Vision

"We conduct *research in the domain of Machine Learning for Earth Observation (ML4EO)* trying to detect Earth system changes, understand their drivers and develop applications that support (agro)ecosystem resilience"

Why

ML4EO has become a blooming research field, almost a hype.

- triggered by methodological advancements in AI and the open science culture in the machine learning and computer vision communities which resulted in open access to codes, benchmark datasets, and even pre-trained models.
- triggered by the fact that EO has become an operational source of open big data.
- this raises high expectations for valuable thematic products and intelligent knowledge retrieval.
- small satellites which have become a complementary and affordable source of EO data (Planet). This requires new data-intensive – or even data-driven – analysis methods from data science and artificial intelligence, among others – deep learning.

How

AgriHUB produces outputs of varying technological readiness level.

from experimental research to operational applications.

Primarily research oriented.

motivated by the fascinating new research domain of AI4EO.

Nevertheless, our research is applied

seek to identify its most mature outputs to then shape into applications that address real world needs.

Scientific pillars

- Climate Change and Ecosystem Services
  - Ecological Memory
    - Understanding the drivers of Earth system change
    - Future trajectories of ecosystem services

- Agriculture Modeling
  - Blending networks and process-based models
  - Blending Earth observations and meteorological data

- Information Extraction from Remote Sensing Images
  - Computer vision on images from heterogeneous sources
  - Big Earth data technologies and distributed learning

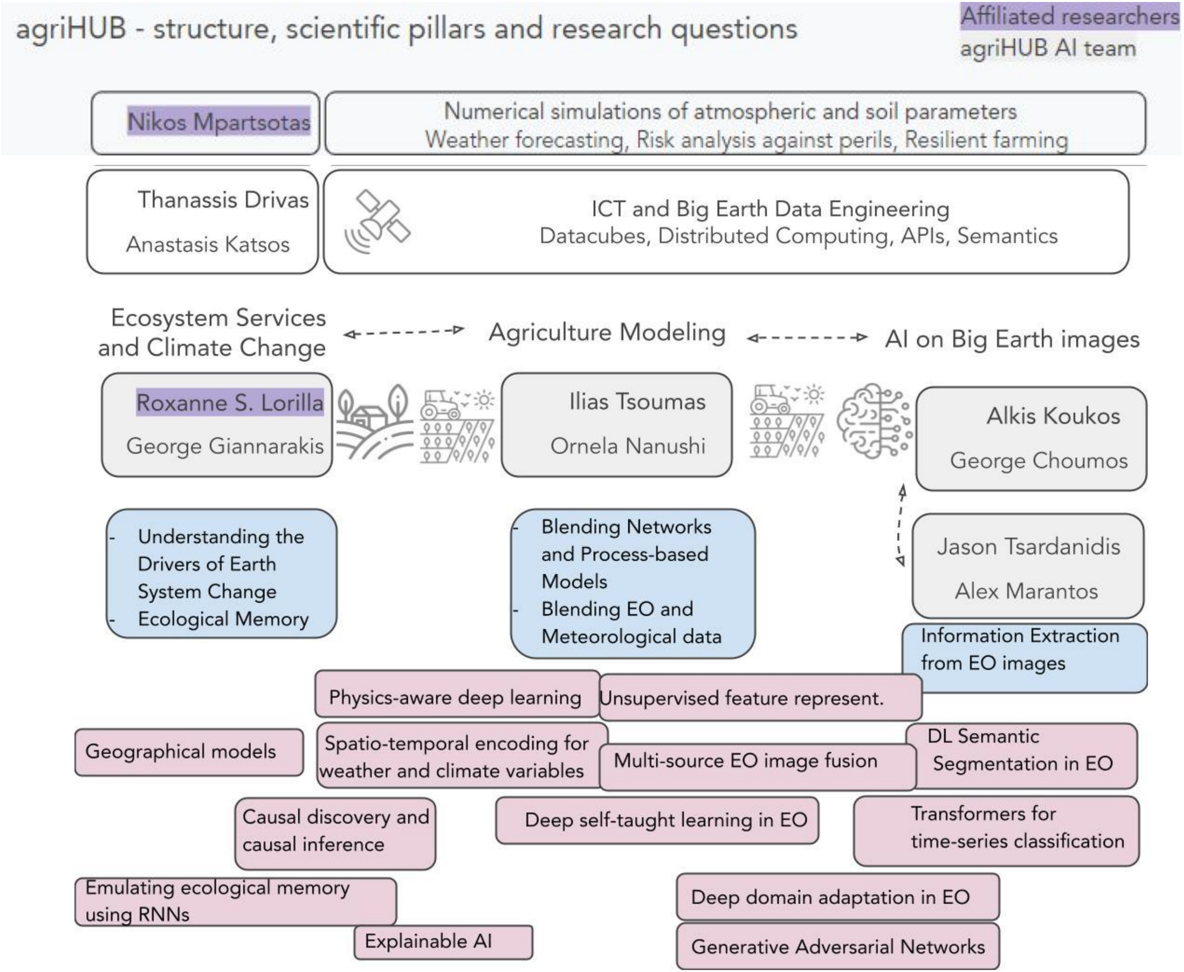
Thematic Areas

Smart farming / e-shape CALLISTO EXCELSIOR

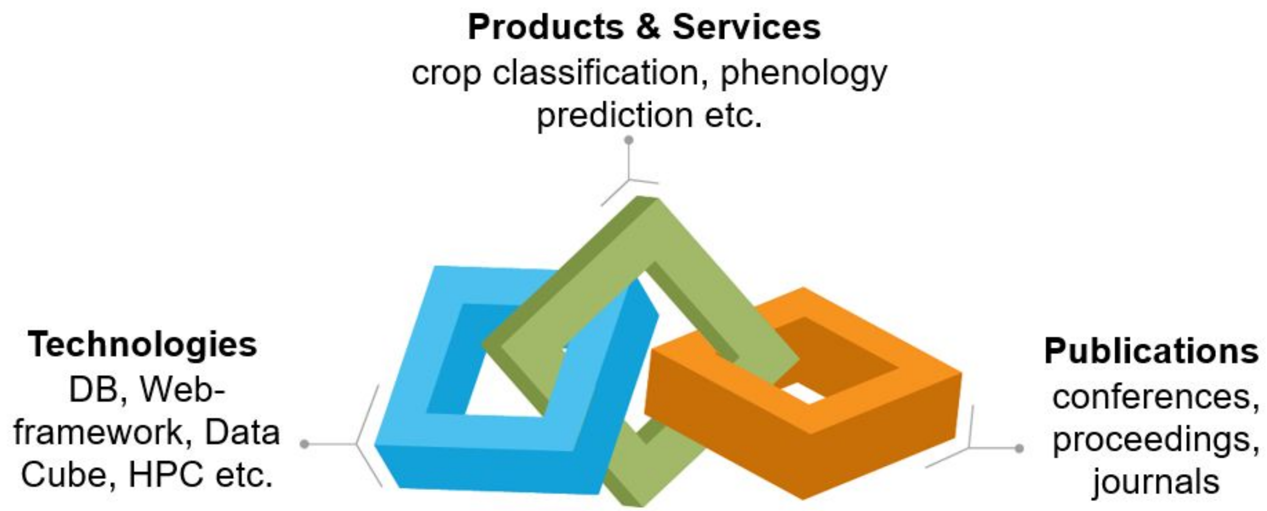
Monitoring of the CAP / RE.CAP Reinforcing CAP; Eiffel GEOSS APPLICATIONS FOR CLIMATE CHANGE; EXCELSIOR; envision; CALLISTO

Food Security / EOPEN; Eiffel GEOSS APPLICATIONS FOR CLIMATE CHANGE; EXCELSIOR

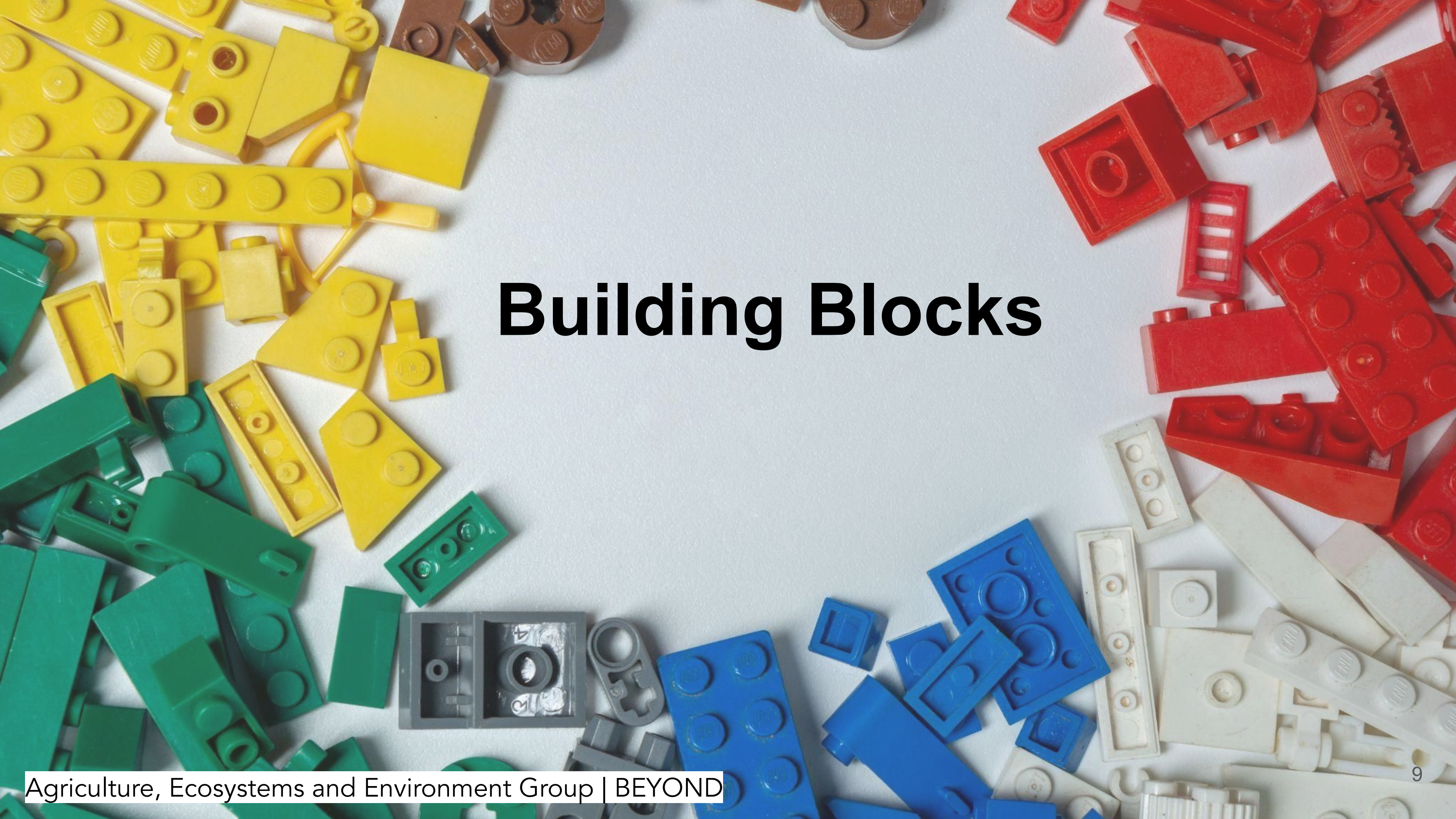
Ecosystem Services and Climate Change/ Eiffel GEOSS APPLICATIONS FOR CLIMATE CHANGE; MICROSERVICES A BiodivERsA Project; Transition


agriHUB - structure, scientific pillars and research questions
Affiliated researchers
agriHUB AI team
Nikos Mpartsotas
Numerical simulations of atmospheric and soil parameters
Weather forecasting, Risk analysis against perils, Resilient farming
Thanassis Drivas
Anastasis Katsos
ICT and Big Earth Data Engineering
Datacubes, Distributed Computing, APIs, Semantics
Ecosystem Services and Climate Change
Agriculture Modeling
AI on Big Earth images
Roxanne S. Lorilla
George Giannarakis
Ilias Tsoumas
Ornela Nanushi
Alkis Koukos
George Choumos
Jason Tsardanidis
Alex Marantos
- Understanding the Drivers of Earth System Change
- Ecological Memory
- Blending Networks and Process-based Models
- Blending EO and Meteorological data
Information Extraction from EO images
Physics-aware deep learning
Unsupervised feature represent.
Geographical models
Spatio-temporal encoding for weather and climate variables
Multi-source EO image fusion
DL Semantic Segmentation in EO
Causal discovery and causal inference
Deep self-taught learning in EO
Transformers for time-series classification
Emulating ecological memory using RNNs
Deep domain adaptation in EO
Explainable AI
Generative Adversarial Networks

The components



Building Blocks



Satellite Image

In-situ observations

Software Engineering

Meteorological data

Soil Content Maps

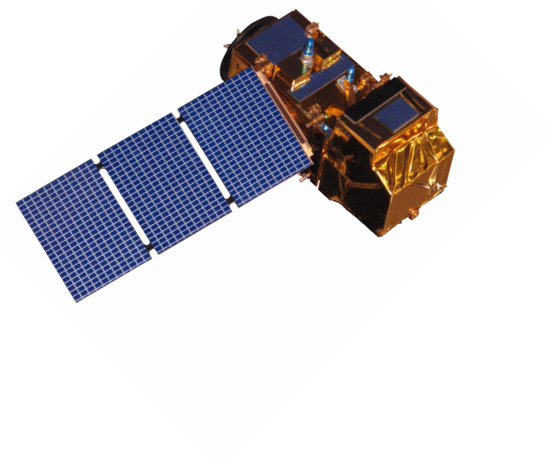
IoT devices/sensors

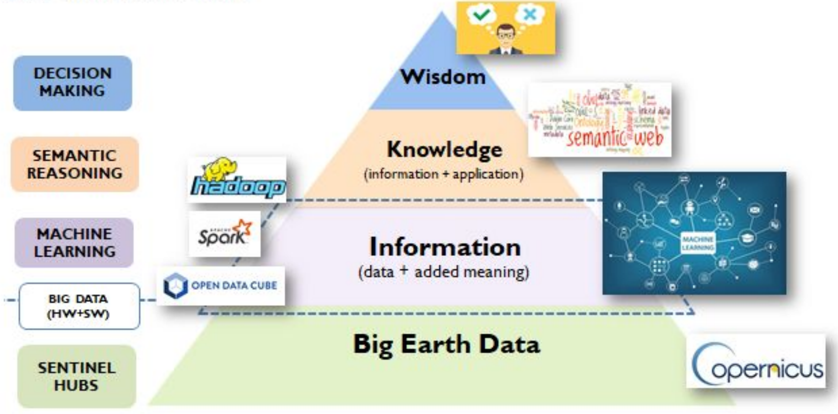
Data Visualization

Agricultural practices

Artificial Intelligence

Land Parcel Identification System (LPIS)





Our group in a nutshell

https://github.com/agri-hub

Technologies and Data

- High Performance Data Analytics Framework (SPARK & HDFS)
- 2 nation-wide DataCubes with Sentinel-1 and Sentinel-2
- Umbrella broker application to connect multiple Sentinel hubs
- Improved zonal statistics for fast feature space creating - x10
- Improved cloud and shadow masks (maja+fmask+sen2cor)
- 2 Field campaigns to collect phenology ground observations
- 2 UAV campaigns for crop and phenology classification
- 1 street-level image acquisition campaign in Cyprus
- 1 git repo for educational purposes
- 3 analysis-ready datasets for ML4EO freely available
- 10 jupyter notebooks available to the community for reuse
- 1 curated dataset catalogue for AI4EO scientists

Our group in a nutshell

Products and Services

- Crop classification at national scale (satellite, uav, street-level)
- Semi-supervised and unsupervised phenology estimation
- Agricultural land suitability for sustainable practices
- Yield estimation for cotton at the field level
- Phenology, biomass and yield metrics at national scale
- Stubble burning identification
- Nitrate polluted soil runoff risk assessment
- Grassland mowing detection
- Pest presence predictions in cotton






Our group in a nutshell

Products and Services

- 3 web applications with graphical user interface
- 1 backend module for transparent use of big satellite data
- >10 integrated services in platforms including DIASs
- >5 externally engaged users (corteva, asoo, thesto etc.)

agrowth alpha version

ResAGRI

DataCAP

Our group in a nutshell

Outreach and Scientific Publications

- 1 publication in the Organisation for Economic Co-operation and Development (OECD)
- 1 publication in 99 success stories of Copernicus for regions (award)
- Blog and social media posts (personal and beyond accounts)
- Lectures in SSTA, Aegean University, University of Reading, ISPRS
- Knowledge transfer workshop - NOA (ECoE)
- >10 mentoring lectures in schools through 100 mentors
- 2 lectures in high school students
- 1 info-day (Virtual)
- 3 user workshops (South Korea, Thessaloniki, Orchomenos)
- 2 videos and 1 podcast
- 1 presentation in industry exhibition (beyond4.0)

Our group in a nutshell

Outreach and Scientific Publications

- 3 project publication (2 EOPEN, 1 CALLISTO - BiDS conference)
- 18 posters and oral presentations (CVPR, EGU, AGU, LPS, ESP, Microsoft etc.)
- 2 Special Session Organizers (MMM21 and IVMSP22)
- 12 peer reviewed publications

Outreach and Scientific Publications

Journals and High Impact Conferences

1. Sitokonstantinou, V., Koukos, A., Tsoumas, I., Bartsotas, N., Kontoes, C. and Karathanassi, V. (2022). Fuzzy clustering for the within-season estimation of cotton phenology. PLOS ONE (under review).

2. Giannarakis, G., Sitokonstantinou, V., Roxanne, L. and Kontoes, C. (2022). Towards assessing agricultural land suitability using causal machine learning. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (accepted).

3. Sitokonstantinou, V., Koukos, A., Drivas, T., Kontoes, C., Papoutsis, I., and Karathanassi, V. (2021). A Scalable Machine Learning Pipeline for Paddy Rice Classification Using Multi-Temporal Sentinel Data. Remote Sensing, 13(9), 1769.

4. Rousi, M., Sitokonstantinou, V., Meditskos, G., Papoutsis, I., Gialampoukidis, I., Koukos, A., ... and Kompatsiaris, I. (2020). 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, 529-552.

5. Sitokonstantinou, V., Papoutsis, I., Kontoes, C., Lafarga Arnal, A., Armesto Andrés, A. P., and Garraza Zurbano, J. A. (2018). Scalable parcel-based crop identification scheme using Sentinel-2 data time-series for the monitoring of the common agricultural policy. Remote Sensing, 10(6), 911.

Outreach and Scientific Publications

Conferences

1. Drivas, T.*, Sitokonstantinou, V.*, Tsardanidis, I., Koukos, A., Karathanassi, V. and Kontoes, C. (2022). A Data Cube of Big Satellite Image Time-Series for Agriculture Monitoring. In 2022 IEEE 14th Image, Video, and Multidimensional Signal Processing Workshop, IVMSP.

2. Nanushi, O.*, Sitokonstantinou, V.*, Tsoumas, I. and Kontoes, C. (2022). Pest presence prediction using interpretable machine learning. In 2022 IEEE 14th Image, Video, and Multidimensional Signal Processing Workshop, IVMSP.

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

4. Sitokonstantinou, V., Koukos, A., Drivas, T., Kontoes, C., and Karathanassi, V. (2022). 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.

5. Sitokonstantinou, V., Koukos, A., Kontoes, C., Bartsotas, N. S., and Karathanassi, V. (2021, July). Semi-Supervised Phenology Estimation in Cotton Parcels with Sentinel-2 Time-Series. In 2021 IEEE International Geoscience and Remote Sensing Symposium IGARSS (pp. 8491-8494). IEEE.

6. Sitokonstantinou, V., Drivas, T., Koukos, A., Papoutsis, I., Kontoes, C. and Karathanassi, V. (2020). Scalable distributed random forest classification for paddy rice mapping. In Proceedings of the Asian Remote Sensing Conference (ACRS 2019) (pp. 836-845).

7. Sitokonstantinou, V., Koutroumpas, A., Drivas, T., Koukos, A., Karathanassi, V., Kontoes, H., and Papoutsis, I. (2020). A Sentinel based agriculture monitoring scheme for the control of the CAP and food security. In Eighth International Conference on Remote Sensing and Geoinformation of the Environment (RSCy2020) (Vol. 11524, pp. 48-59). SPIE.

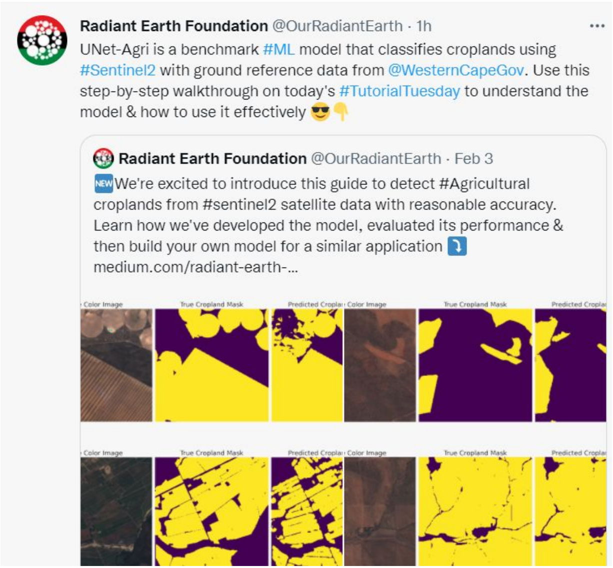
Social Media

Presence in social media is important (mostly twitter, linkedin)

Disseminate your work, you don't need a lot of likes or shares if the right people follow you

Follow relevant projects, and the top tier researchers, every ML scientist has a twitter account (law)

Follow data providers like Radiant MLHub - they release new data constantly



Target journals and conferences

Some examples of journals and conferences we target.

IEEE Geoscience and Remote Sensing Letters (5 pages)

IEEE Access (pass or fail, no revisions)

IEEE Geoscience and Remote Sensing Magazine

IEEE Geoscience and Remote Sensing Transactions

IEEE JSTARS

PLOS ONE

Computers and Electronics in Agriculture

CVPR EarthVision - check for similar workshop of top AI conferences ICML, NeurIPS etc.

Geophysical Research Letters

ISPRS Photogrammetry and Remote Sensing

Remote Sensing of the Environment

Proposals and new funding
What is the next day?

Attract new funding opportunities, our team is not project based but has a vision for the long term

New funding to support the team financially

New funding to accommodate our scientific agenda

Target RIA projects, let the mature science to organically find its way to the user through IA or our collaborations with the users

Proposals and new funding
What types of calls we are looking for

[call link]

Projects should address all of the following outcomes:

- Methods and tools for a systematic monitoring of in situ biodiversity of agricultural areas, considering above ground and soil biodiversity;
- Enhanced methods and indicators to evaluate the impact of agricultural practices and in particular CAP agri-environment measures or ecoschemes on above and below ground biodiversity;
- Increased access to information on carbon- and nature-rich areas;
- More effective farm advisory systems in relation to biodiversity issues and providing special advice for farmers including those operating in Natura 2000 sites

Expected Outcome: Projects are expected to contribute to the following outcomes:

- Copernicus is producing increasingly large data volumes that require specific Big Data technologies and Artificial Intelligence (AI) methods to analyse it and manage it. The adoption of Big Data and AI technologies in the space industry represents a significant opportunity to innovate, following industrial requirements to better respond to well identified user needs.
- Moreover, the data infrastructures offering archiving and distribution services for Earth Observation data, including Copernicus, are often data silos that offer today limited discoverability, querying and linking possibilities. The full exploitation of the archives and data stores require specialized Artificial Intelligence technologies, Linked Open Data paradigms and semantic archives able to scale to the full archives data volumes. Enhancing those cloud infrastructures with technological paradigms that are now typical of other data intensive domains (such as multimedia), will contribute to facilitate the development of new products and services with earth observation data at their core, and connect earth observation data to European Data Spaces.
- Copernicus data are part of the European Data Economy and its value chains. As such,

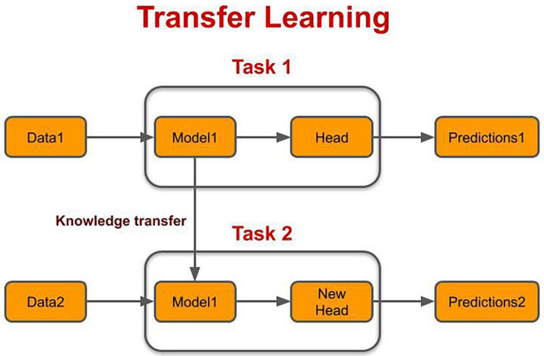
[HORIZON-EUSPA-2022-SPACE-02-55: Large-scale Copernicus data uptake with AI and HPC]

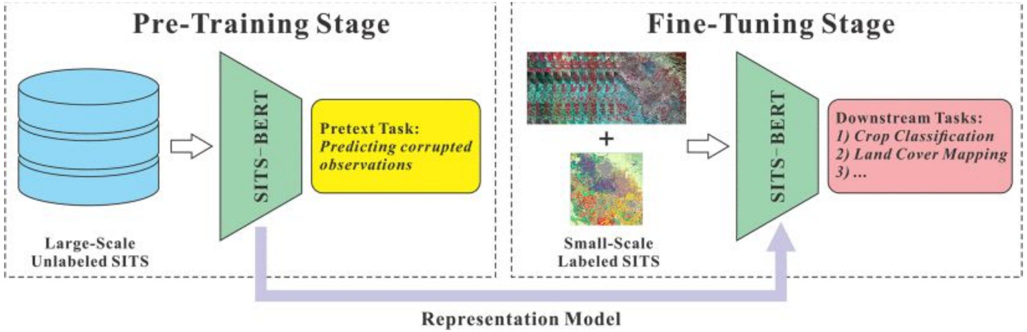
New research dimensions

Boosting by Machine Learning, Deep Learning, Computer Vision, Big Data Management...

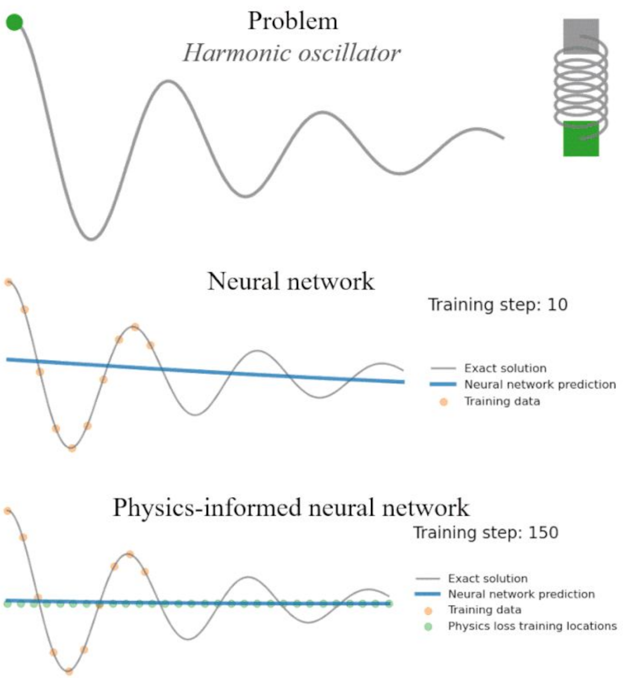
Boosting by the meta-learning paradigm

Self-learning, weakly-supervised learning, transfer learning, domain adaptation ⇒ overcome ground-truth scarcity and sparsity





Boosting by Physics-Aware Deep Learning



[So, what is a physics-informed neural network?]
Author: Ben Moseley

Boosting by Causal Discovery & Inference

A mathematical language for causal notions such as cause and effect

Provides methods and assumptions for answering causal questions and learning causal graphs from data

Causal Inference

Causal Discovery

XAI is artificial intelligence (AI) in which the results of the solution can be understood by humans. It contrasts with the concept of the "black box" in machine learning where even its designers cannot explain why an AI arrived at a specific decision.

Boosting by Explainable AI

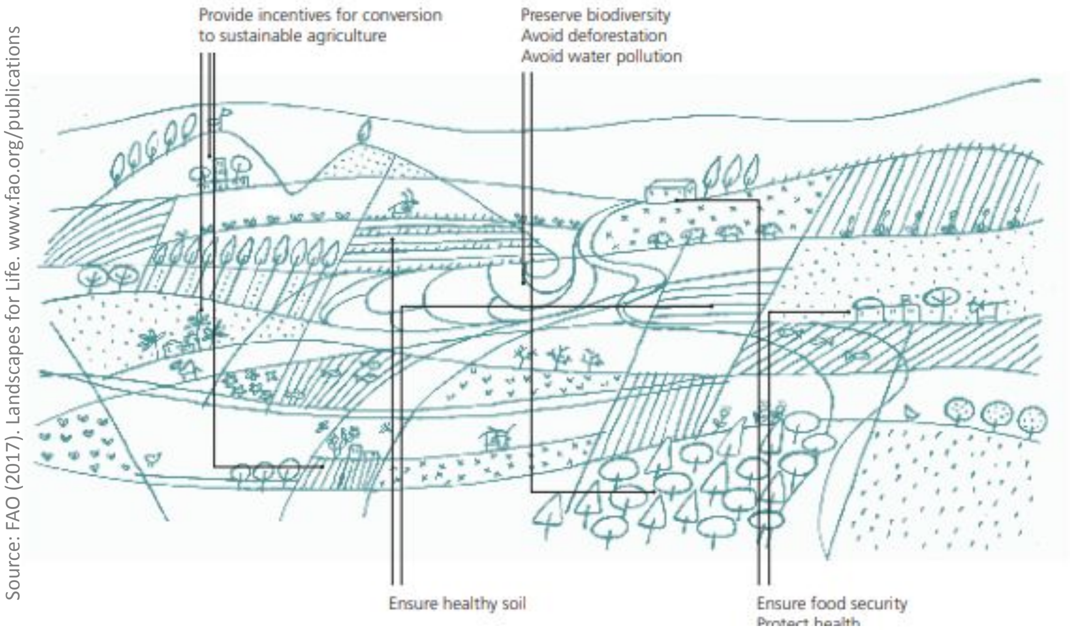
1. Support uptake of methods
2. Increase value through user knowledge
3. Increase trustworthiness and transparency

Scientific pillar I

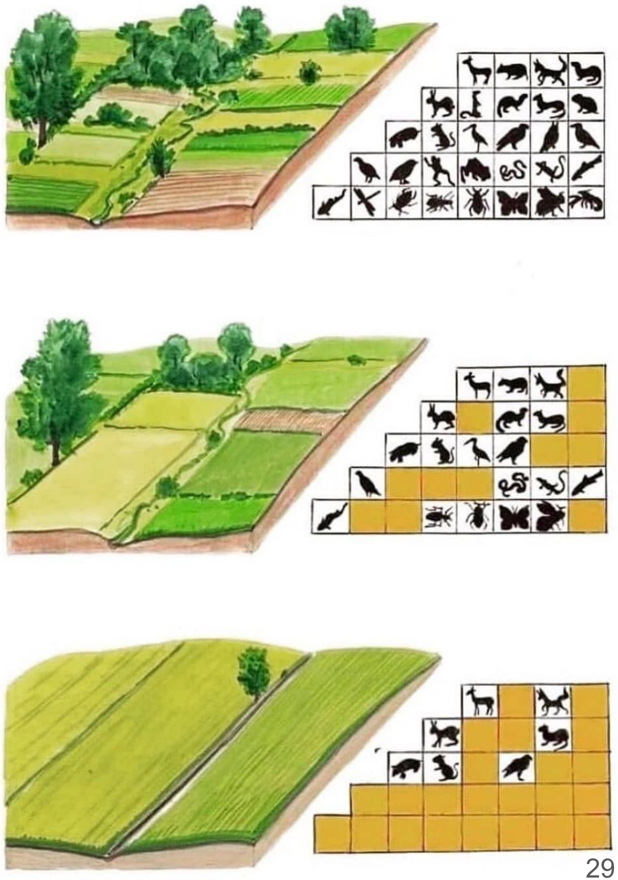
Ecosystem Services and Climate Change

Resilient Ecosystems - Concept

Agricultural intensification ⇒ loss of farmland biodiversity and degradation of ecological processes
Greening measures ⇒ horizontal implementation of management rules ⇒ lack of spatial targeting
Production efficiency ⇒ landscape homogenization



Source: FAO (2017). Landscapes for Life. www.fao.org/publications



Resilient Ecosystems - Concept

Resilient Ecosystems - Objectives

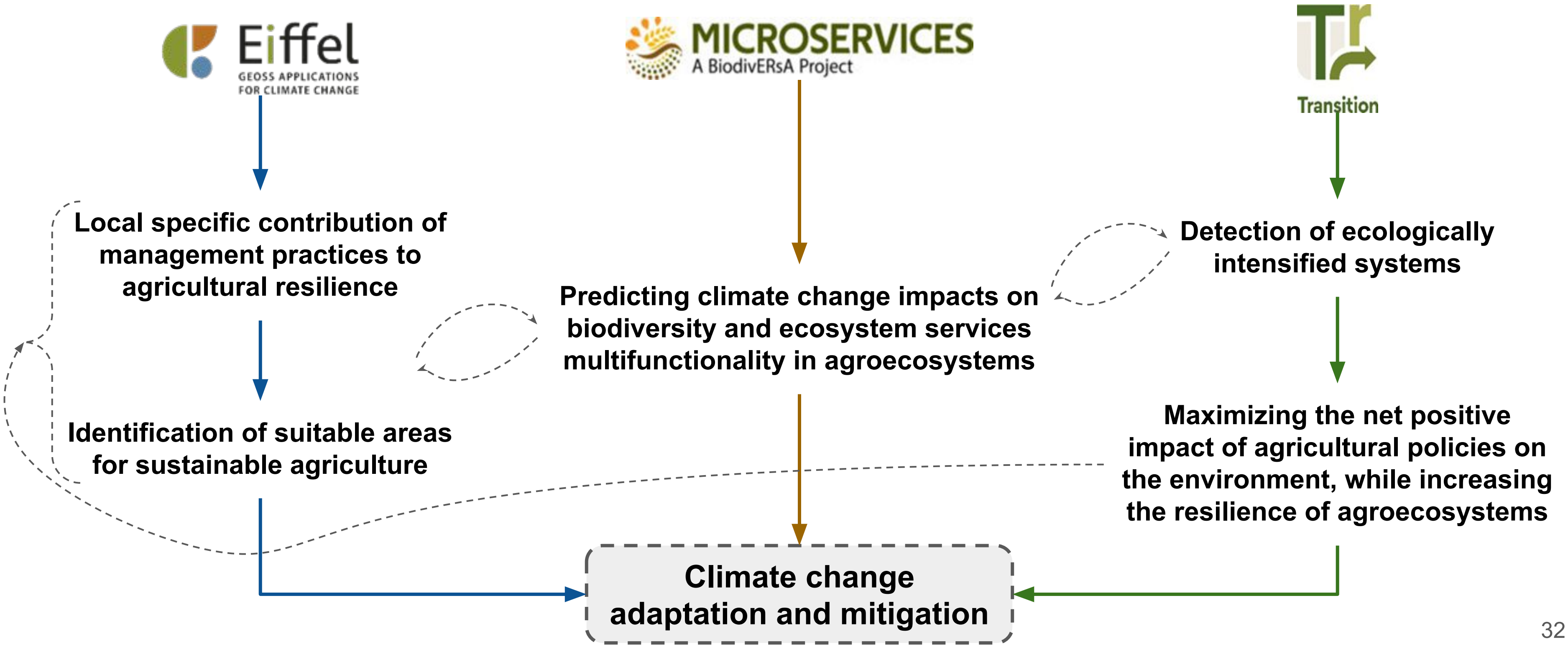
1. Enhance the **understanding of the complex dynamics between the human and ecological aspects** of agricultural landscapes.

2. **Disentangle the context-dependence of drivers** in environmental performance and reveal the mechanisms behind the interactions among ecosystem functions in contrasting agricultural management systems.

3. Contribute to the protection of biodiversity, enhance ecosystem services and preserve habitats and landscapes, fostering **sustainable development and efficient management of natural resources**.

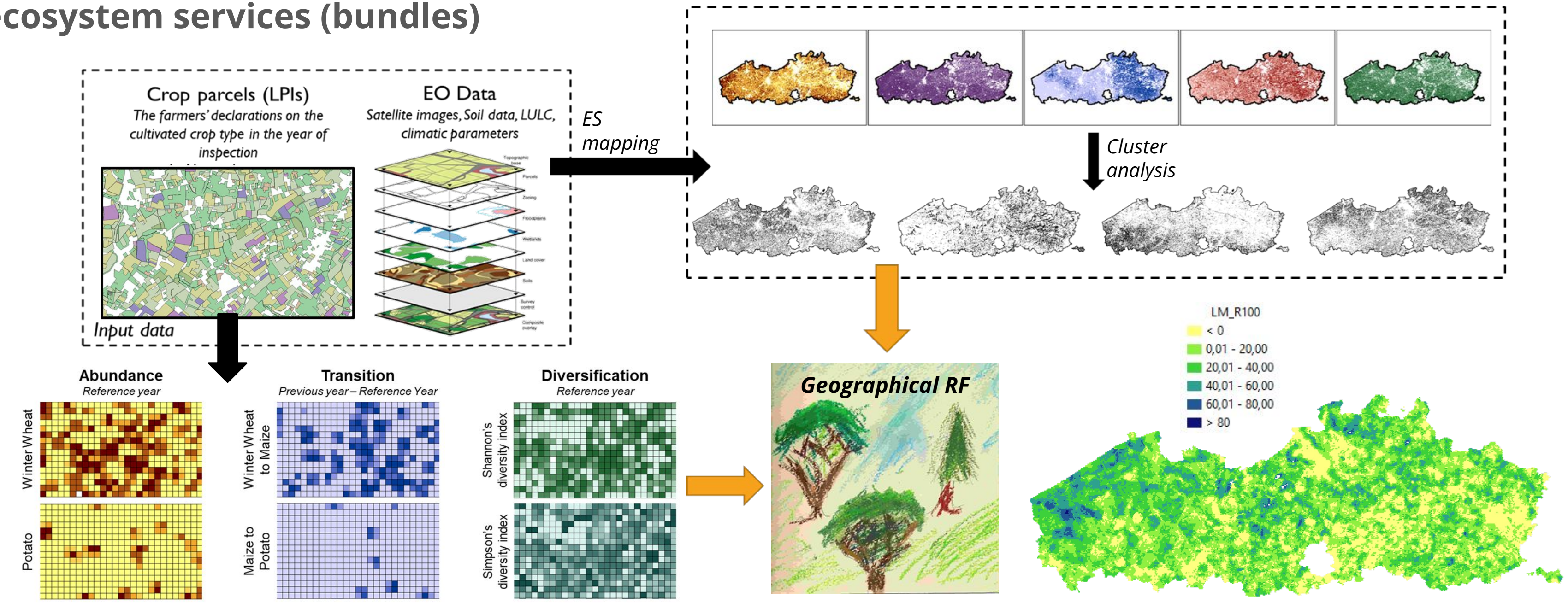
Objectives/goals
Interlinkages

Resilient Ecosystems - Projects



Resilient Ecosystems - Activities so far

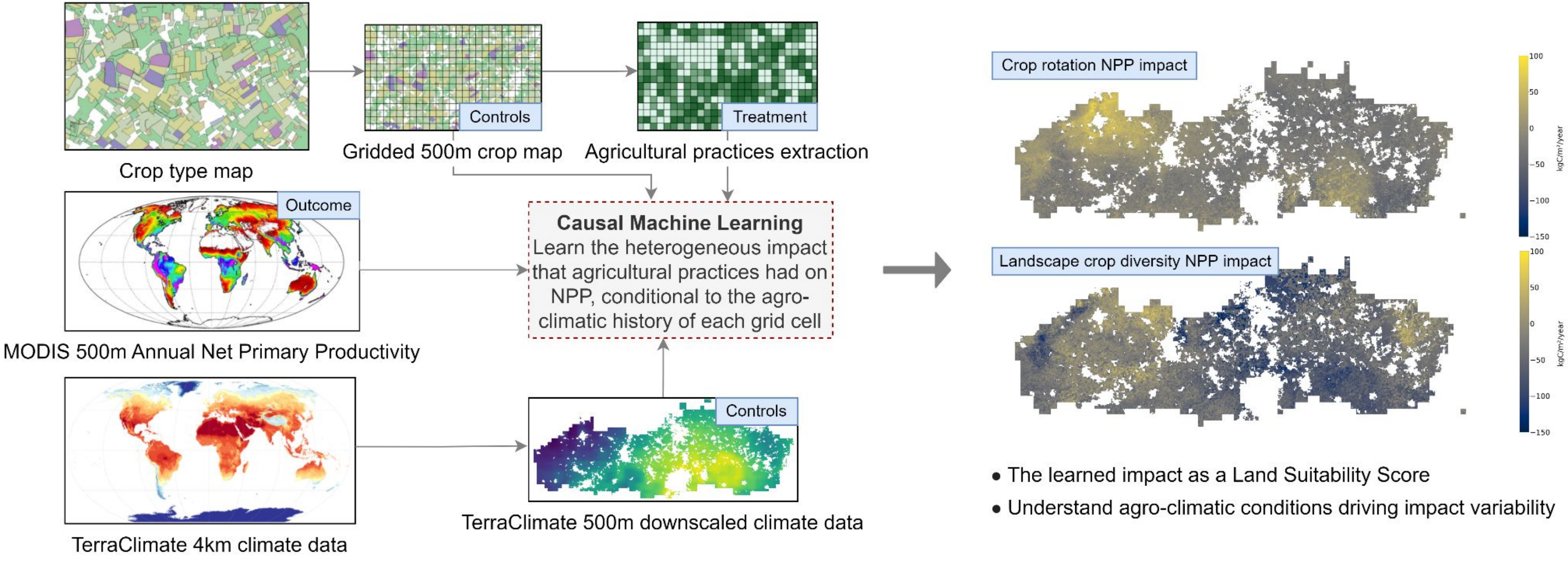
Local specific contributions of management practices to the relationships among multiple ecosystem services (bundles)



Paper in preparation to be submitted to Agriculture, Ecosystems & Environment (Elsevier)

Resilient Ecosystems - Activities so far

Towards assessing agricultural land suitability with causal machine learning



- The learned impact as a Land Suitability Score
- Understand agro-climatic conditions driving impact variability

Accepted paper: Giannarakis, G., Sitokonstantinou, V., Lorilla, R. S., & Kontoes, C. (2022). Towards assessing agricultural land suitability with causal

Resilient Ecosystems - Achievements so far

GIANNARAKIS, G., SITOKONSTANTINOU, V., LORILLA, R.S., & KONTOES, C. (2022). Towards assessing agricultural land suitability with causal machine learning. EarthVision: Large Scale Computer Vision for Remote Sensing Imagery, **Computer Vision and Pattern Recognition Conference (CVPR)**. To be presented. New Orleans, Louisiana, 19 June 2022. https://arxiv.org/abs/2204.12956

GIANNARAKIS, G. Towards assessing agricultural land suitability using the EconML tool. **Community Workshop on Microsoft's Causal Tools** organized by **Microsoft Research**, Breakout discussions (by industry use cases): Climate change applications. 3 May 2022.

LORILLA R.S., SITOKONSTANTINOU, V., KONTOES, C., KOUKOS, A. & TSOUMAS, I. (2021). Using Machine learning to analyze the relationships between ecosystem services and agricultural practices. **3rd Ecosystem Services Partnership (ESP) Europe Conference** (Book of Abstracts). Estonian University of Life Sciences (Tartu, Estonia), 7-10 June 2021, Sectoral Session S1. Available at: https://www.espconference.org/europe2020/wiki/486623/session-overview#Sectoral

Lead Team Member of the **ESP Thematic Working Group 3 for Ecosystem Services Indicators**; RS Lorilla, APE van Oudenhoven, L Nel, U Schwaibold. https://www.es-partnership.org/community/workings-groups/thematic-working-groups/twg-3-es-indicators/

Session co-host in the upcoming **4th ESP Europe Conference**. Session title "The operationalization of ecosystem services indicators: a matter of scale, data, purpose and end-users; RS Lorilla et al. https://www.espconference.org/europe22/wiki/754946/session-overview

RS Lorilla included in the Scientific Program Committee (SPC) of the **4th ESP Europe Conference** as member of the Young Ecosystem Services Specialists (YESS) https://www.espconference.org/europe22/wiki/723161/organisation

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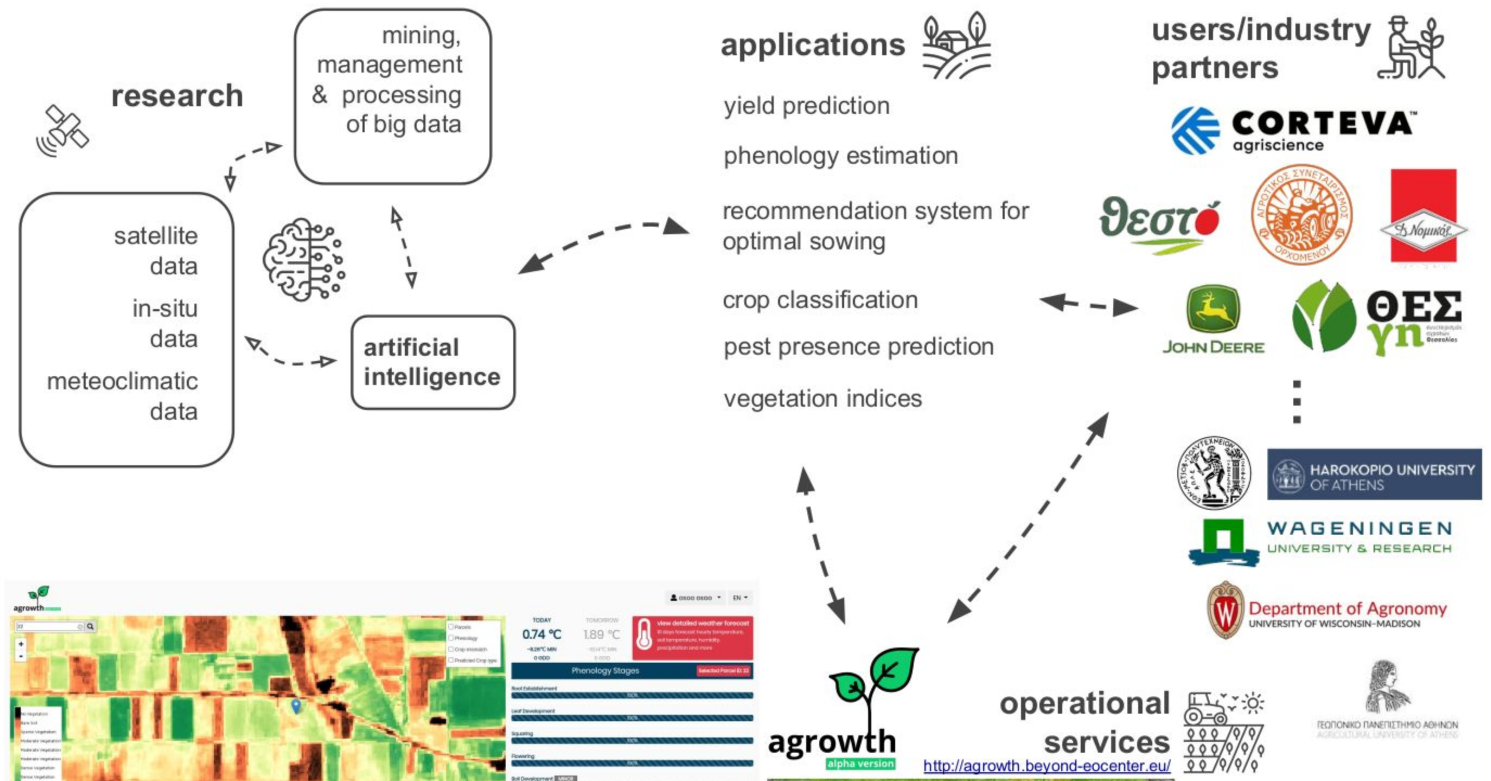
2022 - 2024: RS Lorilla selected as Fellow of the **Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Nexus Assessment** representing Greece and BEYOND; participation in "Chapter 2: Status and past trends of interactions in the nexus" of the thematic assessment of the interlinkages among biodiversity, water, food, climate and health. https://ipbes.net/nexus/experts

Agriculture Modeling

our middle way

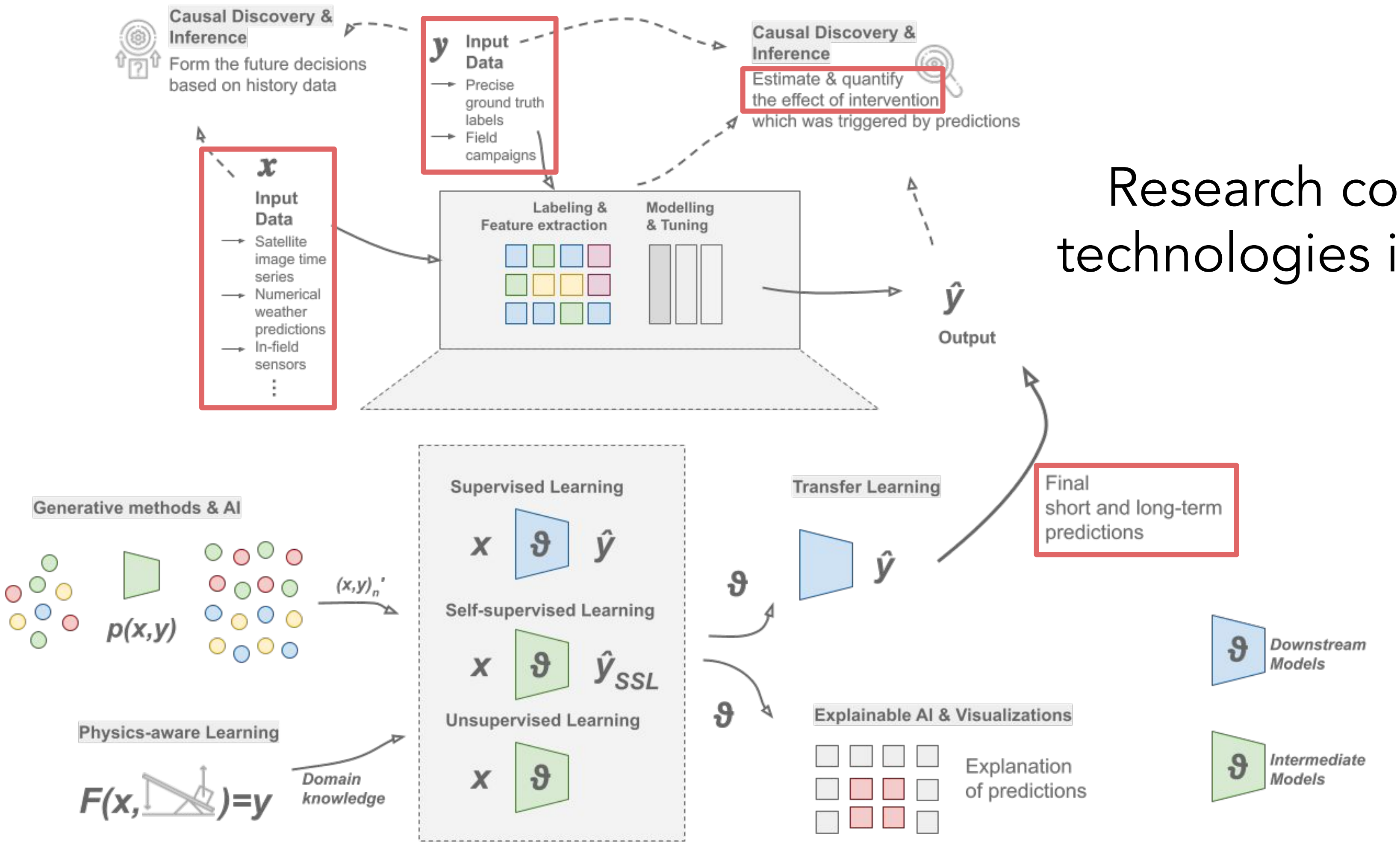
aim of the scientific pillar II is to form AI algorithms and methodologies that can leverage this big skein of observational data and blend them with the domain knowledge in order to promote a sustainable, resilient and fair Agriculture.

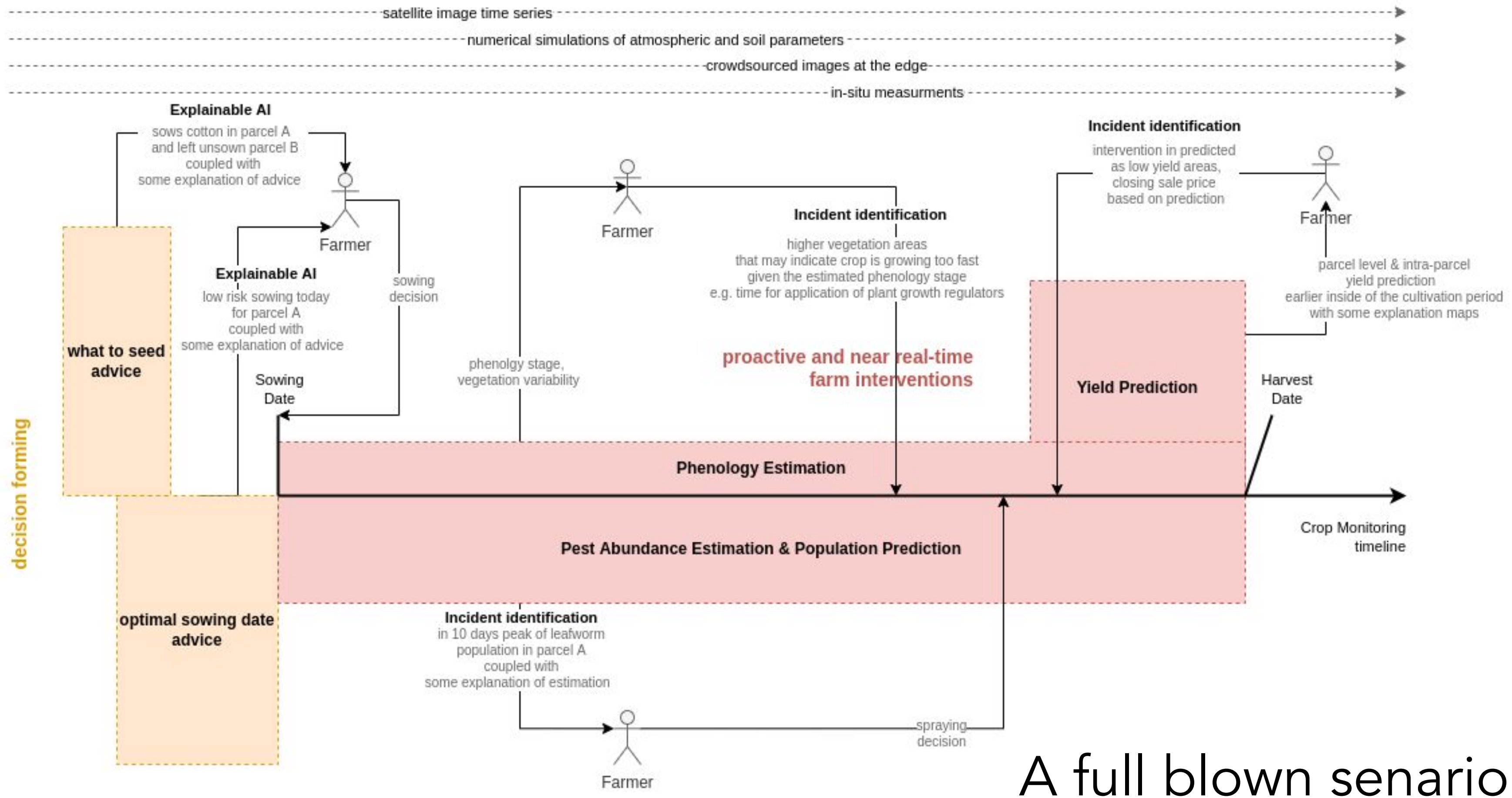
second aim of the scientific pillar II,
equally important as the first,
serve your user as your research.



The narrative from the user to the research and back

Research concept & technologies involved

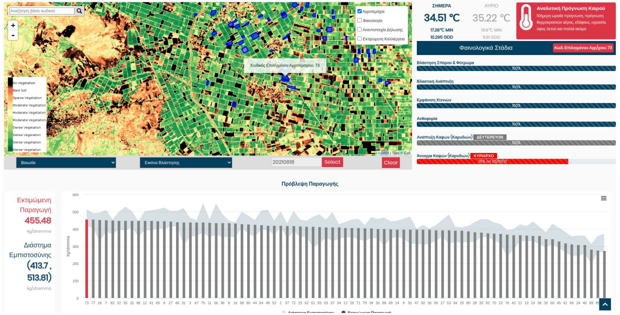




A full blown senario

Achievements so far & work in progress

Real life services



yield prediction
phenology estimation
weather & rs indexes

agrowth
alpha version

CORTEVA agriscience

<u>commercial/paid use of sowing maps</u> for cultivation period of 2022 in GR

<u>research & development</u> of new service about pest abundance in GR

Research paper

IGARSS BRUSSELS 2021 — IEEE published

SEMI-SUPERVISED PHENOLOGY ESTIMATION IN COTTON PARCELS WITH SENTINEL-2 TIME-SERIES

Vasileios Sitokonstantinou[1,2], Alkiviadis Koukos[1], Charalampos Kontoes[1], Nikolaos S. Bartsotas[1], Vassilia Karathanassi[2]

[1]Institute for Space Applications and Remote Sensing, National Observatory of Athens, Penteli, Greece
[2]Laboratory of Remote Sensing, National Technical University of Athens, Zografou, Greece

IVMSP 2022 26 - 29 JUNE 2022 Nafplio, Greece — IEEE accepted

Pest Presence Prediction Using Interpretable Machine Learning

Ornela Nanushi*[1], Vasileios Sitokonstantinou*[1,2], Ilias Tsoumas[1] and Charalampos Kontoes[1]
[1] National Observatory of Athens, IAASARS, BEYOND Center, Penteli, Greece
Email: {ornela.nanushi, vsito, i.tsoumas, kontoes}@noa.gr
[2]Laboratory of Remote Sensing, National Technical University of Athens, Athens, Greece

PLOS ONE submitted

Fuzzy clustering for the within-season estimation of cotton phenology

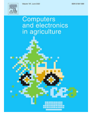
Vasileios Sitokonstantinou[1,2*], Alkiviadis Koukos[1], Ilias Tsoumas[1], Nikolaos S. Bartsotas[1], Charalampos Kontoes[1], Vassilia Karathanassi[2]

1 National Observatory of Athens, IAASARS, BEYOND Centre of EO Research and Satellite Remote Sensing, Athens, Greece, **2** Laboratory of Remote Sensing, National Technical University of Athens, Athens, Greece.

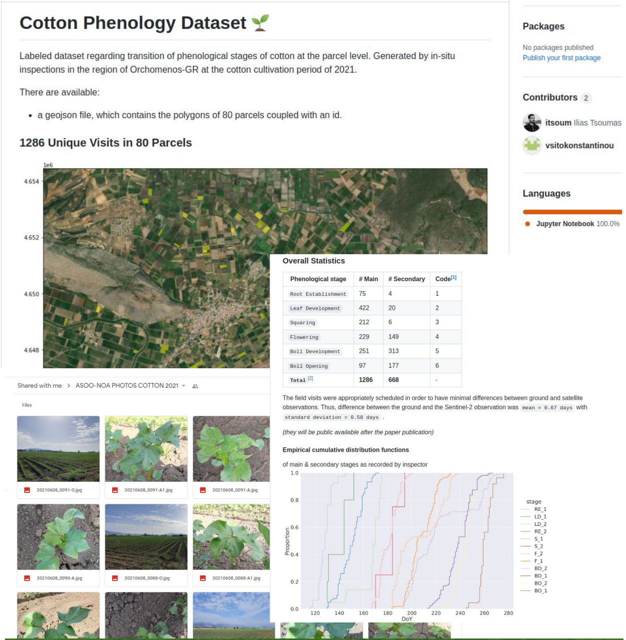
Leveraging causal inference to assess a knowledge-based recommendation system for optimal sowing

work in progress

ELSEVIER



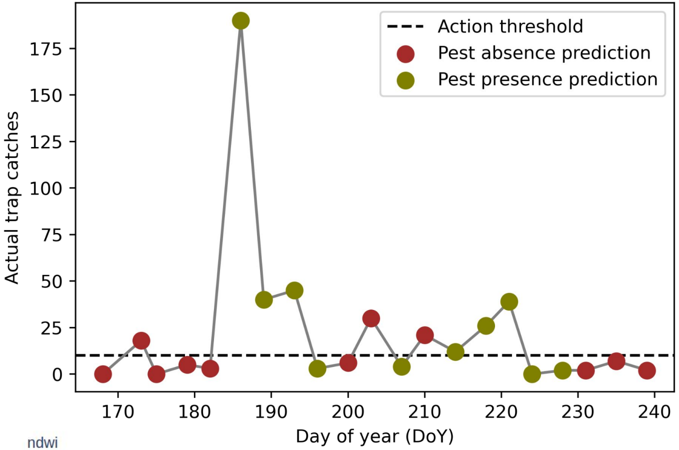
Data

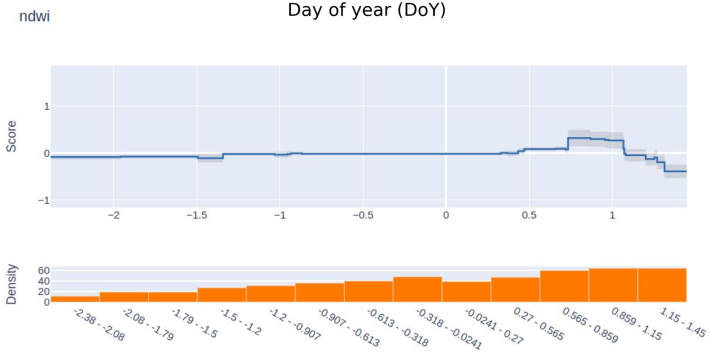


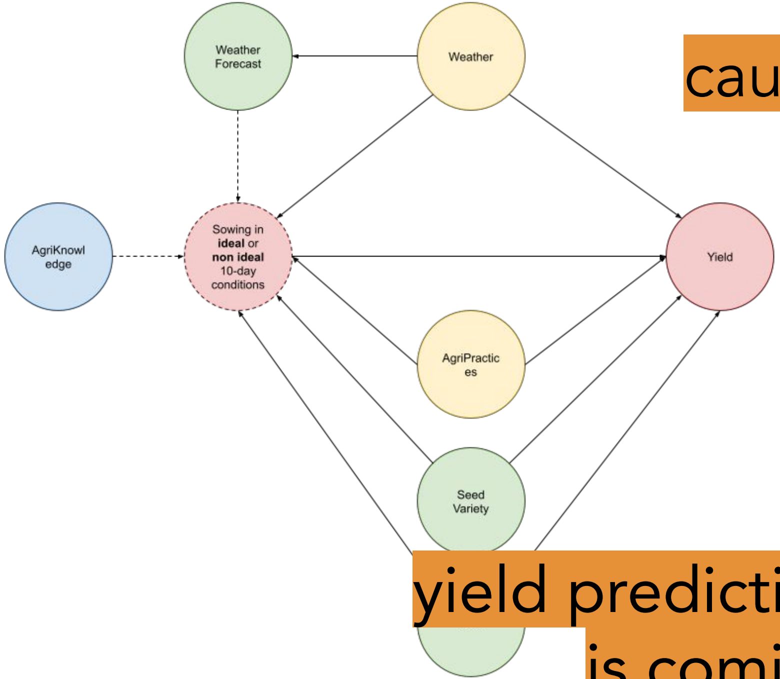
Phenological stage	# Main	# Secondary	Code[1]
Root Establishment	75	4	1
Leaf Development	422	20	2
Squaring	212	6	3
Flowering	229	149	4
Boll Development	251	313	5
Boll Opening	97	177	6
Total [2]	1286	668	-

Bonus slide

explainability







causality

Treatment Effect Estimates

	Est.					
ATE	597.544	227.350	2.628	0.009	15	0
ATC	703.395	277.681	2.533	0.011	15	8
ATT	449.354	234.425	[illegible]	[illegible]	[illegible]	7

yield prediction is coming where self-supervised meets physics-informed learning

Pillar III

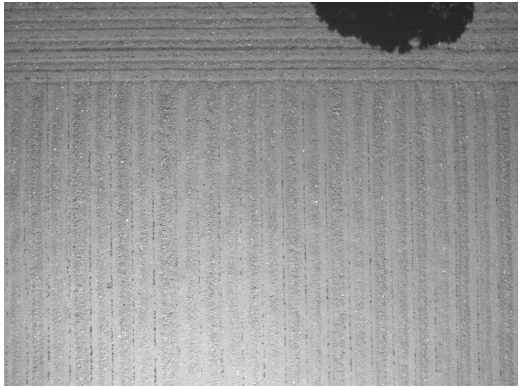
Information Extraction from Big Remote Sensing Data

Information Extraction from Remote Sensing Images

Concept - Extract information from various data sources

Satellite Images

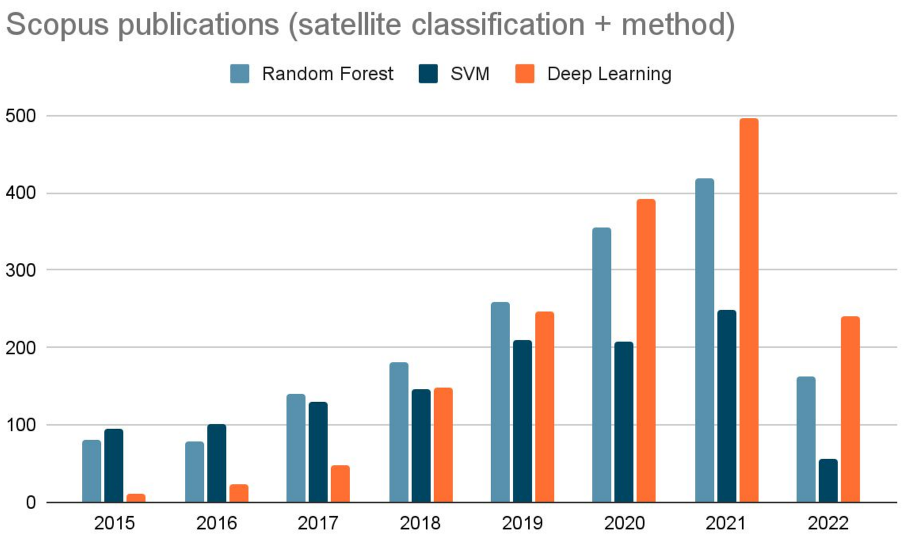
UAV Images



Street-Level Images

Information Extraction from Remote Sensing Images

Deep Learning and Big EO data (2 scientific targets)



Scopus publication with “dataset” in the title and “Sentinel” in the abstract

Year	Number
2017	8
2018	16
2019	29
2020	51
2021	56
2022	23

Information Extraction from Remote Sensing Images

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.

Information Extraction from Remote Sensing Images

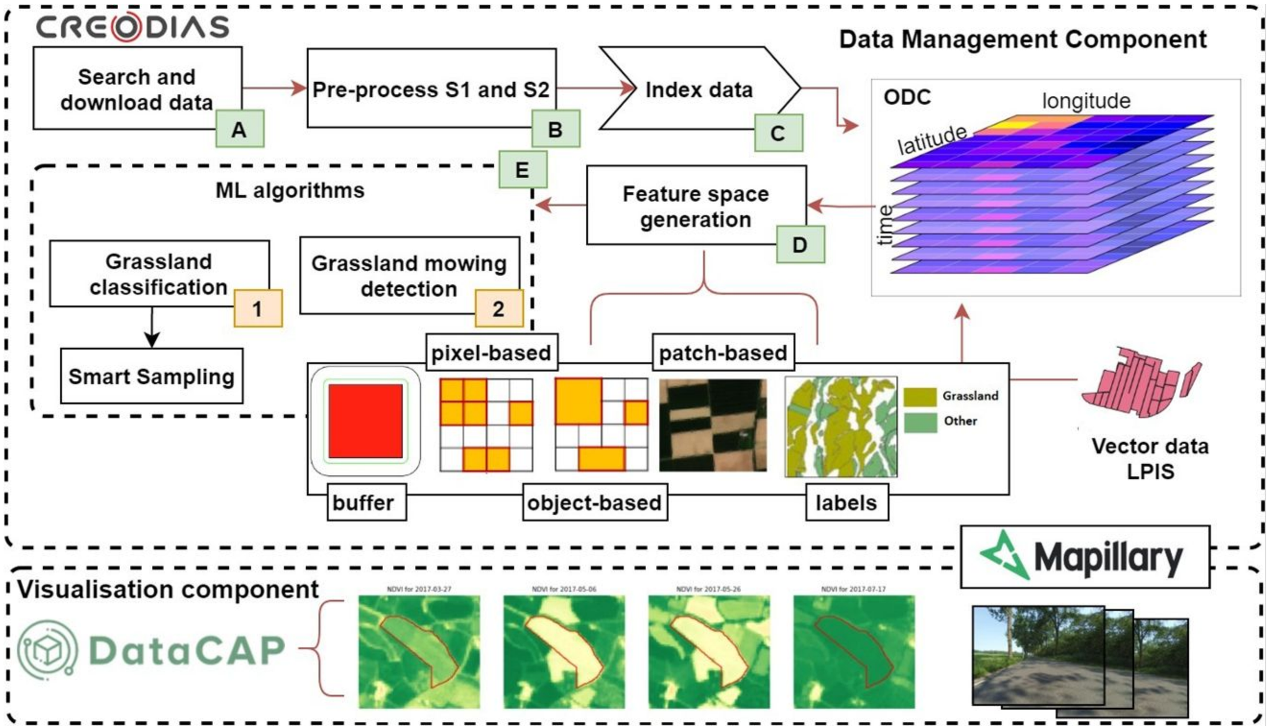
New CAP – Steering towards exhaustive monitoring

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

Information Extraction from Remote Sensing Images



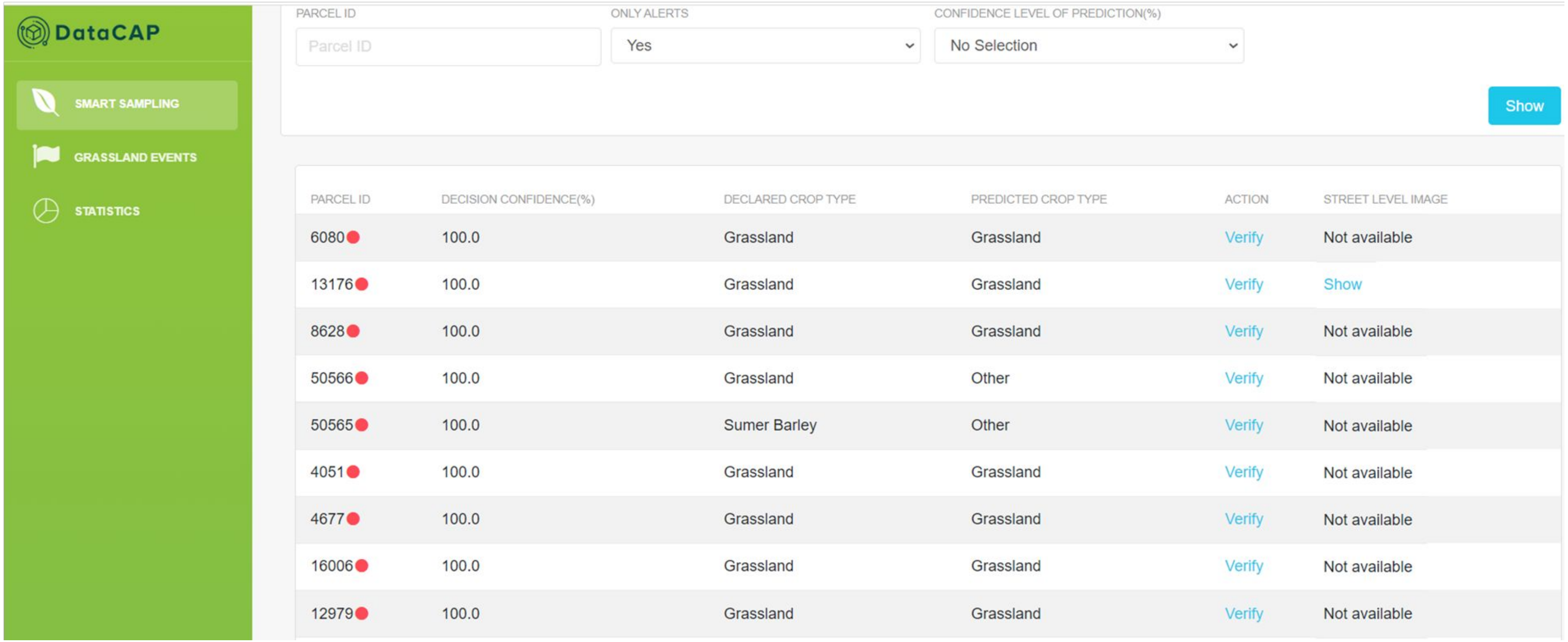
in the office

SCAN ME

envision

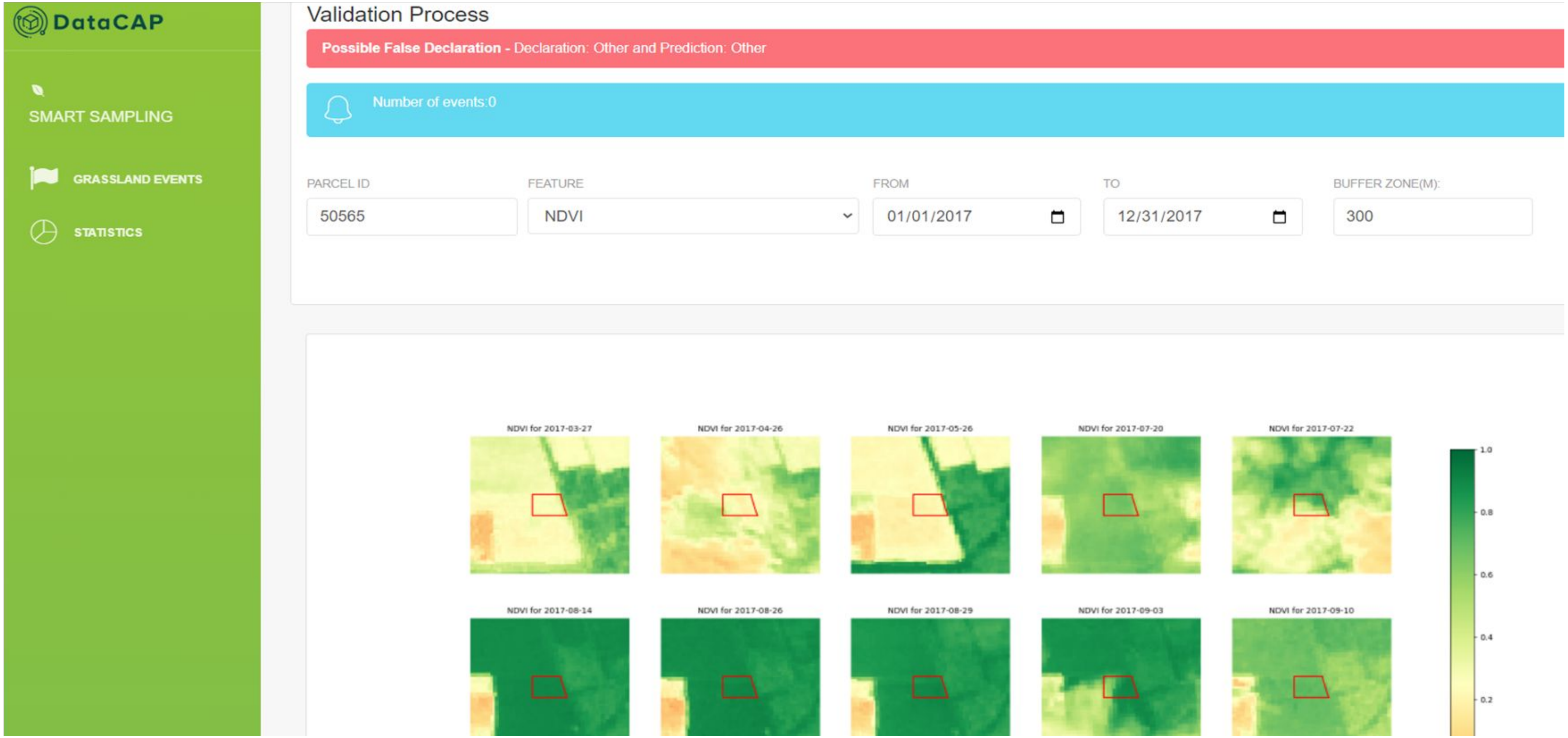
CALLISTO

DataCAP GUI



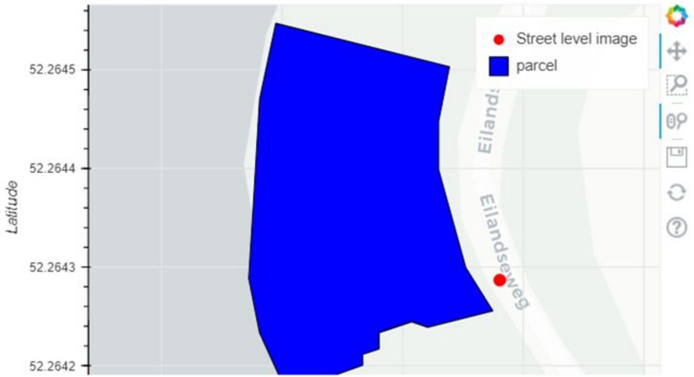
PARCEL ID	DECISION CONFIDENCE(%)	DECLARED CROP TYPE	PREDICTED CROP TYPE	ACTION	STREET LEVEL IMAGE
6080	100.0	Grassland	Grassland	Verify	Not available
13176	100.0	Grassland	Grassland	Verify	Show
8628	100.0	Grassland	Grassland	Verify	Not available
50566	100.0	Grassland	Other	Verify	Not available
50565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

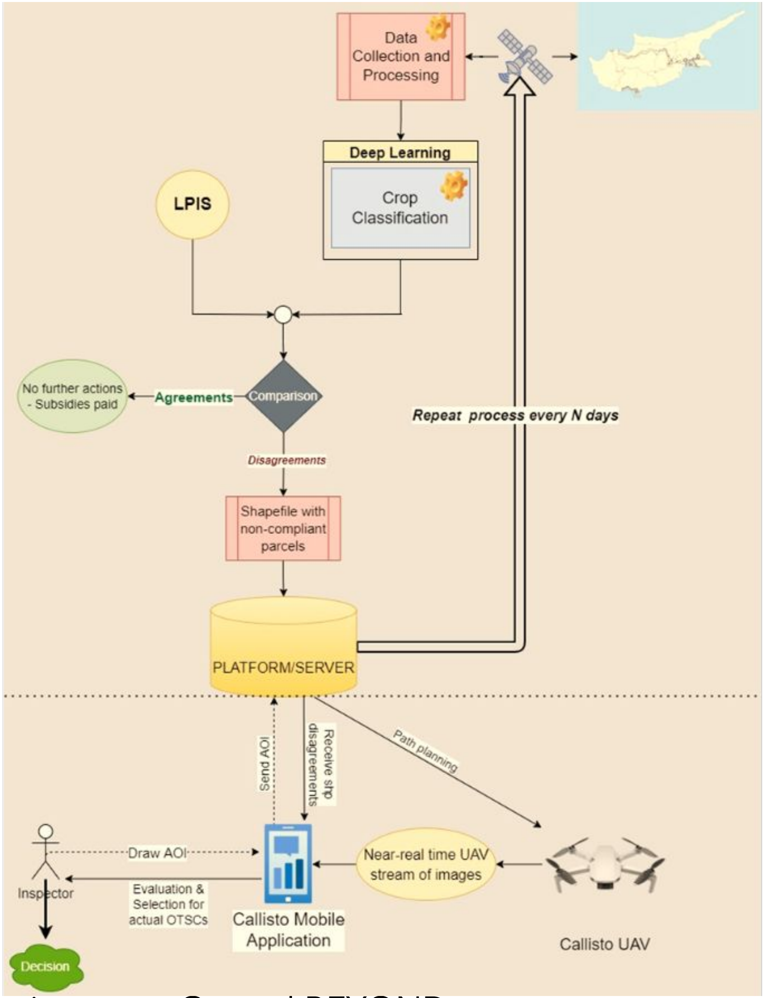

DataCAP
SMART SAMPLING
GRASSLAND EVENTS
STATISTICS
Validation Process
Possible False Declaration - Declaration: Other and Prediction: Other
Number of events:0
PARCEL ID
50565
FEATURE
NDVI
FROM
01/01/2017
TO
12/31/2017
BUFFER ZONE(M):
300
NDVI for 2017-03-27
NDVI for 2017-04-26
NDVI for 2017-05-26
NDVI 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

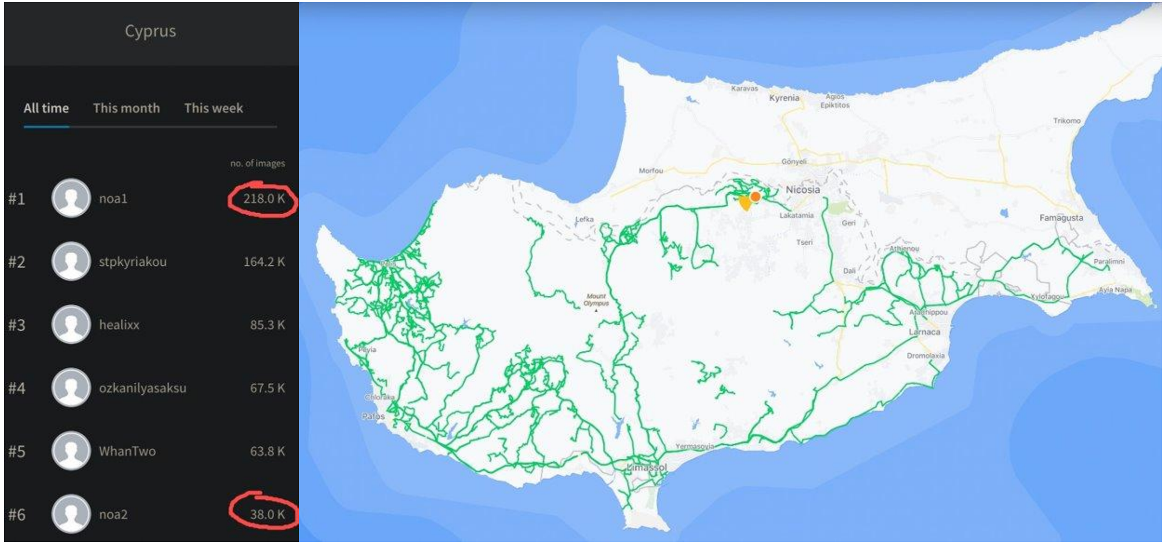
Street-Level Images

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

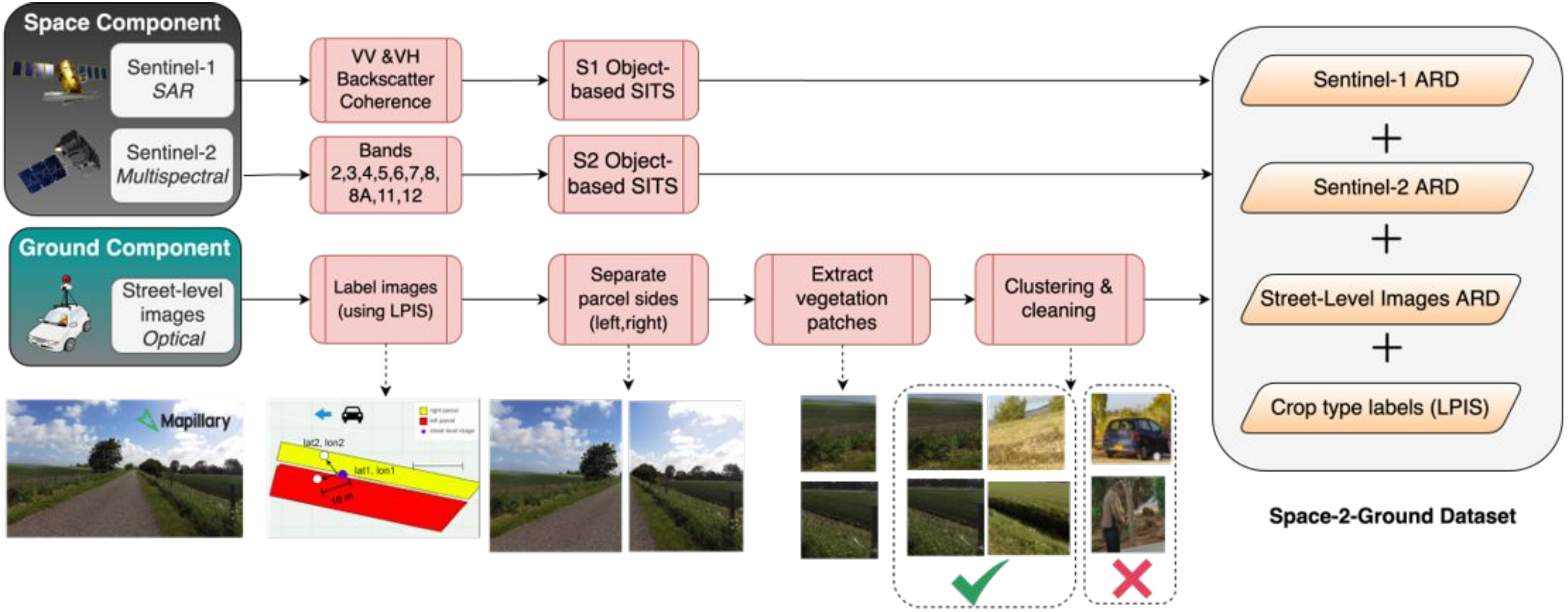
- **Campaigns**
  - Acquisition methodology
    - Cost-efficient, easy to set up by inspectors & using existing operational framework
  - Mapillary platform analysis
  - Action cam (better results than smartphone)
  - Giving back to the community – **Mapillary crowdsourcing platform**
    - ✓ **300 k street-level images** already uploaded - Top contributors in Cyprus
- **Annotation through LPIS matching** – *"DataCAP"* - publication on MMM – Callisto generated dataset

Information Extraction from Remote Sensing Images

Benchmark Datasets - **Cyprus Campaigns**

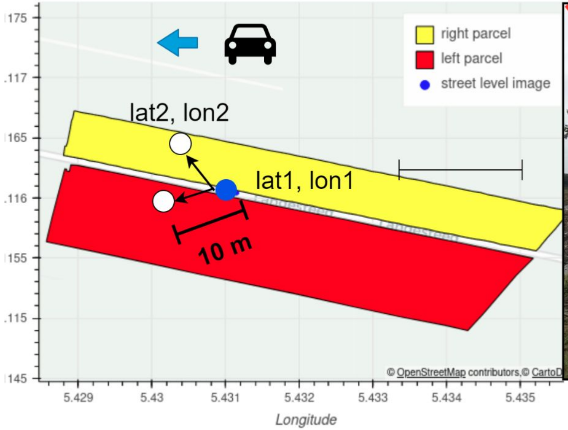


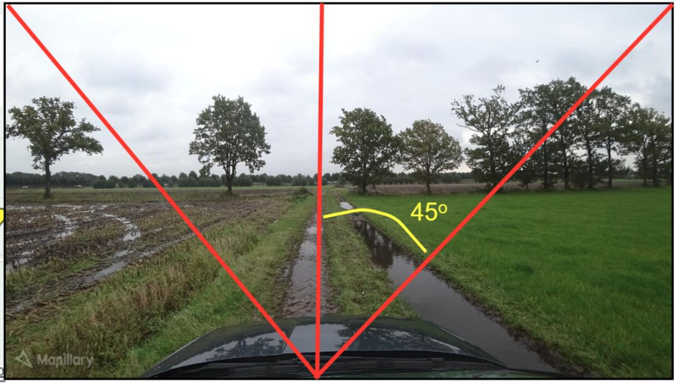
Information Extraction from Remote Sensing Images



Information Extraction from Remote Sensing Images

Deep Learning on Street-Level images





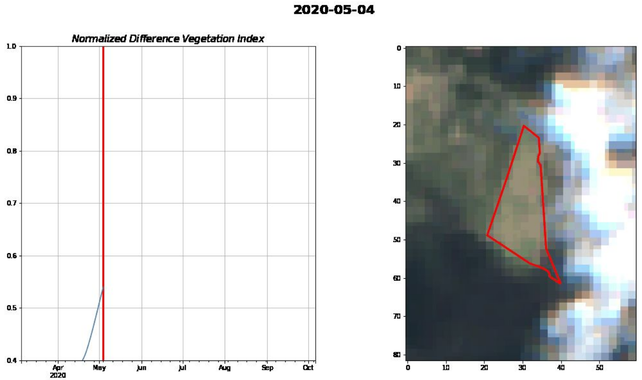
1. Annotation
2. Removal of Low-Quality Images
3. Semantic Segmentation
4. Crop/Vegetation identification
5. DL for Crop Classification

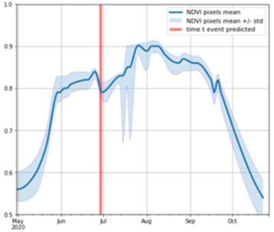
Sitokonstantinou, V., Koukos, A., Drivas, T., Kontoes, C. and Karathanassi, V., 2022. Datacap: A satellite datacube and crowdsourced street-level images for the monitoring of the common agricultural policy. In *International Conference on Multimedia Modeling* (pp. 473-478). Springer, Cham.

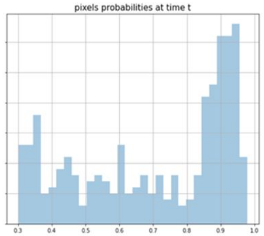
Choumos, G., Koukos, A., Sitokonstantinou, V. and Kontoes, C., 2022. Towards Space-to-Ground Data Availability for Agriculture Monitoring. *arXiv preprint arXiv:2205.07721*.

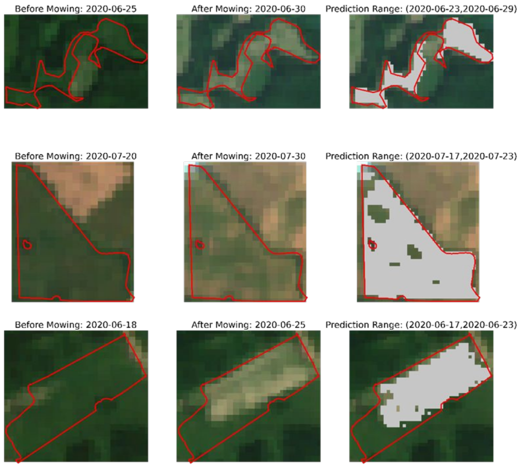
Information Extraction from Remote Sensing Images

Deep Learning on Satellite images (Grassland Mowing Event Detection)



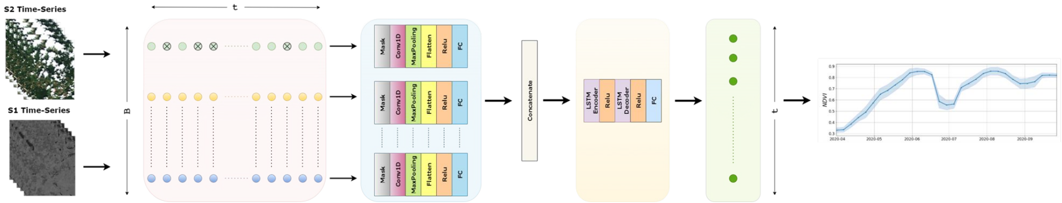




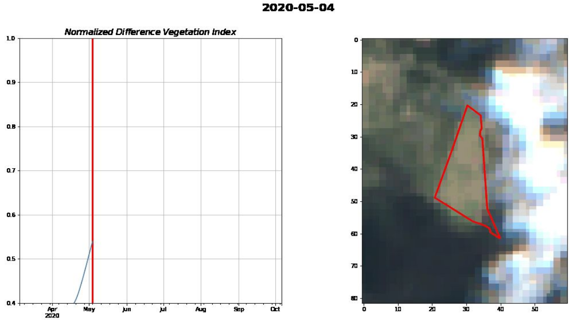


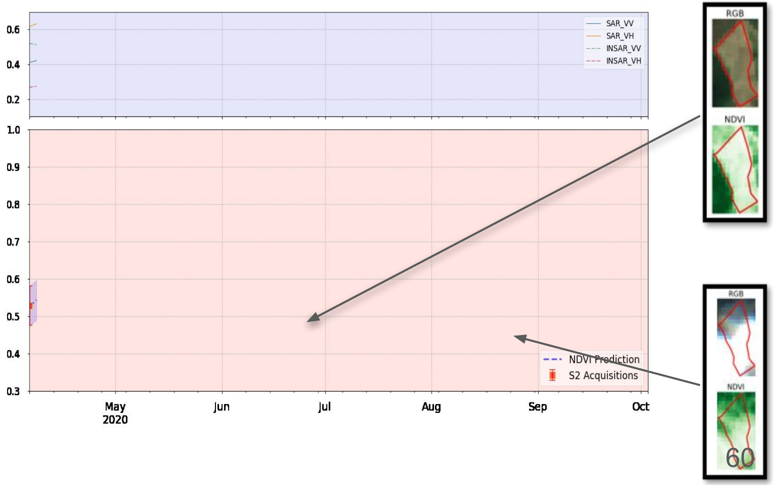
Information Extraction from Remote Sensing Images

- S1/S2 fusion for cloud gap filling in Grasslands



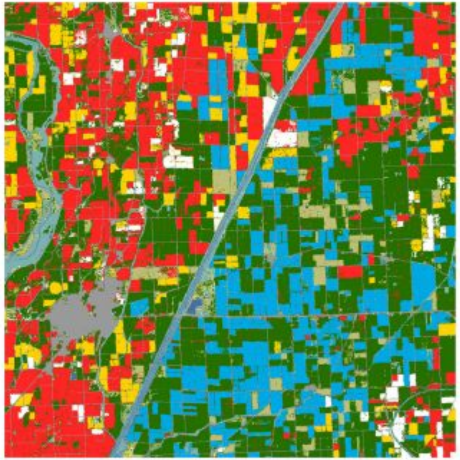
- Grassland mowing event detection



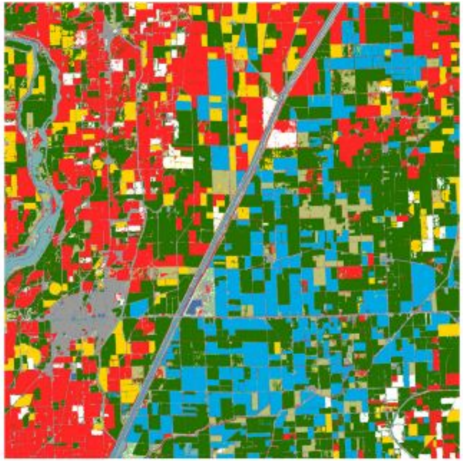


Information Extraction from Remote Sensing Images

Deep Learning on Satellite images (Crop Classification)



(1) Ground truth



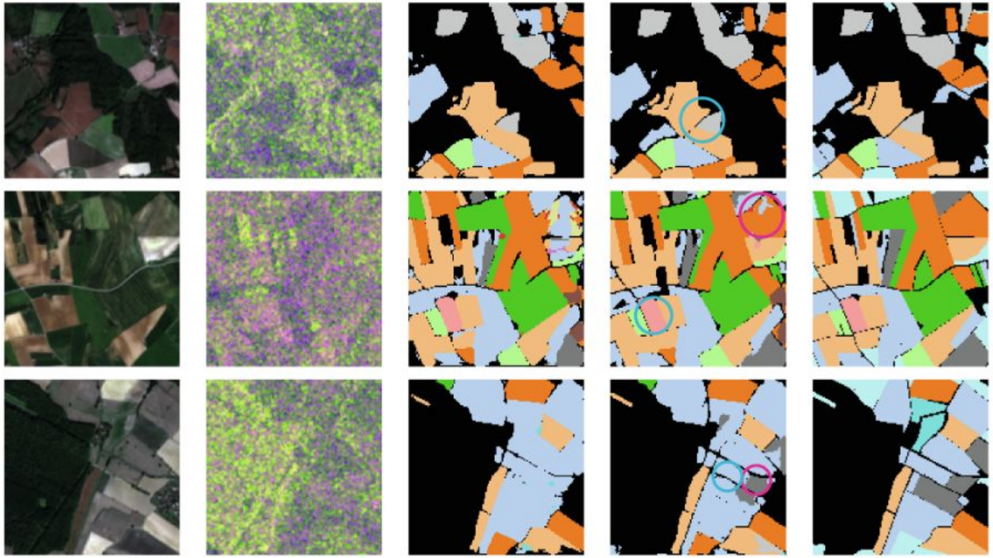
(8) Pre-trained SITS-BERT

Multiple DL approaches

- LSTM
- Temporal CNN
- Transformers
- Fully Convolutional Networks (UNet)
- Spatio-Temporal Encoders

Information Extraction from Remote Sensing Images

Deep Learning on Satellite images (Crop Classification)



(a) Optical (b) Radar (c) S2 Prediction (d) Fusion Prediction (e) Ground Truth

Garnot, V.S.F., Landrieu, L. and Chehata, N., 2022. Multi-modal temporal attention models for crop mapping from satellite time series. ISPRS Journal of Photogrammetry and Remote Sensing, 187, pp.294-305.

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.

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)

Information Extraction from Remote Sensing Images

Choumos, G., Koukos, A., Sitokonstantinou, V. and Kontoes, C., 2022. Towards Space-to-Ground Data Availability for Agriculture Monitoring

Drivas, T., Sitokonstantinou, V., Tsardanidis, I., Koukos, A., Kontoes, C., & Karathanassi, V. (2022). A Data Cube of Big Satellite Image Time-Series for Agriculture Monitoring

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Sitokonstantinou, V., Koukos, A., Drivas, T., Kontoes, C. and Karathanassi, V., 2022. Datacap: A satellite datacube and crowdsourced street-level images for the monitoring of the common agricultural policy.

Tsardanidis, I., Sitokonstantinou, V., Koukos, A., Drivas, T.,Kontoes, C., Deep Learning Methods for Grassland Activity Monitoring

Sitokonstantinou, V., Koukos, A., Choumos G., Kontoes, C. DataCAP: Sentinel datacubes, crowdsourced street-level images and annotated benchmark datasets for the monitoring of the CAP

Sitokonstantinou, V., Koukos, A., Drivas, T., Kontoes, C., Papoutsis, I. and Karathanassi, V., 2021. A Scalable Machine Learning Pipeline for Paddy Rice Classification Using Multi-Temporal Sentinel Data

Sitokonstantinou, V., Papoutsis, I., Kontoes, C., Lafarga Arnal, A., Armesto Andrés, A.P. and Garraza Zurbano, J.A., 2018. Scalable parcel-based crop identification scheme using Sentinel-2 data time-series for the monitoring of the common agricultural policy.

Rousi, M., Sitokonstantinou, V., Meditskos, G., Papoutsis, I., Gialampoukidis, I., Koukos, A., Karathanassi, V., Drivas, T., Vrochidis, S., Kontoes, C. and Kompatsiaris, I., 2020. Semantically enriched crop type classification and linked earth observation data to support the common agricultural policy monitoring

Information Extraction from Remote Sensing Images

Upcoming publications

Title	Publisher
Assessment of Sentinel-1's polarimetric satellite data contribution to crop type mapping	IEEE journal
Event detection on grasslands through collaborative exploitation of Sentinel time-series	High IF RS journal (ISPRS, Remote Sensing of Environment..)
Big Sentinel data and Machine Learning for Crop Classification and Crop Growth Monitoring: A Review	RS Journal (IEEE, Elsevier)
Cyprus national space2ground benchmark dataset	High IF journal or top ML conference (NIPS, CVPR, ICML..)
DL for Crop Classification with fusion of multiple data source (Sentinel, VHR, street-level)	High IF journal or top ML conference (NIPS, CVPR, ICML..)

Information Extraction from Remote Sensing Images

Going beyond State-of-the-art

- Enhance Sentinel’s spatial analysis with the use of UAV images
- GAN with Sentinel-1 input for reconstruction of noisy S2 images
- DL for:
  - Crop Classification with fusion (early/late) of different data sources (Sentinel/VHR/Street-level)
  - Event Detection
- **Computer Vision tasks targeted in agricultural areas**
  - Image Quality Assessment
  - Image Classification
  - Semantic Segmentation
  - Object Detection
- **National scale dataset in Cyprus of street-level images combined with Satellite data (ongoing campaings)**

Thank you!

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for EO Sciences and Services