GLOSOLAN
GLOBAL SOIL LABORATORY NETWORK

GLOBAL SOIL PARTNERSHIP

FAO FIAT PANIS

IBEC INTERBALKAN ENVIRONMENT CENTER

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Promoting standardized & Earth Observation-aware Soil Spectral Libraries for land monitoring: Lessons learned from GEO-CRADLE and the EuroGEO perspective

Prof. George C. Zalidis

Never forget our goal ...

Large-scale soil mapping to

- Ensure food security
- Support SDG reporting
- Achieve Land Degradation Neutrality

The problem:
In the era of Open Big EO Data ...

... our data are incompatible, closed, proprietary, and our methods are heavily guarded ...

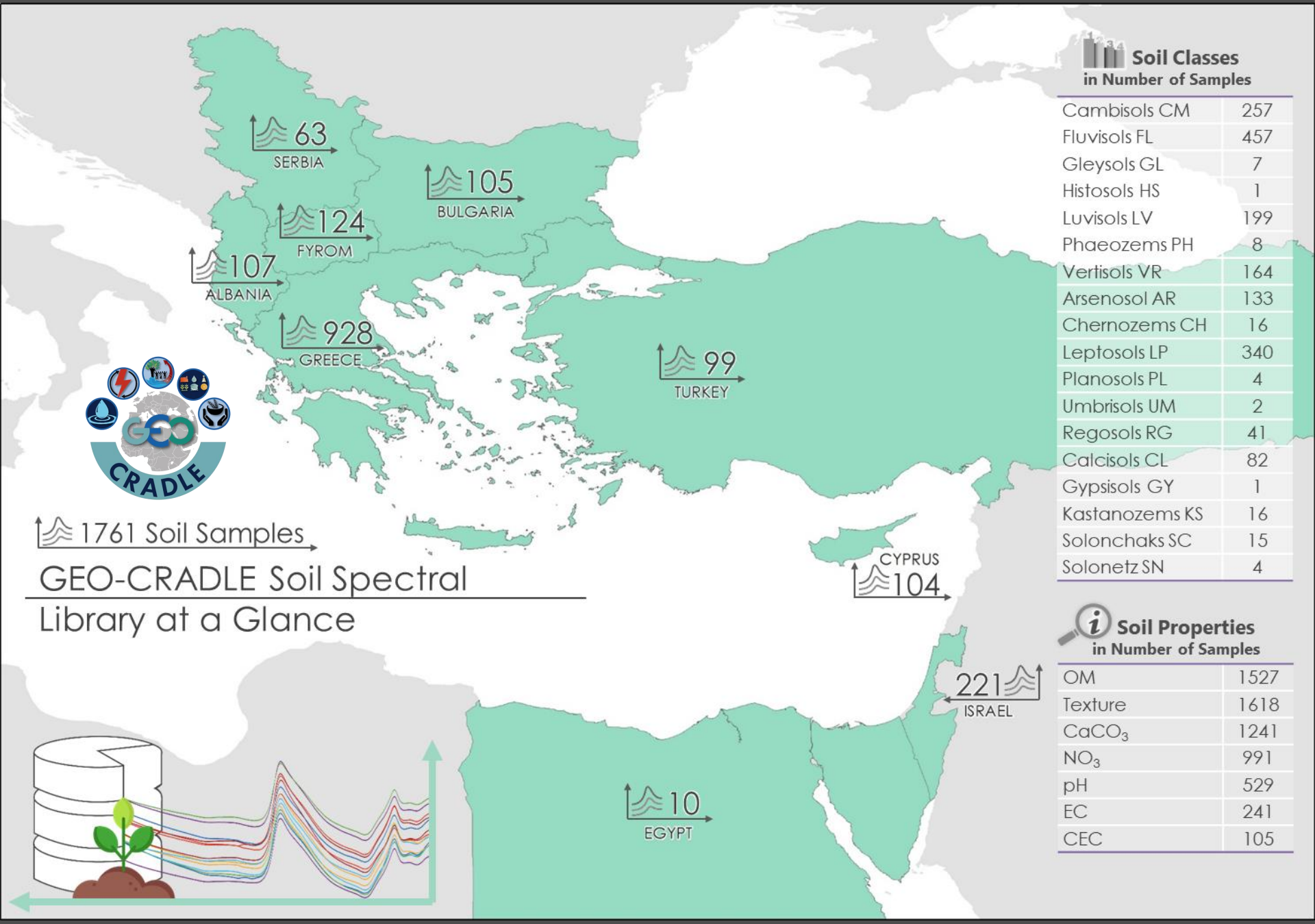
We need to standardize and open our repositories!

Past solutions ...

- Focused on large laboratory SSLs
- Each national/regional focal point has their own closed and potentially incompatible solution!
- Techniques were developed for inter-calibration

The open and standardized GEO-CRADLE Soil Spectral Library (SSL)

Composed of 1761 samples from 1017 soil profiles distributed in **nine countries** from three continents and covering an area with well recognized gaps in GLOSOLAN



Soil Classes
in Number of Samples

Cambisols CM	257
Fluvisols FL	457
Gleysols GL	7
Histosols HS	1
Luvisols LV	199
Phaeozems PH	8
Vertisols VR	164
Arsenosol AR	133
Chernozems CH	16
Leptosols LP	340
Planosols PL	4
Umbrisols UM	2
Regosols RG	41
Calcisols CL	82
Gypsisols GY	1
Kastanozems KS	16
Solonchaks SC	15
Solonetz SN	4

Soil Properties
in Number of Samples

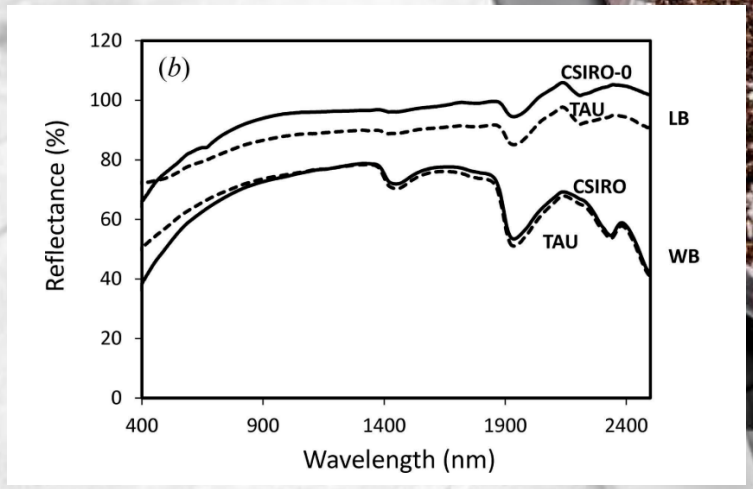
OM	1527
Texture	1618
$CaCO_3$	1241
NO_3	991
pH	529
EC	241
CEC	105

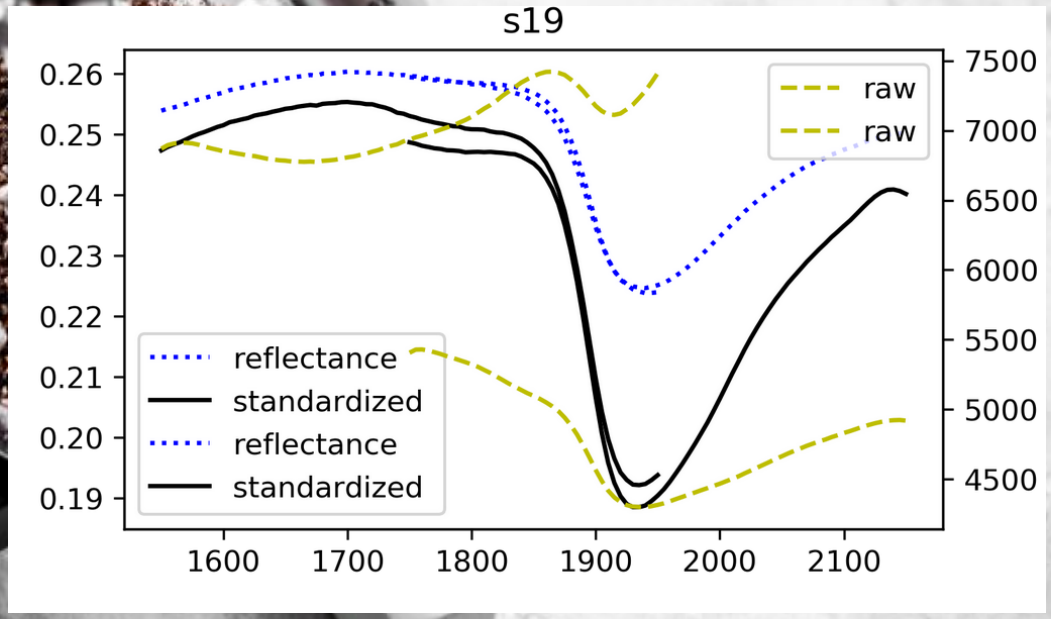
GEO-CRADLE standardization tiers

1. Sampling
   (methodology + metadata collection)
2. Chemical Laboratory
   (inter-calibrations)
3. Laboratory spectral measurement
   (Internal Soil Standard)

GEO-CRADLE:
Spectral Standardization protocols

Difference in ISS – TAU vs CSIRO
doi: 10.1080/01431161.2016.1148291





GEO-CRADLE: Spectral Standardization protocols

e.g. R^2 for SOC unstandardized is 0.56 with standardized is 0.78

Standardization process followed by the collaborating actors enable the achievement of promising results despite the high diversity of GEO-CRADLE SSL

Regional Soil Spectral Library

PILOT 2: Improved Food Security – Water Extremes Management (IFS)

Regional Soil Spectral Library

Part of pilot 2 - Improved Food Security and Water Extremes Management

GEO-CRADLE outcomes: Infrastructure

services such as food production, (flooding and drought), vegetation stresses, yield monitoring, soil quality monitoring and sustainability. Plants need...

It has been thus recognized that a spatio-temporal monitoring of soil quality and soil properties is necessary. One of the most important technologies used to monitor soils is soil spectroscopy which utilizes the spectral information of soil samples to

An **open access** SSL based on internal standard methods that can be extended (future proof)!

datahub.geocradle.eu/dataset/regional-soil-spectral-library

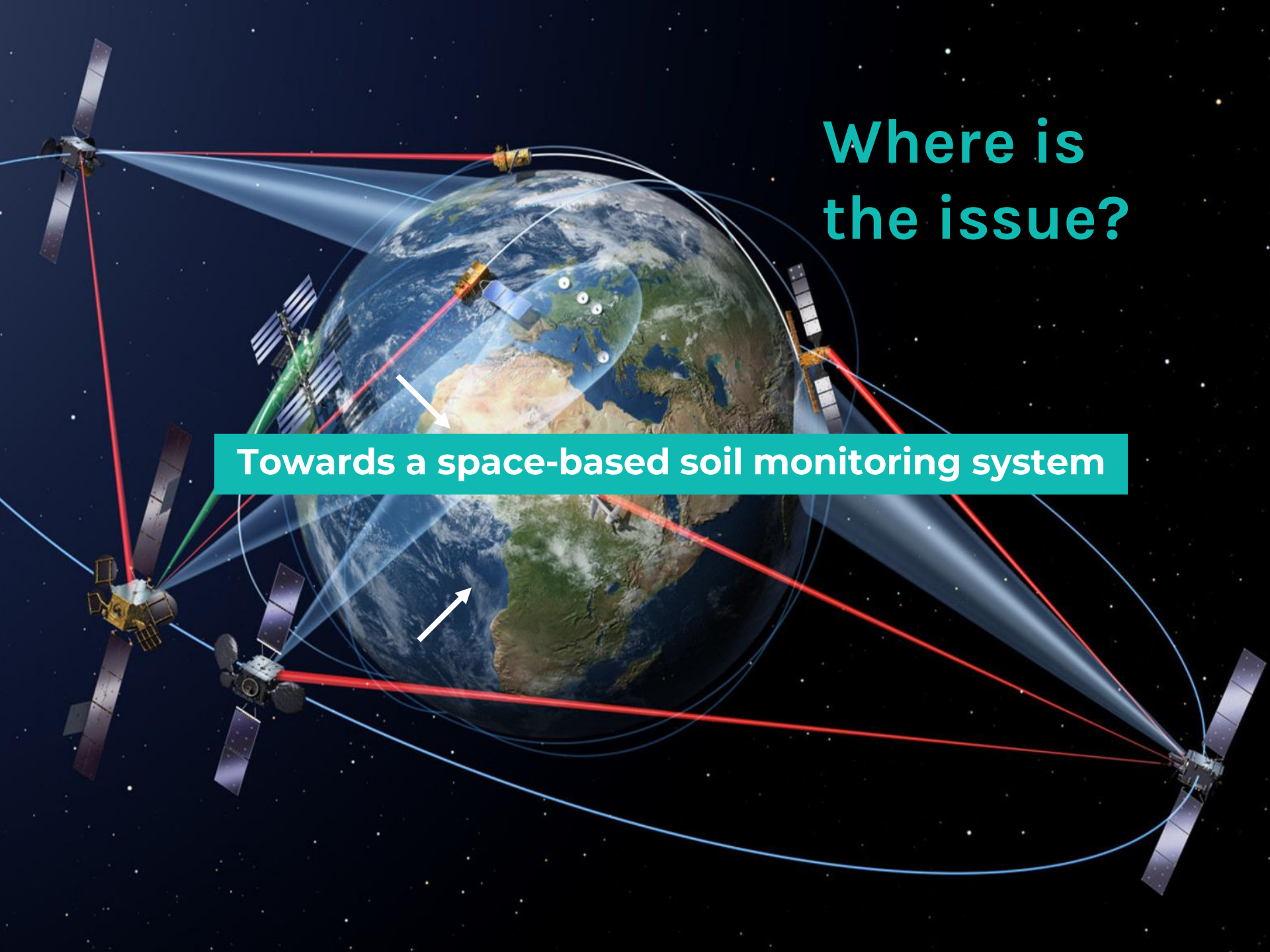
Data Extent

License

Open Data Commons Open

were obtained using a standardization protocol. The dataset encompasses the following countries and soil properties:

Country	Samples	SOM	Texture	CaCO3	pH	NO3	EC	CEC
Albania	107	107	107	X	X	X	X	X
Bulgaria	105	105	105	X	105	X	X	105
Cyprus	96	96	94	96	96	X	93	X
Egypt	10	6	X	4	6	X	6	X

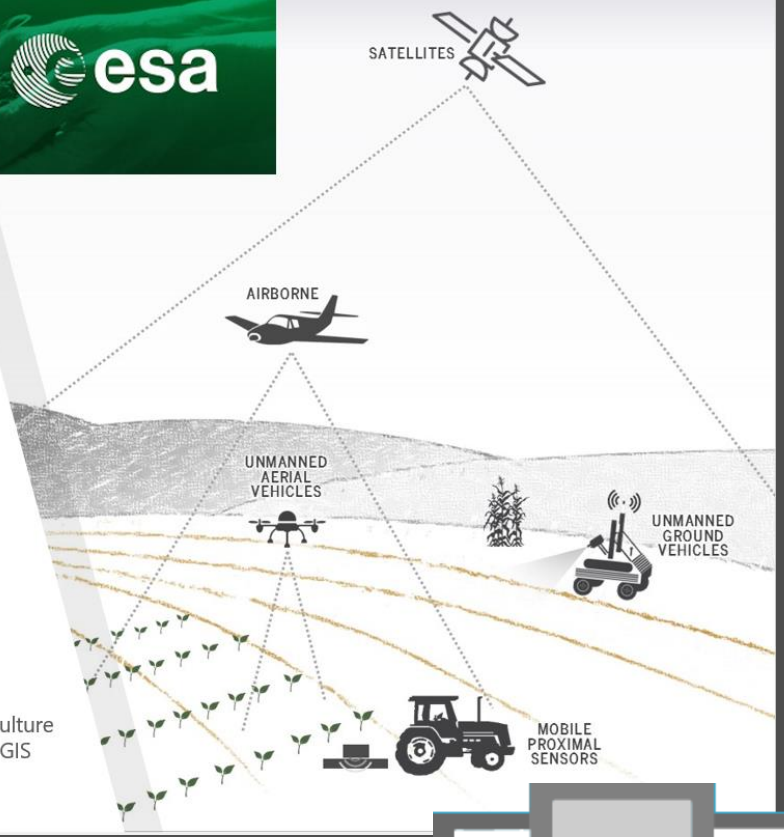

Where is the issue?
Towards a space-based soil monitoring system

world soils user consultation meeting
2–3 July 2019 | ESA–ESRIN | Frascati (Rome), Italy

esa

Supporting Soil Health and Sustainability by utilizing Hyperspectral data – the need for standardization

Session-2: Potential information derived from space-based EO systems for soil monitoring



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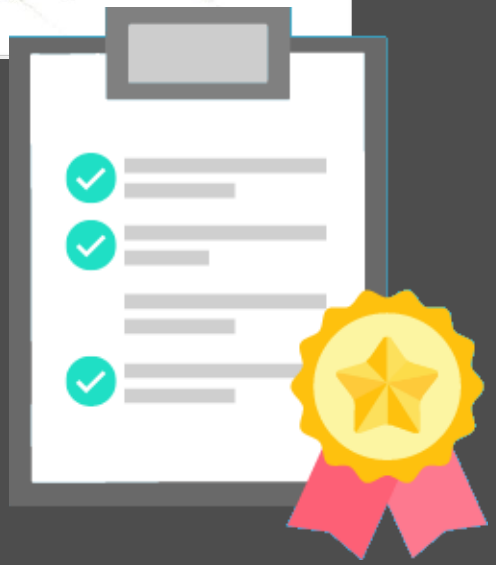
Director of the Laboratory of Remote Sensing and GIS
Scientific Coordinator of i-BEC

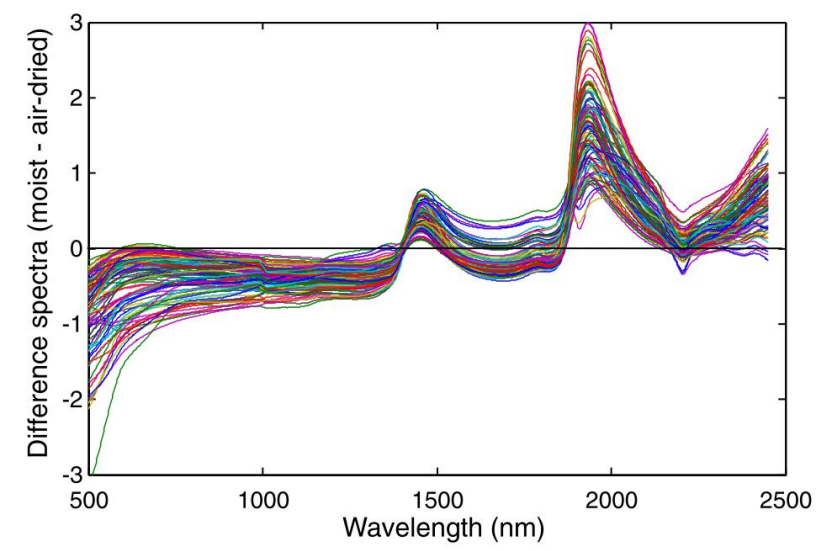
The need for common protocols and procedures

Ensure the validity and repetition!

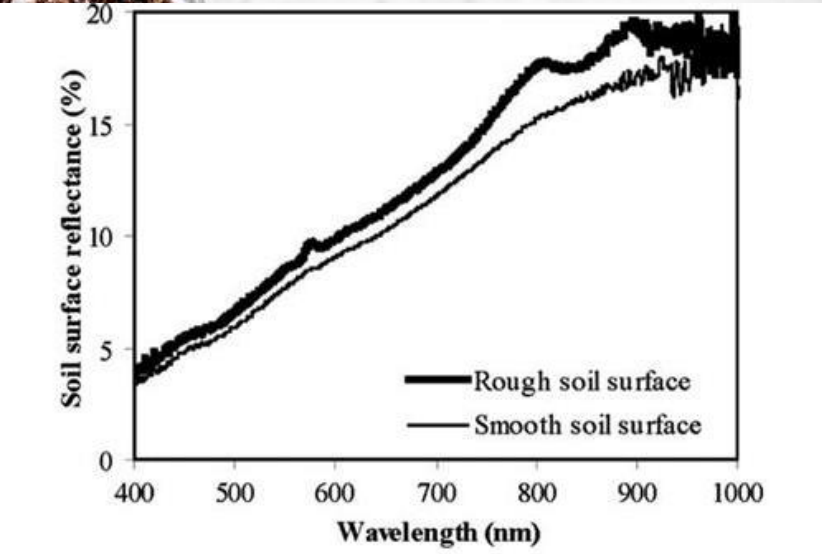


From lab to the field ...

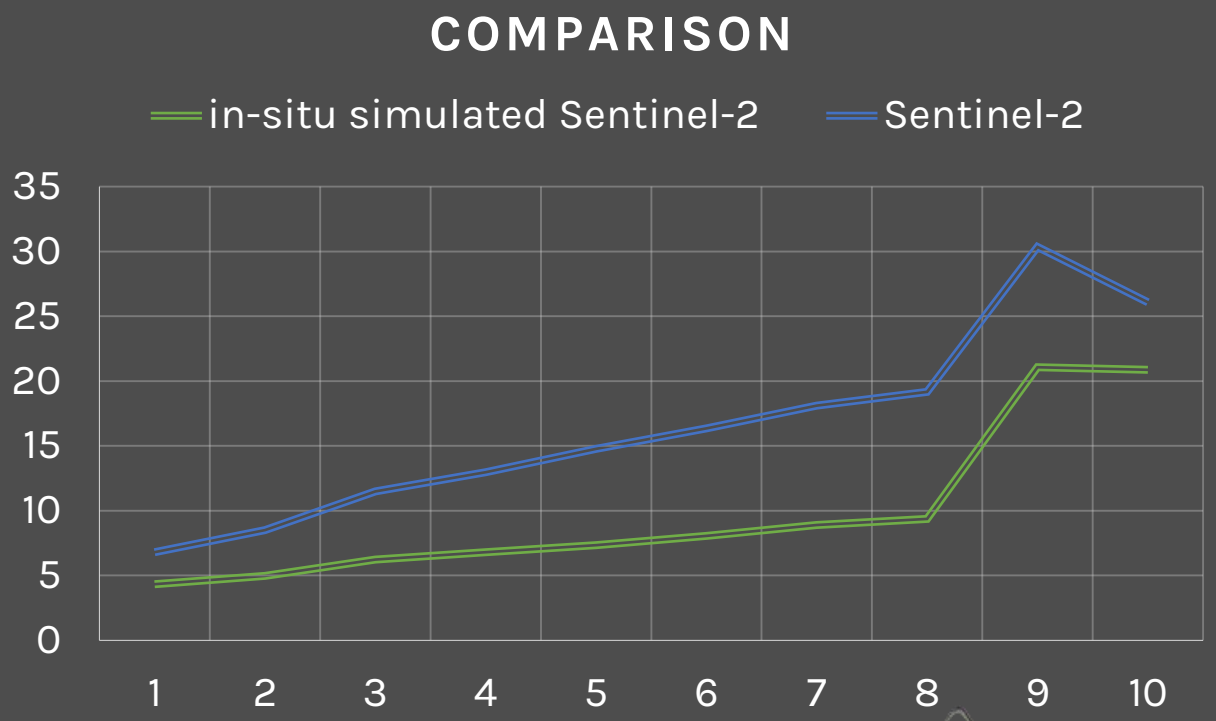
Moisture effect
doi: 10.1016/j.geoderma.2011.09.008

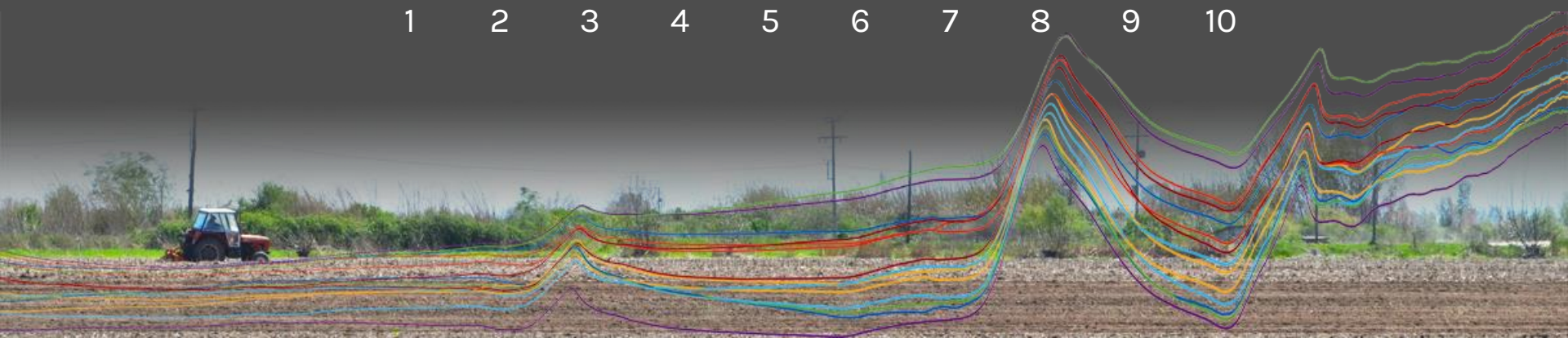


Roughness effect
doi.org/10.1139/CJSS2011-069



Spectral discrepancy





We have to create a SSL that is **EO-aware** and can handle the aforementioned issues

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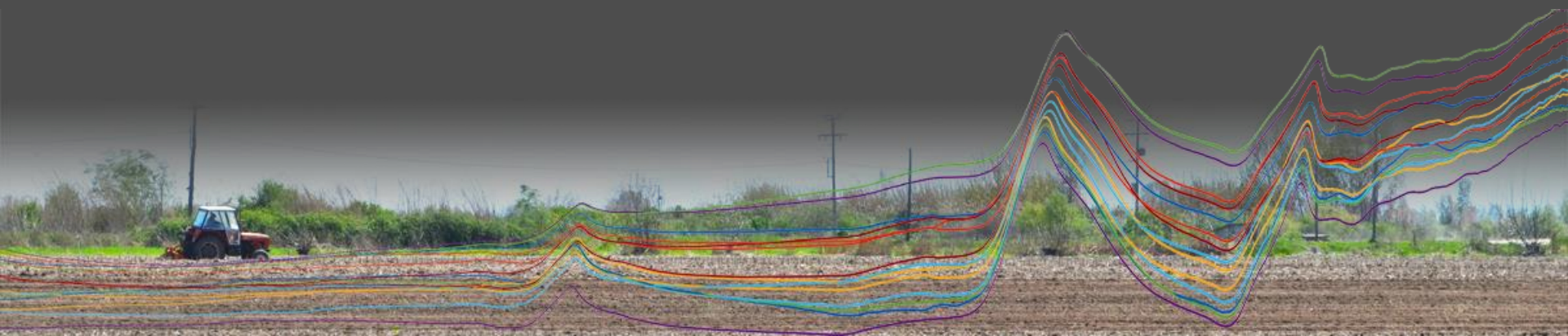
Advanced models trained on **EO-aware SSL data** obtained from larger extents, can be “localised”, taking advantage of optical and radar space-borne data to make predictions at larger scales



We have to expand our SSLs to MIR and TIR

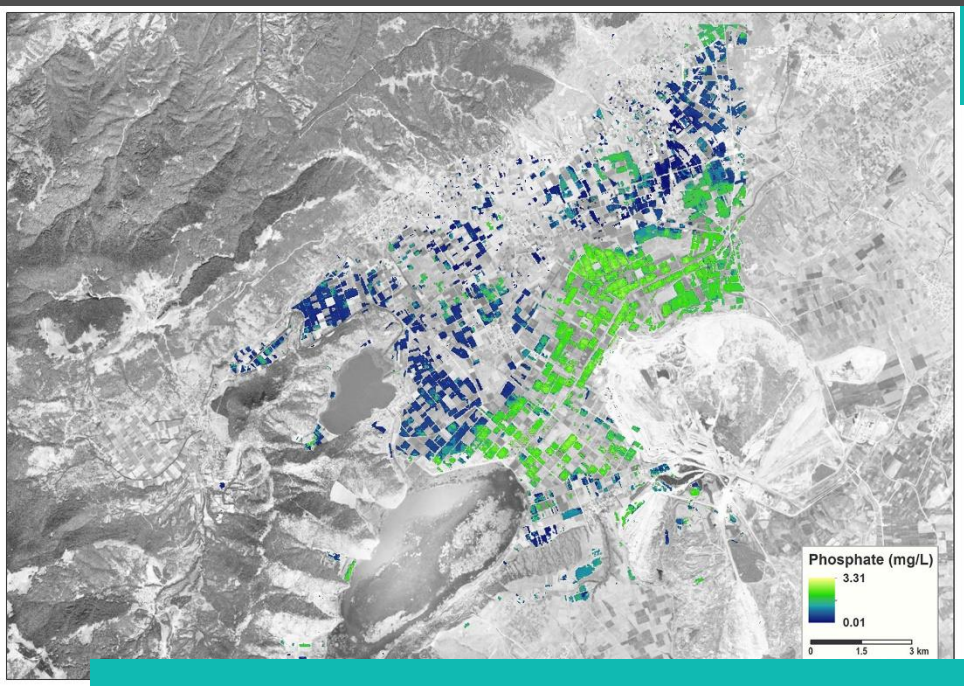
European Space Agency
Agence spatiale européenne

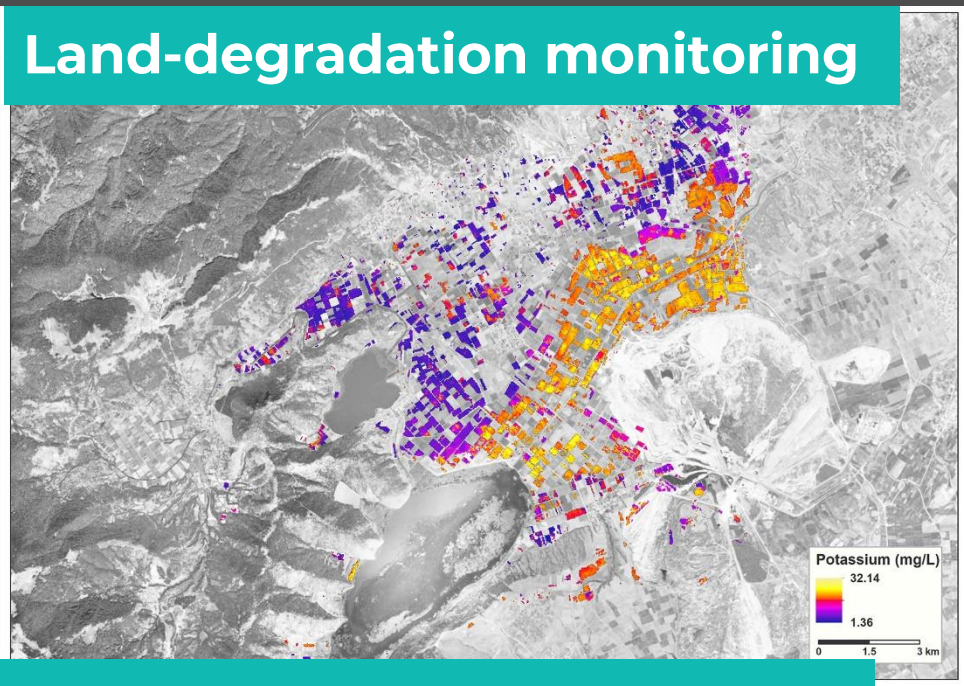
Hyper-spectral flights combined with in situ soil sampling for calibration was performed by a joint research team on behalf of ESA and EnMAP

EnMAP
Hyperspectral Imager

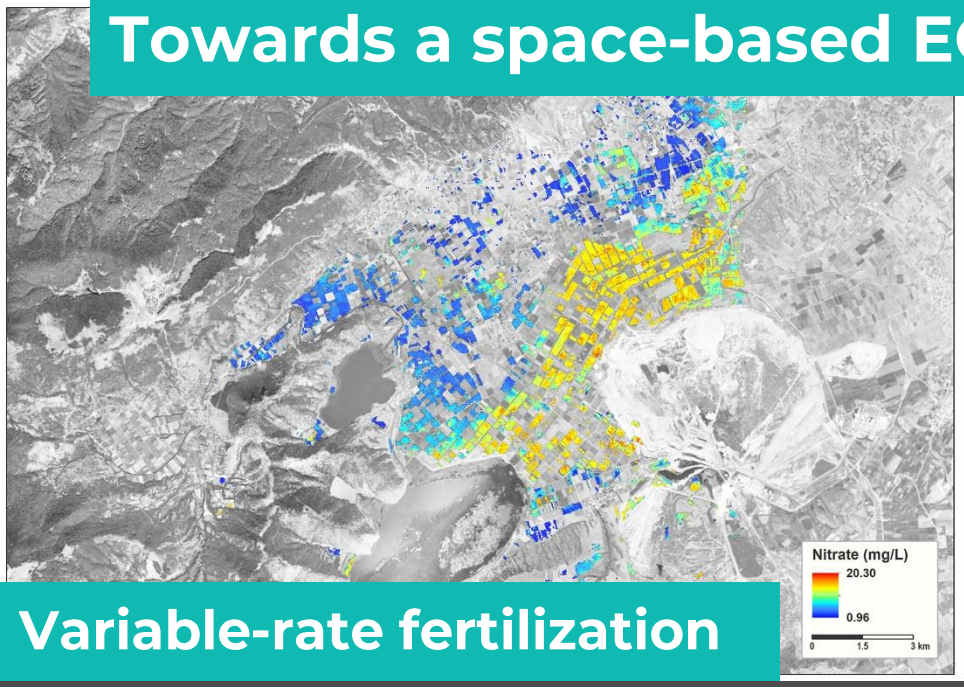
Towards a space-based EO soil monitoring system

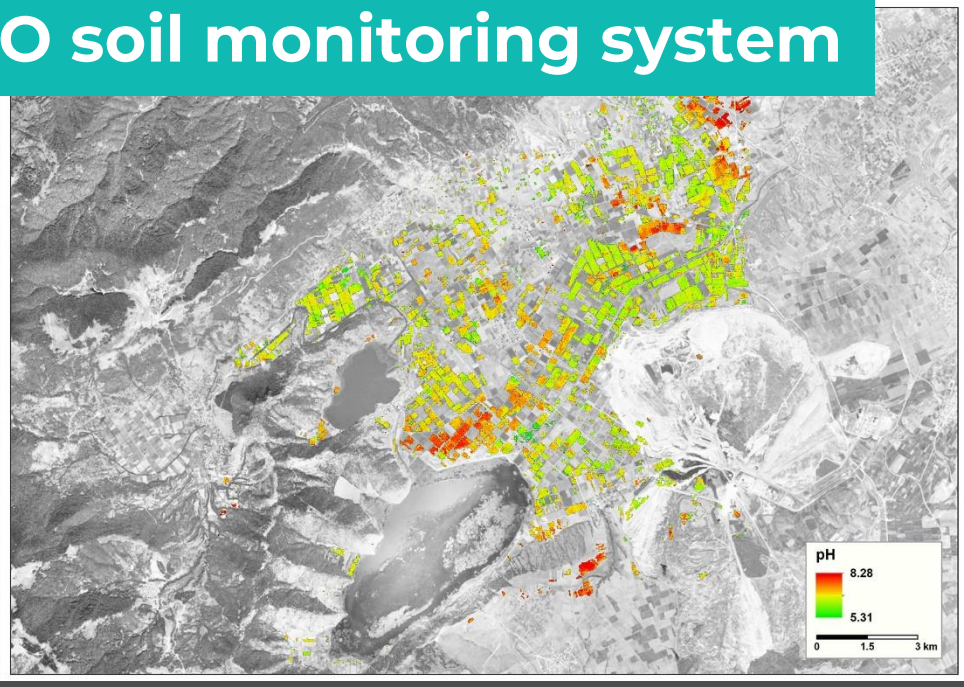
Land-degradation monitoring





Variable-rate fertilization

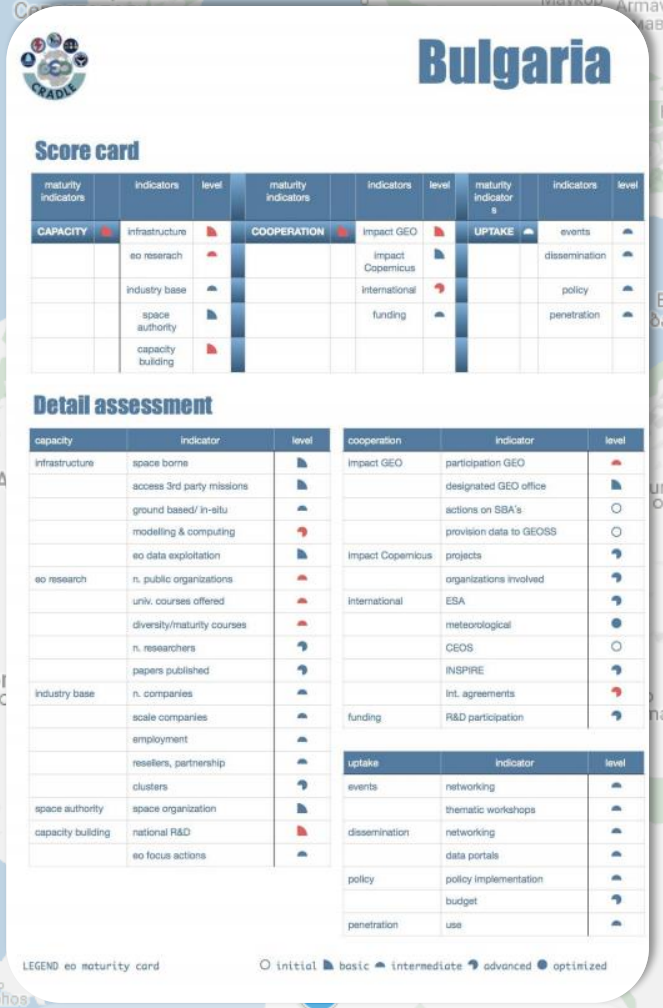




Assess the maturity level

CAPACITIES, COOPERATION and NATIONAL UPTAKE & AWARENESS

Develop "**Maturity Indicators**" as an independent and replicable methodology for the assessment and monitoring of maturity at national level (e.g. chemical and spectral analytics) -> example of GEO-CRADLE



Bulgaria

Score card

maturity indicators		indicators	level	maturity indicators		indicators	level	maturity indicators		indicators	level
CAPACITY		infrastructure		COOPERATION		impact GEO		UPTAKE		events	
		eo reserach				impact Copernicus				dissemination	
		industry base				international				policy	
		space authority				funding				penetration	
		capacity building									

Detail assessment

capacity	indicator	level
infrastructure	space borne	
	access 3rd party missions	
	ground based/ in-situ	
	modelling & computing	
	eo data exploitation	
eo research	n. public organizations	
	univ. courses offered	
	diversity/maturity courses	
	n. researchers	
	papers published	
industry base	n. companies	
	scale companies	
	employment	
	resellers, partnership	
	clusters	
space authority	space organization	
capacity building	national R&D	
	eo focus actions	

cooperation	indicator	level
impact GEO	participation GEO	
	designated GEO office	
	actions on SBA's	
	provision data to GEOSS	
impact Copernicus	projects	
	organizations involved	
international	ESA	
	meteorological	
	CEOS	
	INSPIRE	
	int. agreements	
funding	R&D participation	

uptake	indicator	level
events	networking	
	thematic workshops	
dissemination	networking	
	data portals	
policy	policy implementation	
	budget	
penetration	use	

LEGEND eo maturity card — initial, basic, intermediate, advanced, optimized

Ensure the GLOSOLAN implementation

CAPACITIES, COOPERATION and NATIONAL UPTAKE & AWARENESS

Select interregional players to boost these activities building on the concept of regional coordinator and HUBs

Common challenges – shared solutions
What to do next

The establishment of GLOSOLAN regional offices to act as boosting mechanisms

Collaboration and data sharing becomes important (e.g. blockchain)