

Satellite Earth Observations for Evaluation

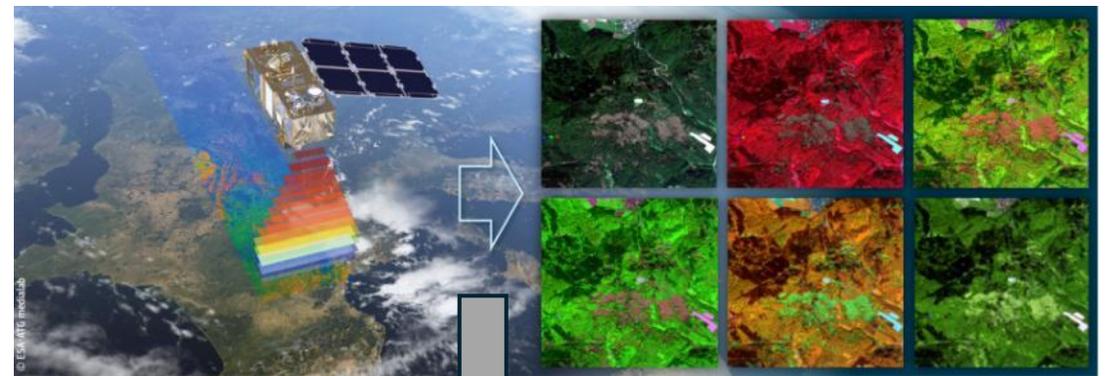
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Why this presentation

- To answer “*why to use Earth Observations in evaluation?*”
- To show an example of how to use Earth Observations for evaluation
- **What is an earth observation?**
- **How is information collected and delivered via satellites?**

Earth Observation is the process of gathering information about the Earth's surface, waters and atmosphere via ground-based, airborne and/or satellite remote sensing platforms



Markers

Biophysical or temporal indicators extracted from satellite data

Markers

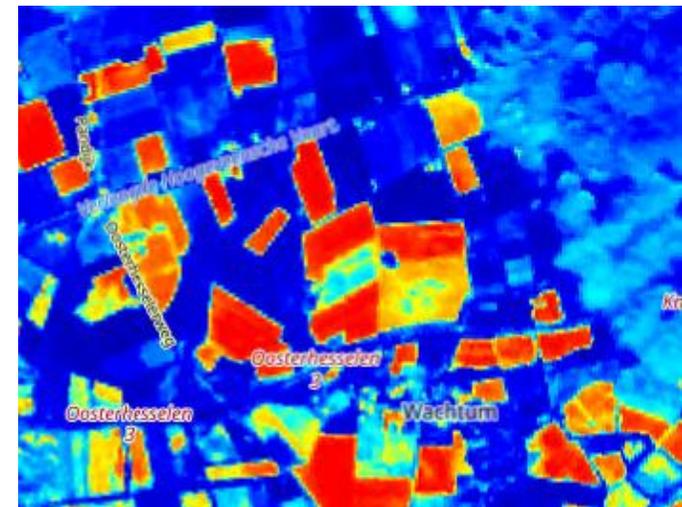
Parameter	Definition	Range	Use Case
LAI	Leaf area per ground area	0–10+	Photosynthesis modeling
FCOVER	Fraction of ground covered by vegetation	0–1 (0–100%)	Land cover mapping
NDVI	Vegetation "greenness"	-1 to +1	Crop health monitoring



The human eye perspective



The "NDVI" Perspective



The "Moisture Index" perspective

How can I use this information in evaluation?

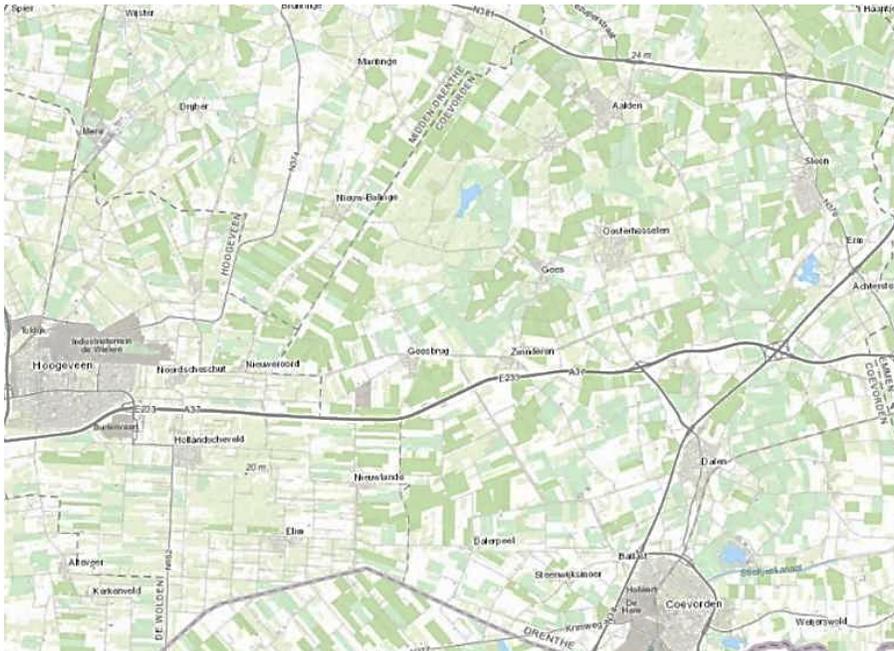
Case Study: Support to Cover Crops

Obligation: Cover crops established after 15th of October

Location: somewhere in the Netherlands

Evaluation Question: Which is the effectiveness of support to cover crops?

Effectiveness criterion: How much land remains covered?



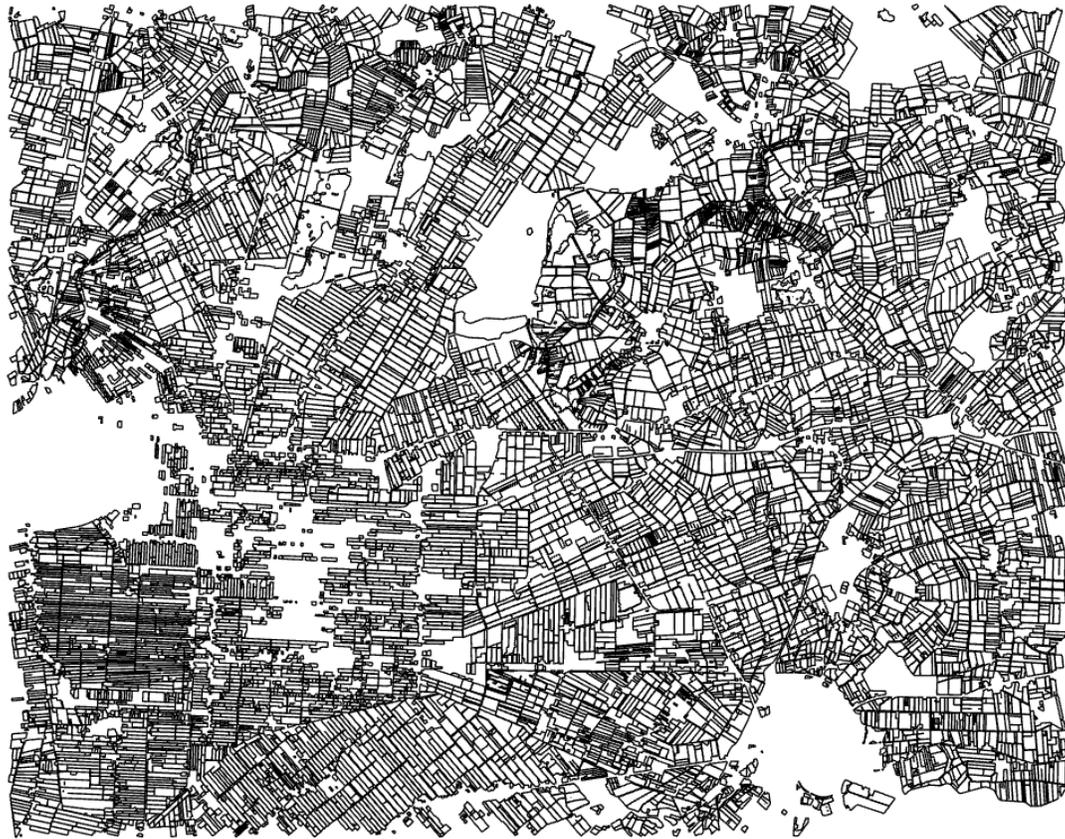
General land use



FCOVER: Fraction of ground covered by vegetation

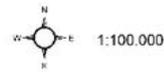
GSAA (GeoSpatial Aid Application):

The important glue to bring together land use, IACS/LPIS info and satellite readings



Land Use

- EFA catch crop
- Semi-natural area
- Arable
- Permanent plantation
- Grassland
- Fallow
- Greenhouse or nursery



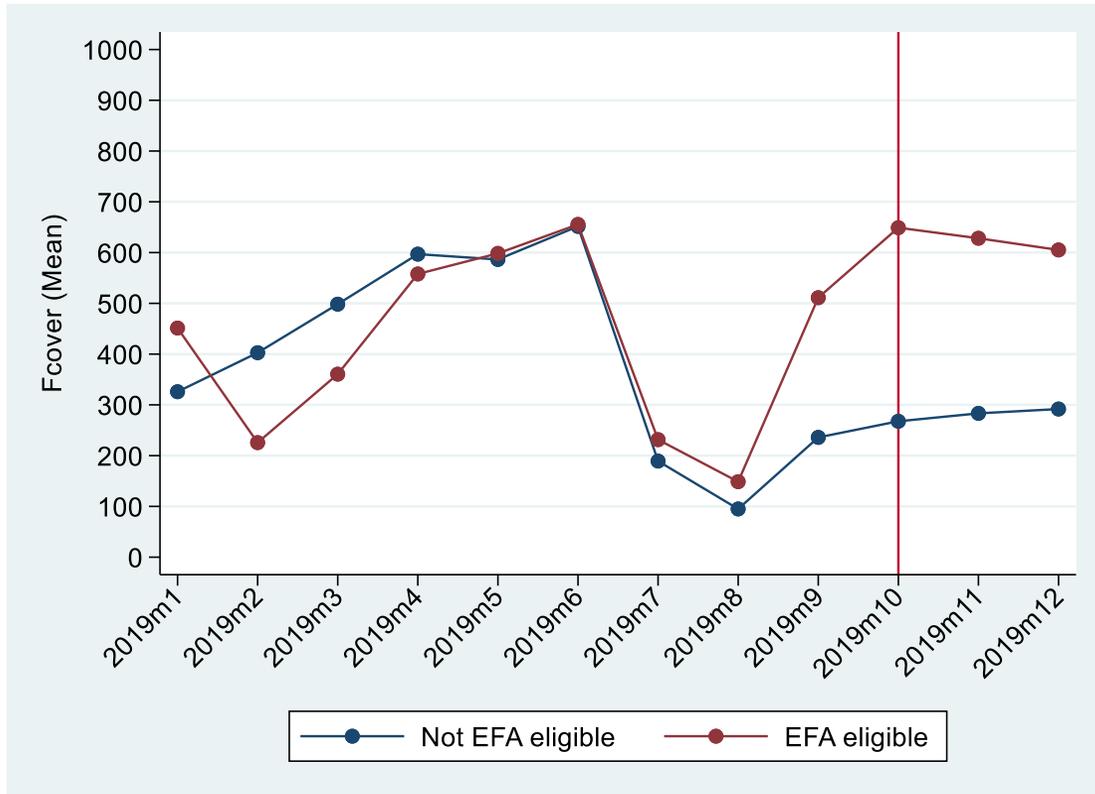
Data for each one of the plots in this area:

This is part of the data
each line is a plot

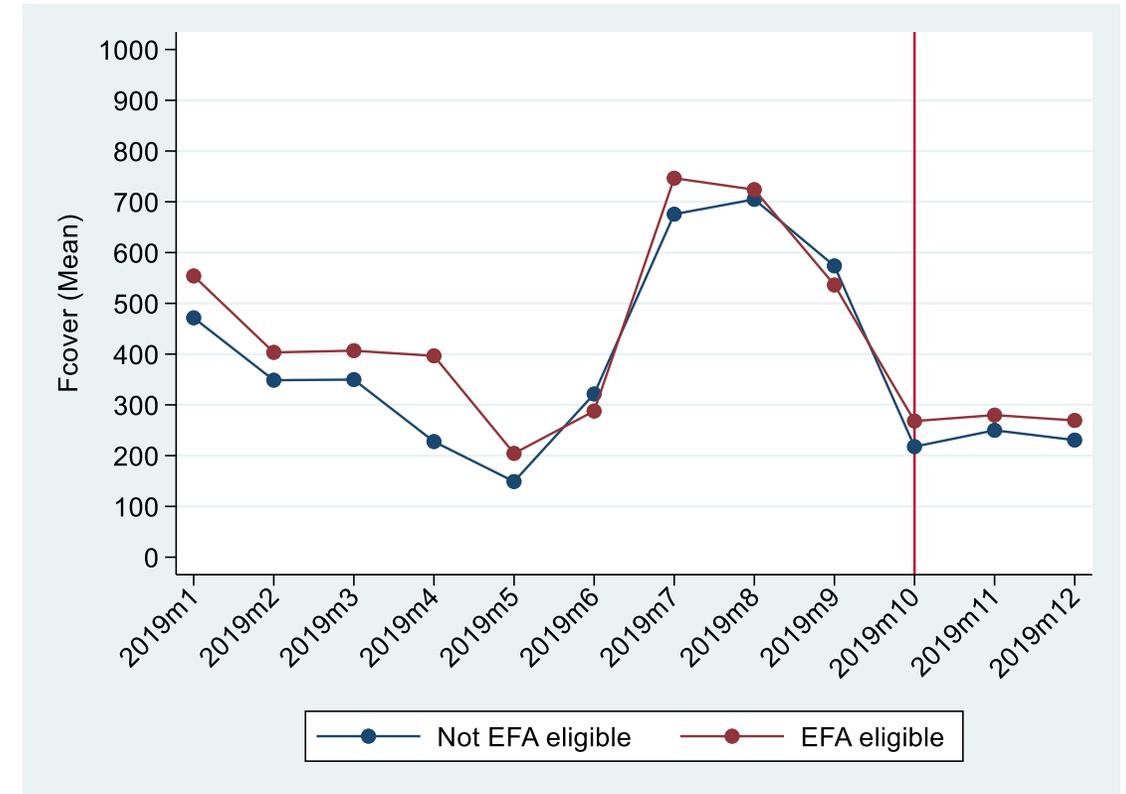
- Ownership (who cultivates the plot)
- Eligibility for cover crops support (declaration to EFA)
- Exact main crop and cover crop cultivation
- Location
- Every 5 days a value of the markers (FCOVER, NDVI, LAI)
- Big data: 73 observations per plot per year

oppervlak	grondbe	de	omschrijvi	NewID	HoldID	LC	CT_dec	efa_eli	EFA	Arable
6.830	259	Mais, snij-	2	361	1	153	0	0.00	1.00	
6.320	259	Mais, snij-	3	361	1	153	0	0.00	1.00	
1.990	259	Mais, snij-	5	362	1	153	0	0.00	1.00	
5.140	259	Mais, snij-	6	362	1	153	0	0.00	1.00	
1.600	259	Mais, snij-	11	613	1	153	0	0.00	1.00	
5.000	259	Mais, snij-	14	358	1	153	0	0.00	1.00	
10.130	259	Mais, snij-	23	358	1	153	0	0.00	1.00	
2.150	259	Mais, snij-	30	358	1	153	0	0.00	1.00	
3.730	2017	zetmeel Aardappelen,	35	93	1	131	1	1.00	1.00	
6.470	2017	zetmeel	36	93	1	131	0	0.00	1.00	
10.860	234	Tarwe, zomer-	48	106	1	142	1	1.00	1.00	
9.280	256	Bieten, suiker-	49	106	1	13	0	0.00	1.00	
1.130	233	winter- Tarwe,	50	106	1	151	1	1.00	1.00	
0.240	233	winter-	51	106	1	151	1	1.00	1.00	

The evolution of the average satellite FCOVER observation through out 2019 (month 1st to 12th) for 3 main crops for beneficiaries and non-beneficiaries

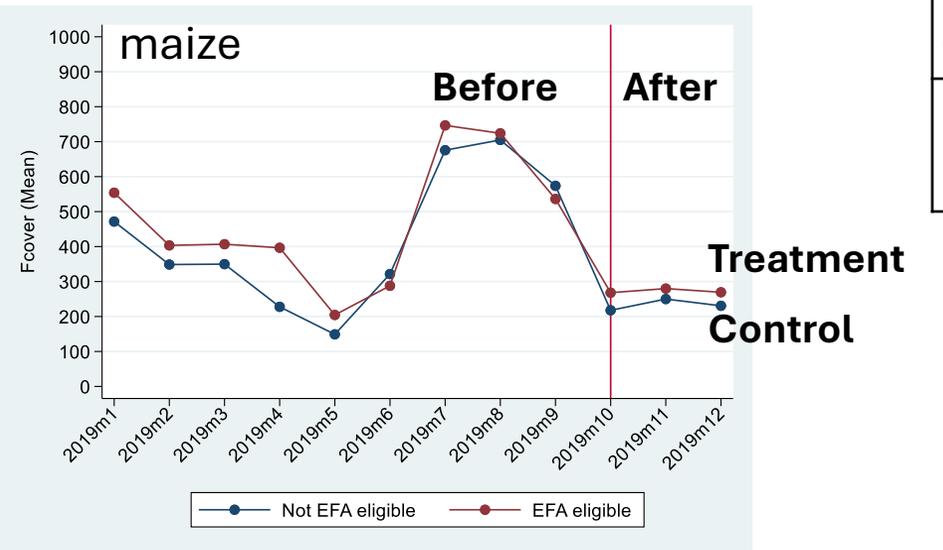
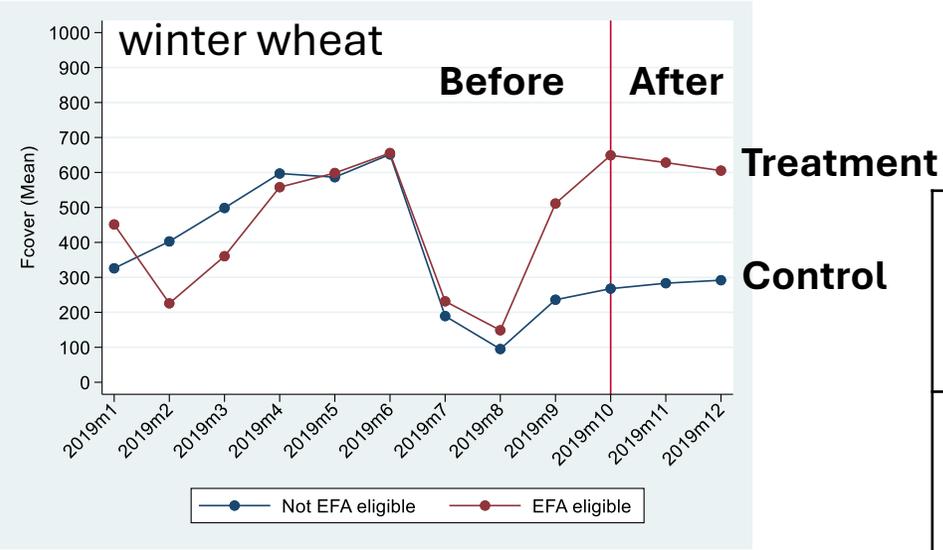


winter wheat



maize

Difference in Differences (DiD)



	Before 15/10 2019			After 15/10 2019			(DiD)
	Control	Treatment	Difference Before	Control	Treatment	Difference After	
Winter wheat	452.6	432.6	-20.0 (15.58)	274.2	637.7	363.5*** (40.35)	383.6*** (44.05)
Maize	424.0	745.4	51.6*** (15.26)	207.7	254.9	47.2** (14.96)	-4.2 (42.28)

How can I use this in netting out a PMEUF indicator?

Soil erosion:

$$E = R \times K \times C \times LS \times P \quad (\text{RUSLE equation})$$

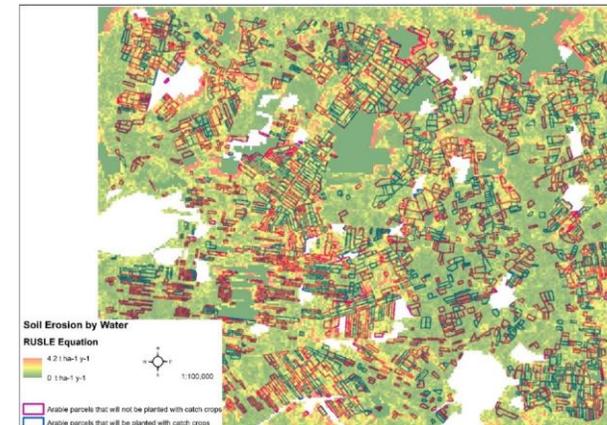
$$C_{arable} = C_{crop} \times C_{management}$$

$$C_{management} = C_{tillage} \times C_{cover} \times C_{residues}$$

$$C_{cover} = \frac{1 - imp}{e^{LU} * FCover}$$

If nothing else changes but the cover crops, then this change in C_{cover} due to cover crops can be reflected directly into a change in erosion and the risk to soil loss (PMEF impact indicator I.13).

Do I have a baseline? YES

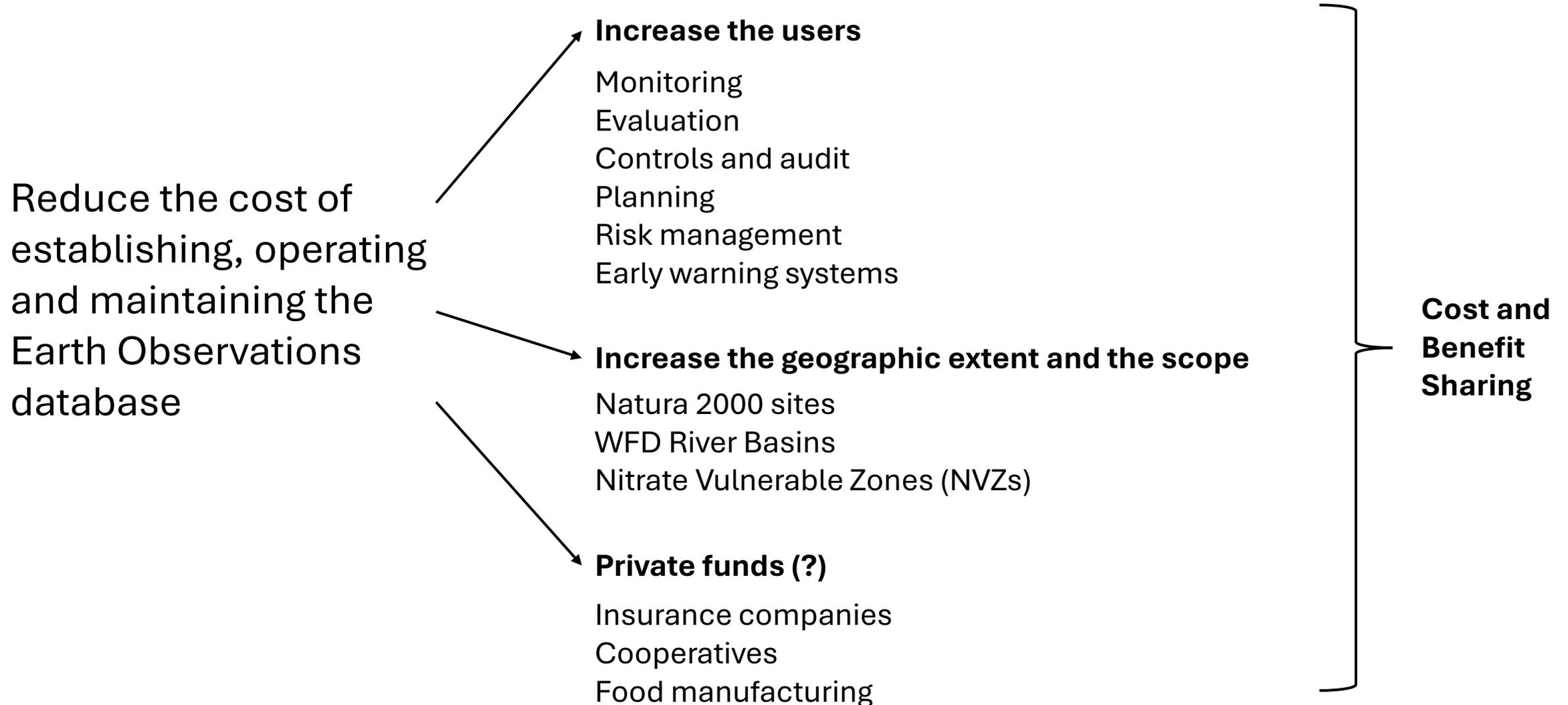


Map of soil erosion in Europe, 2013

Where else can I use Earth Observations?

PMEF Indicator	EO Marker	Application
CLIMATE		
I.11: Carbon sequestration	LAI, NDVI, FAPAR	LAI quantifies leaf density (carbon uptake); NDVI/FAPAR track vegetation productivity.
I.10: GHG mitigation	CH₄/CO₂ flux maps, FCOVER	FCOVER identifies wetlands (CH ₄ hotspots); NDVI detects deforestation (CO ₂ release).
WATER		
I.17: Water use in agriculture	NDWI, ET (Evapotranspiration)	NDWI monitors vegetation water content; ET estimates irrigation needs.
I.17: Water use in agriculture	Radar (Sentinel-1), NDWI	Radar detects surface water; NDWI maps flood extent.
I.09 (part): Water stress	SWI (Soil Water Index), NDVI	SWI measures root-zone soil moisture; NDVI detects drought-induced vegetation stress.
SOIL		
I.11: Soil organic carbon	FCOVER, NDVI	Low FCOVER/NDVI = bare soil exposure; correlates with RUSLE's C-factor.
I.13: Soil erosion by water	SMI (Soil Moisture Index), Sentinel-2 SWIR	SWIR bands estimate organic matter; SMI links moisture to decomposition rates.
BIODIVERSITY		
I.22: Crop diversity	NDVI, Spectral Diversity Index	NDVI measures greenness; spectral diversity proxies species richness.
I.22: Land cover change	FCOVER, Land Cover Maps	FCOVER trends detect fragmentation; land cover maps classify habitat loss.

Here is the catch: How to Make Earth Observations Appealing?



...thank you



This work was possible due to the efforts of:

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- **Valdis Kudins**, Evaluation Manager, Evaluation Helpdesk

Appendix: Most frequently used markers

Marker	What It Measures	Satellite Source
NDVI	Vegetation health/greenness	Sentinel-2, Landsat, MODIS
LAI	Leaf area per ground area (photosynthesis capacity)	Sentinel-2, PROBA-V
FCOVER	Ground covered by vegetation	Sentinel-2, Copernicus Global Land
NDWI	Water content in vegetation/water bodies	Sentinel-2, Landsat
LST	Surface temperature (energy balance)	MODIS, Landsat Thermal Bands
SWI	Root-zone soil moisture	SMAP, Sentinel-1 (radar)