CLMS: operational NRT products to tackle environmental crimes

Environmental Crimes Workshop 2024

Simone Balbo - JRC

11-12 June 2024

PROGRAMME OF THE EUROPEAN UNION

Copernicus Europe's eyes on Earth

Land Monitoring

Implemented by European Environment Agency

European Commission

The Copernicus Land Monitoring Service (CLMS)

Land Monitoring

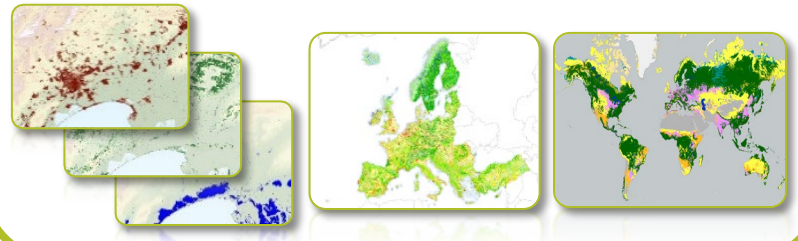
- Land cover and land use mapping
- Priority area monitoring
- Satellite data
- Bio-geophysical parameters
- Ground motion monitoring
- Reference and validation data

- **Geographical** information on **land cover and its changes, land use, vegetation** state, **water cycle** and Earth's surface **energy variables** on European and global levels for environmental applications
- **Harmonized** and **consistent** in time and space
- Products and manuals are **free** and **open**
- Implemented by **JRC** and **EEA**
- Website: https://land.copernicus.eu/

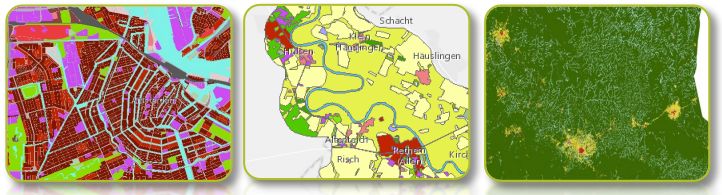
Land Monitoring

CLMS overview

Land cover and land use mapping

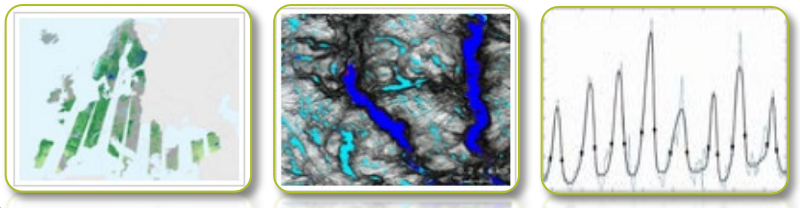


Priority area monitoring

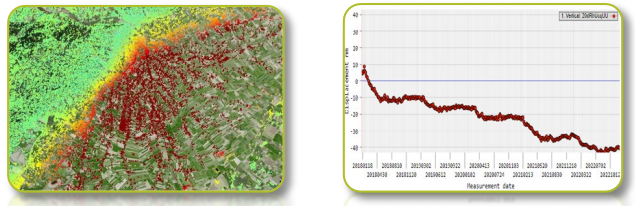


Satellite data

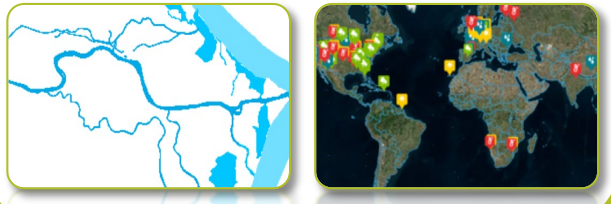
Bio-geophysical parameters



Ground motion monitoring

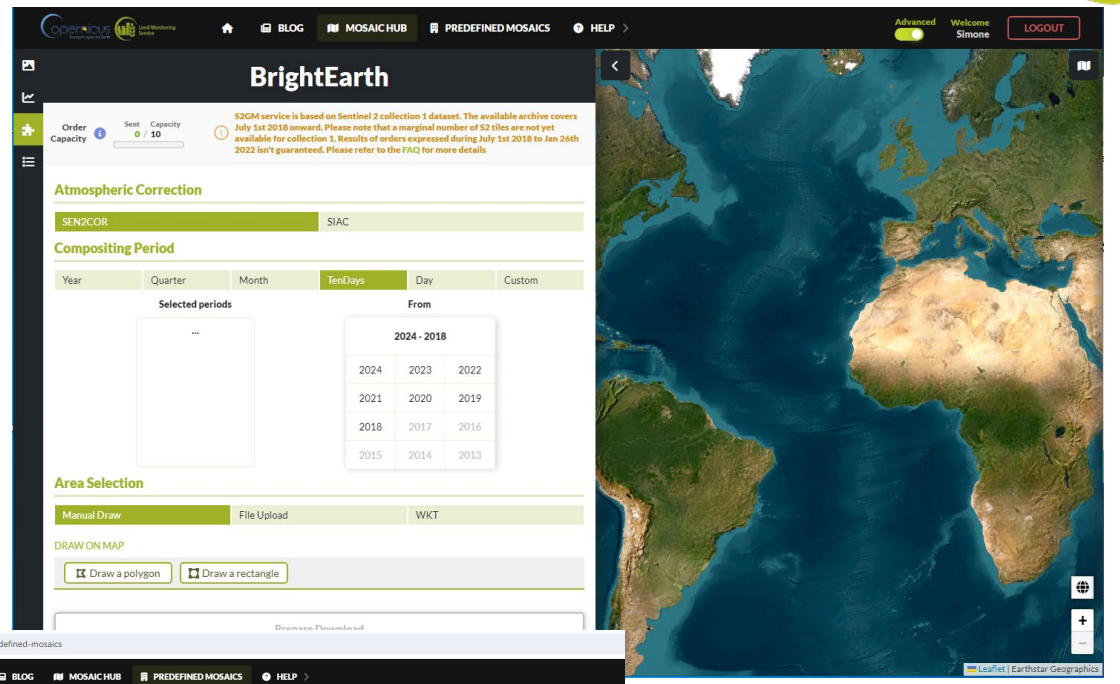


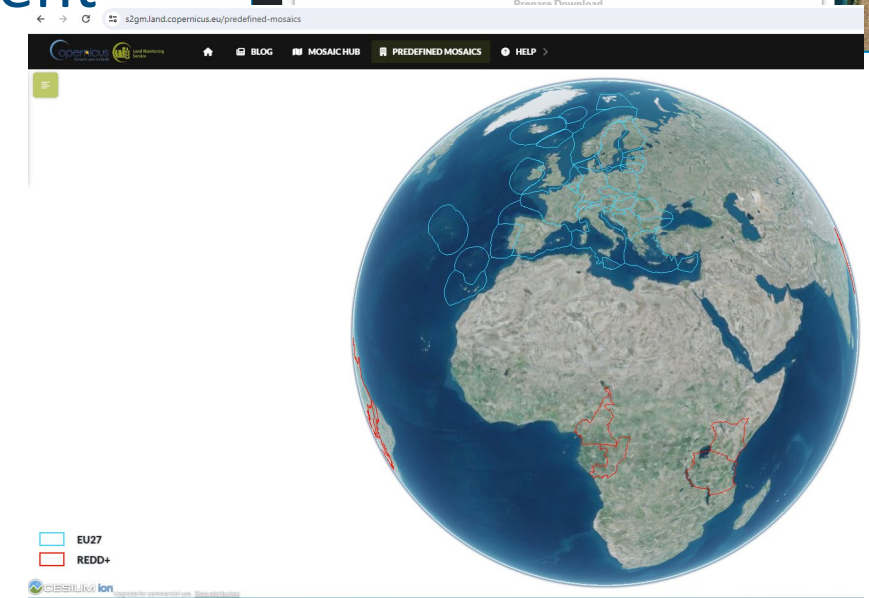
Reference and validation data



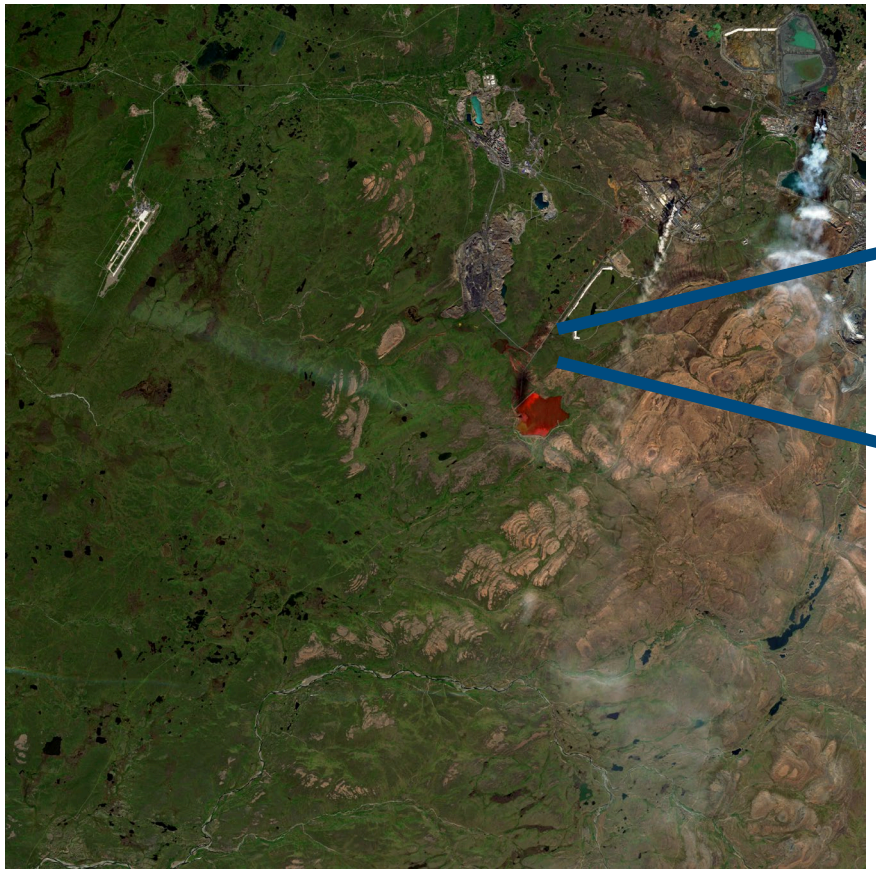
Sentinel-2 On-Demand Mosaic

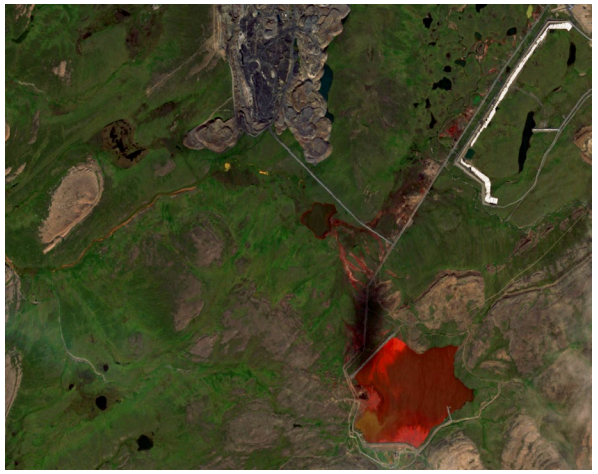
- mosaic surface reflectance products
- provides images and Analysis Ready Data for further thematic processing
- foundation for a wide range of applications
- forest monitoring, urban settlement monitoring



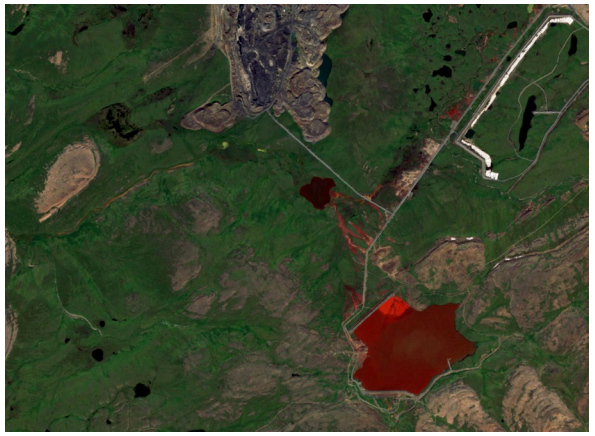


S2GM use case - Noril'sk (Siberia)





Aug 2022

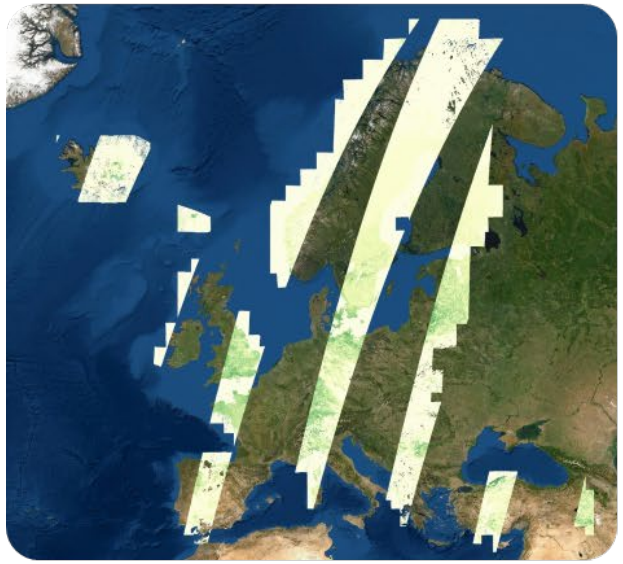


Aug 2023

- "Blood-red Siberian river reminds us that mining is a risky business" [The conversation - 2016]
- "Siberian River Has Turned Red Before, Satellite Show" [Earth Observatory – NASA earthobservatory.nasa.gov]

HR-Vegetation Phenology & Productivity

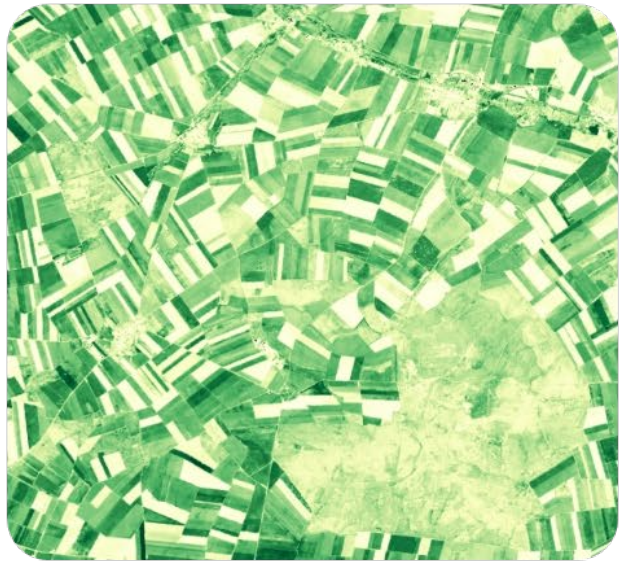
Vegetation Indices



Daily (NRT)

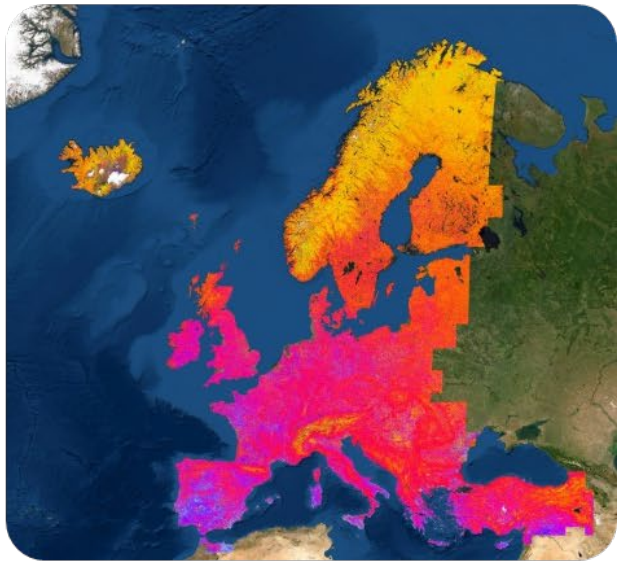
- ✓ PPI
- ✓ FAPAR
- ✓ LAI
- ✓ NDVI
- ✓ Quality Flag

Seasonal Trajectories



10 Days
(Plant Phenology Index)

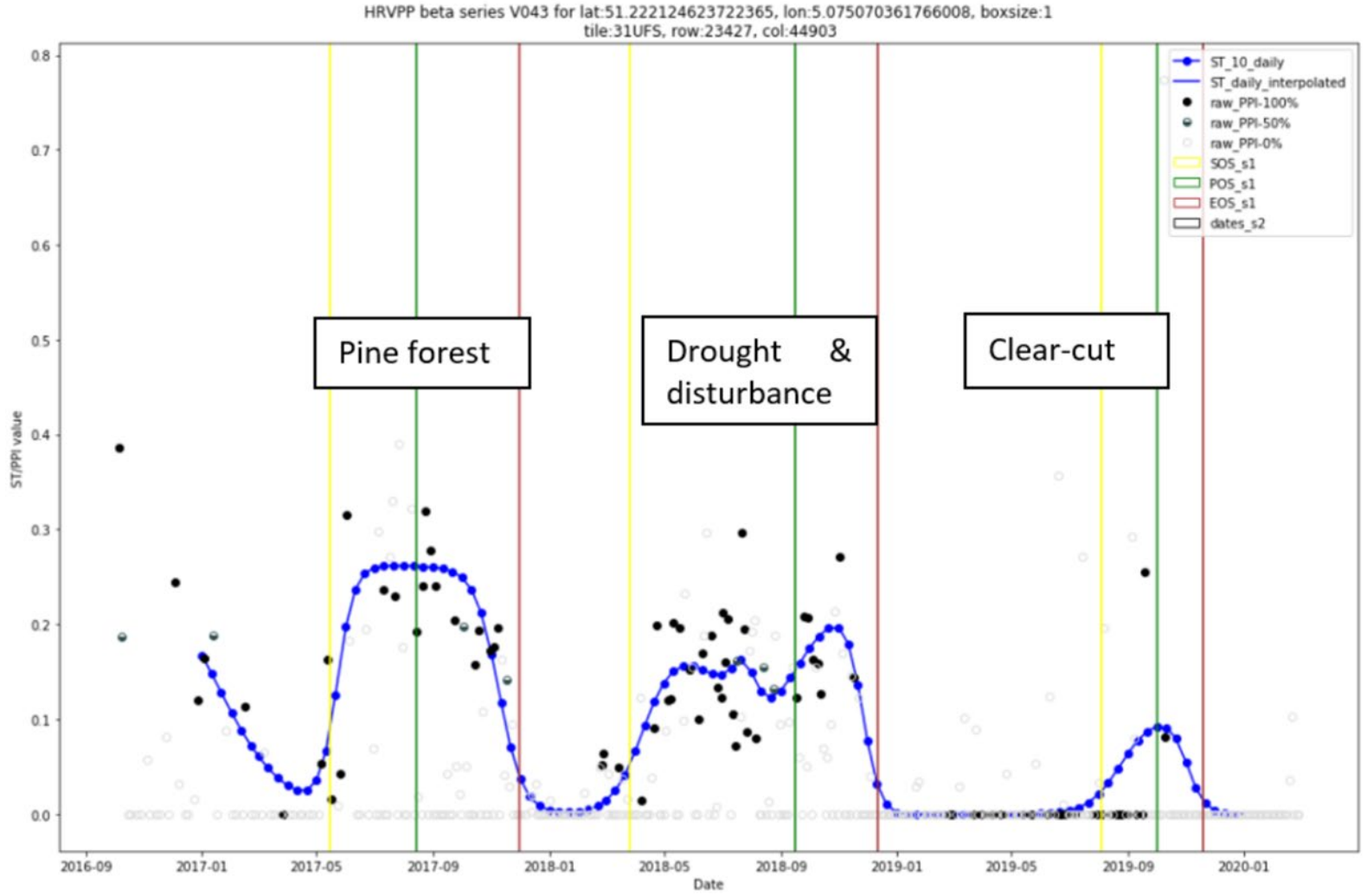
Phenology & Productivity



Yearly (2 seasons)

- ✓ Start-of-Season
- ✓ End-of-Season
- ✓ Season length
- ✓ Season Max
- ✓ Season Min
- ✓ Amplitude
- ✓ Slope of green up/down
- ✓ Seasonal Productivity
- ✓ Total Productivity

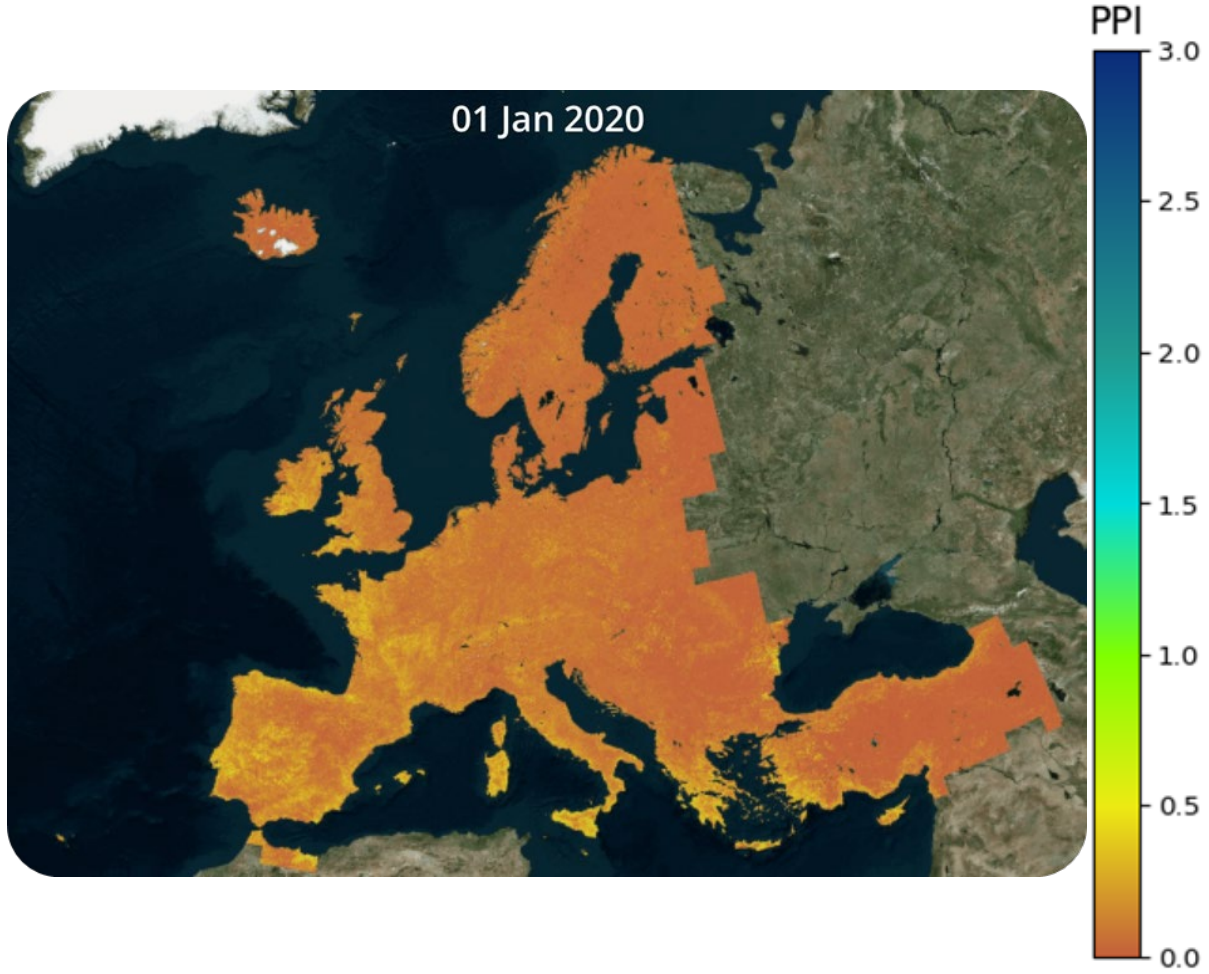
HR-Vegetation Phenology & Productivity



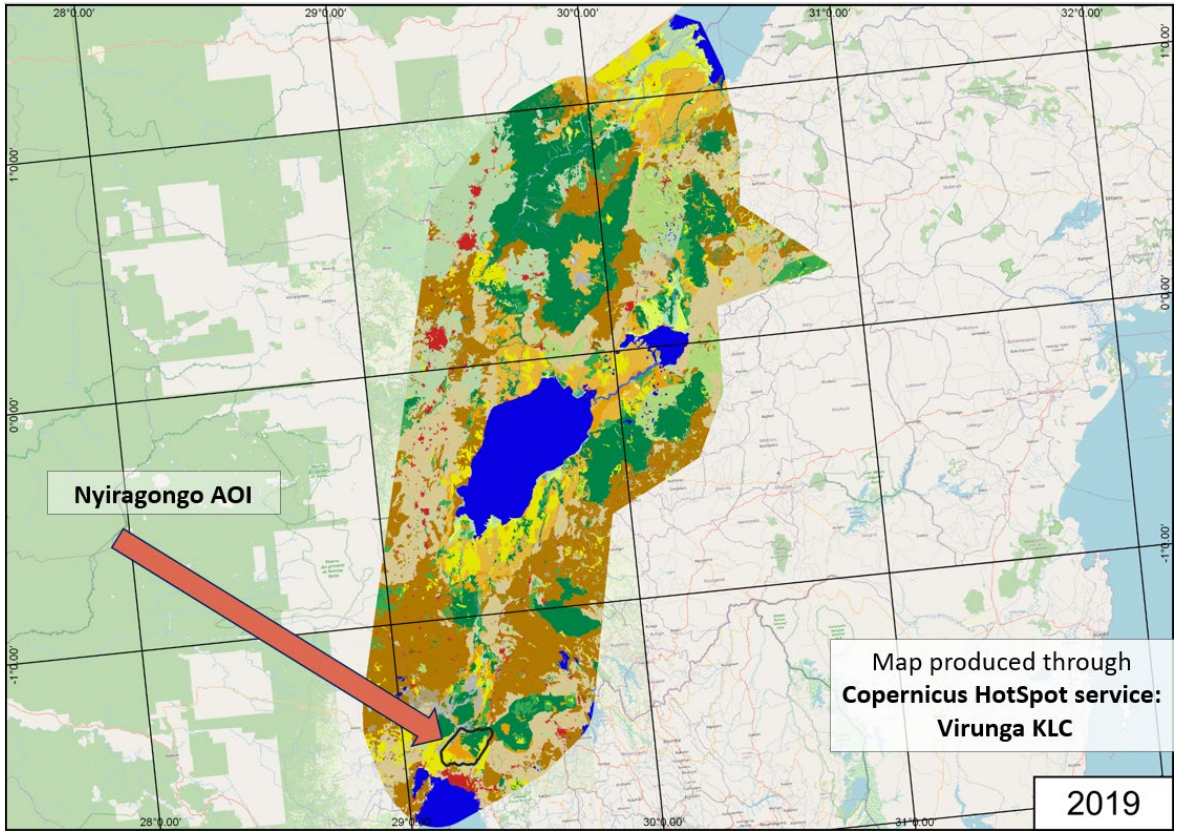
HR-Vegetation Phenology & Productivity

- 2017-2023
- **10 meter annual** processing of **Phenology & Productivity** metrics.
- **Near Real-Time**: vegetation indices & biophysical variables

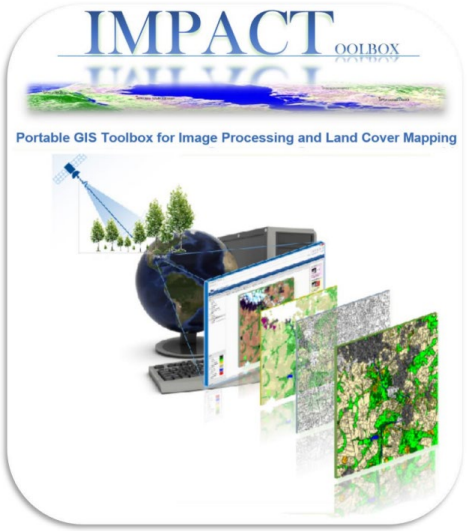
- **Future prospects**:
  - Tree Cover **Disturbances**
    - **Minimum**: Timeliness, Magnitude, Duration, Recovery/Regeneration
    - **Goal**: Biotic, Abiotic, Anthropogenic
  - **Biomass** Productivity (GPP/NPP)

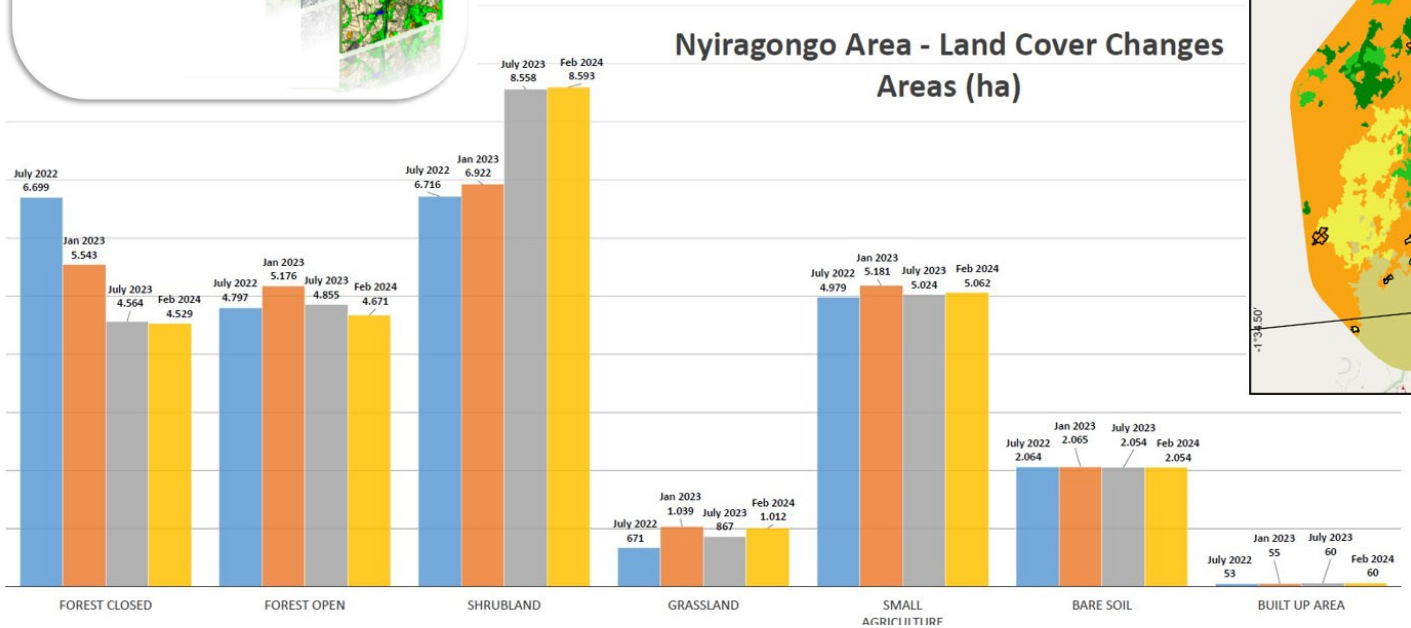


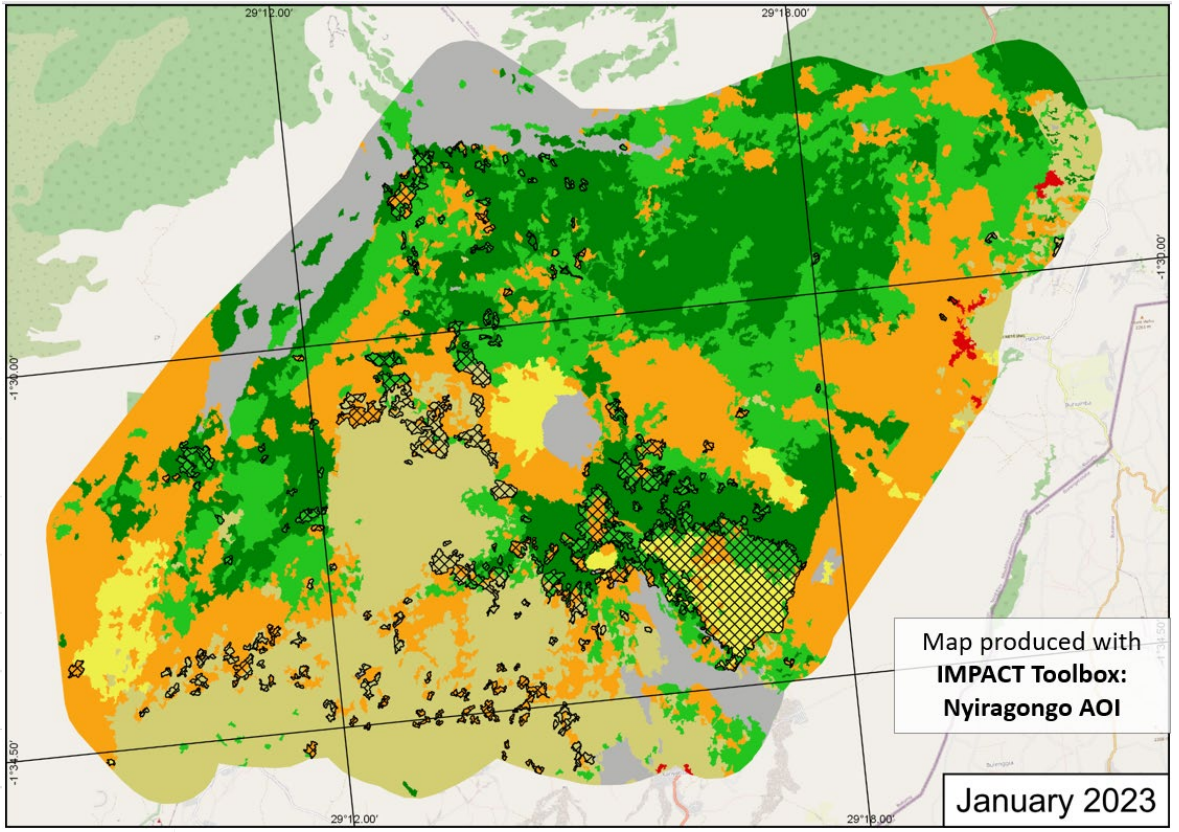
Hot Spot Monitoring



Hot Spot Monitoring – use case

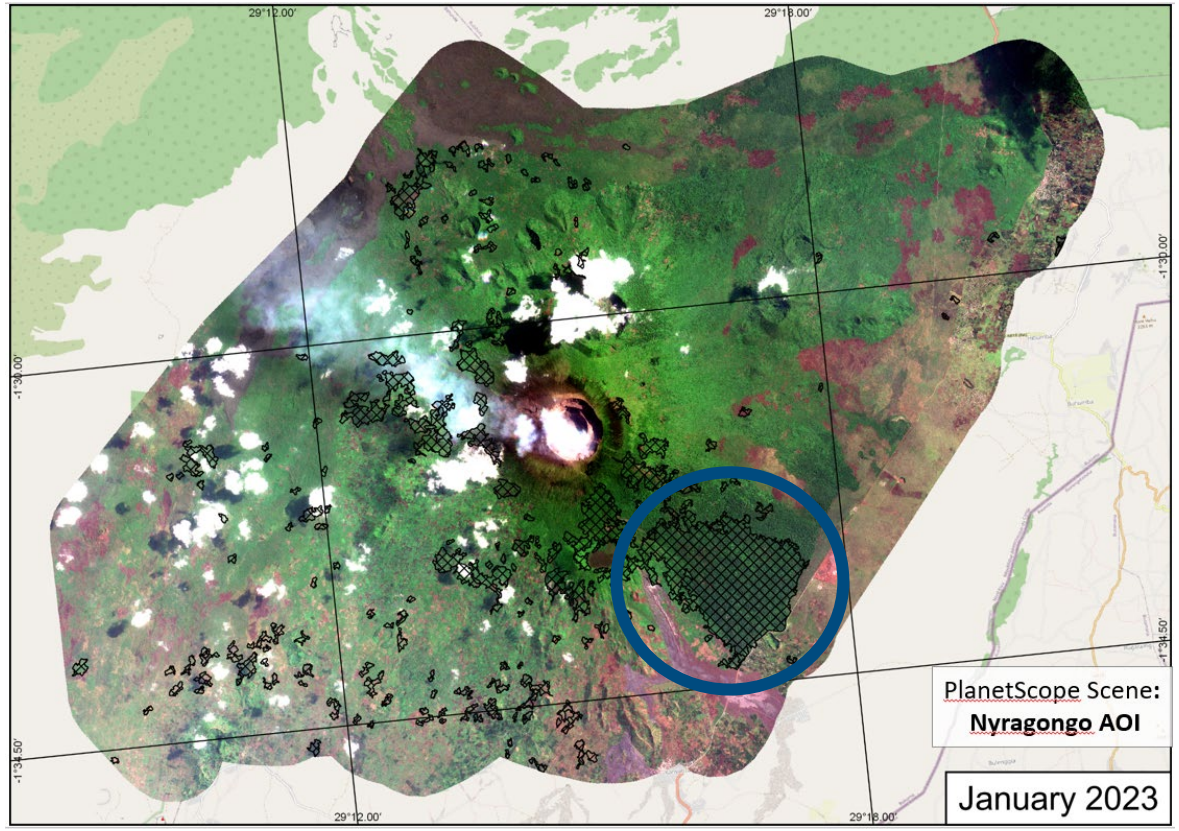


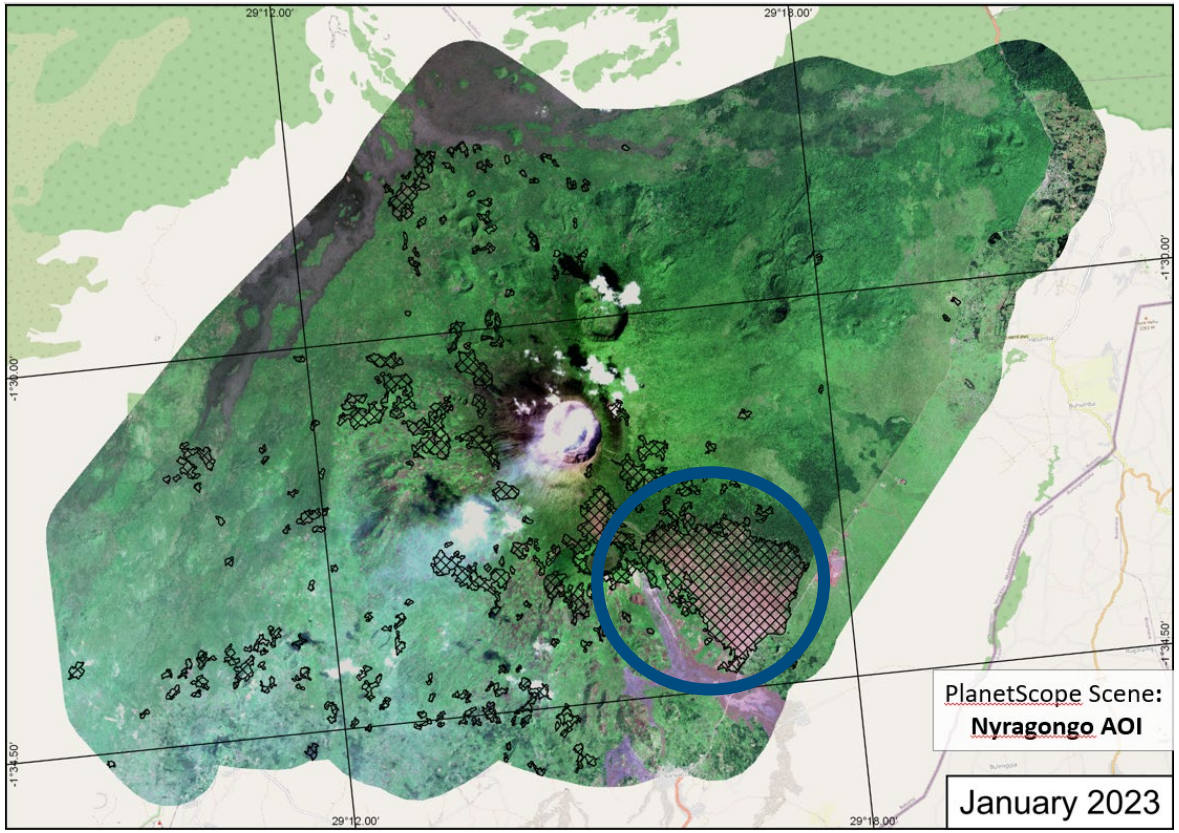




https://forobs.jrc.ec.europa.eu/IMPACT

Hot Spot Monitoring – use case





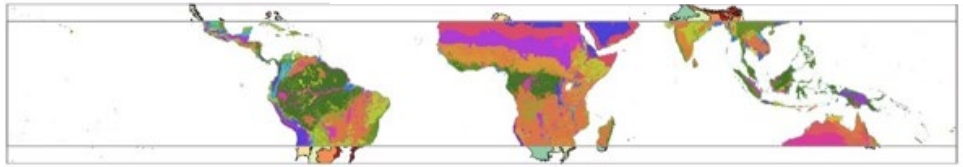
"In DRC, Virunga deforestation escalates as fighting sends refugees into park" – Mongabay – news.mongabay.com

Future: Land Cover & Forest Monitoring

Land Cover Characteristics	Land Surface Categories	Land Cover Map	Land Cover Change Map	Land Cover Map	Land Cover Change Map	Land Cover Characteristics
Sub-annual	Sub-annual	Annual	Annual	Annual	Annual	Annual
10m	10m	10m	10m	100m	100m	10m
2020-2026	2020-2026	2020-2026	2021-2026	2020-2026	2021-2026	2020-2026
Per pixel based feature extractions	Categories of direct observable surface properties	Land cover map minimum of 11 land cover classes	Annual land cover changes	Land cover map, cover fraction layers	Annual land cover changes	Per pixel based yearly statistics

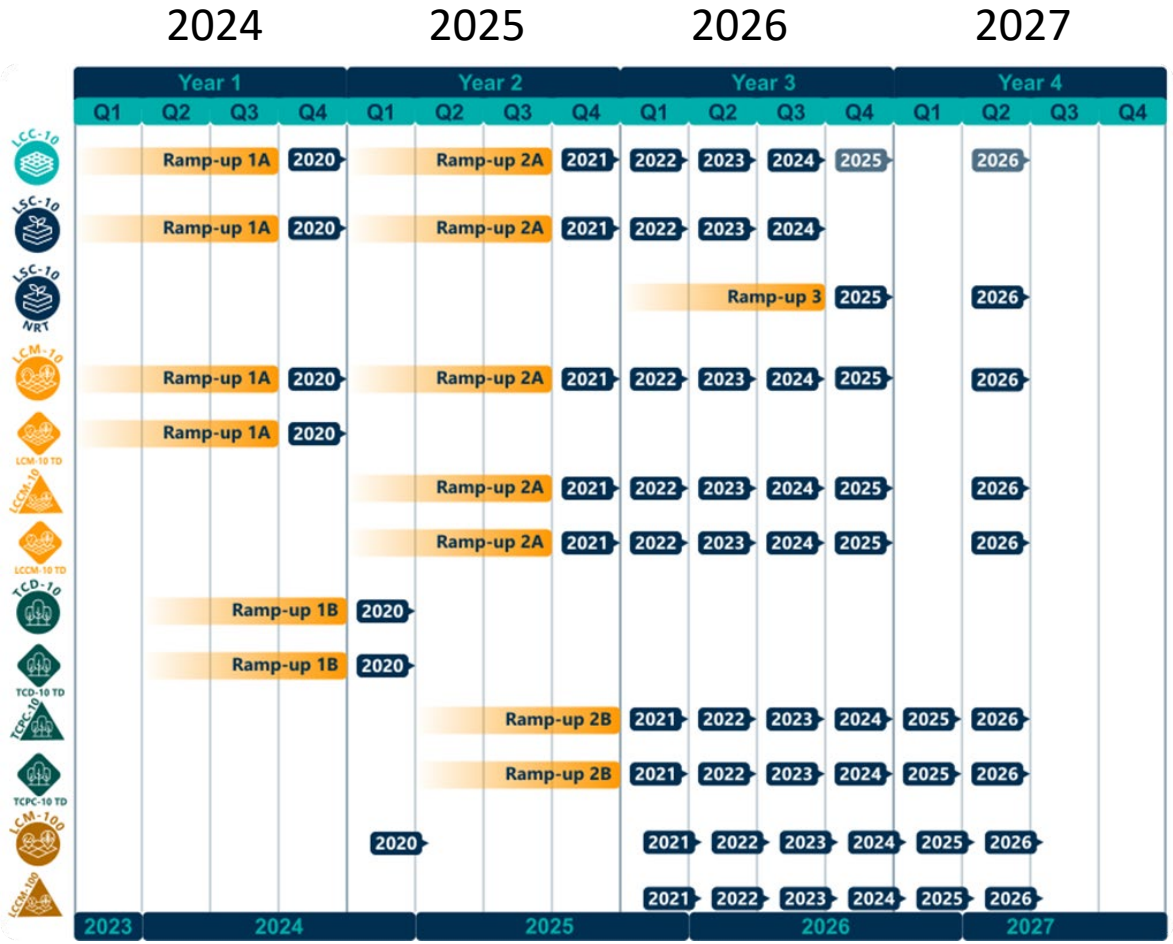
Tree Cover Density	Tree Cover Presence Change
Annual	Annual
10m	10m
2020	2021-2026
Tree cover in percent per pixel	Annual tree cover presence changes

- Intermediate products for further analysis/processing
- Global coverage/tropical coverage
- Increased spatial resolution -> 10 m
- Unprecedented combination of spatial and temporal resolution

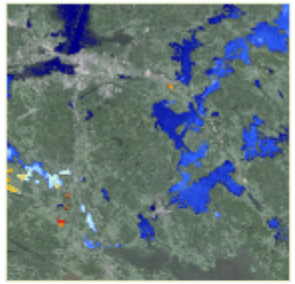


Future: LCFM – Activities & Timing

- **10 month ramping-phase** for the activities to deliver prototype product (10%) (2020, 2021)
- Subsequently 2 months roll-out to 100%
- Subsequent years: 3 month delivery schedule
- **Sub-annual products: first produced at monthly interval (2020-2023), transitioning to 10 days (2024), and NRT updates (2025, 2026)**
- Internal map product validation



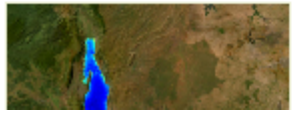
Lake Water Quality



Lake Water Quality 2019-present (raster 100 m), global, 10-daily – version 1

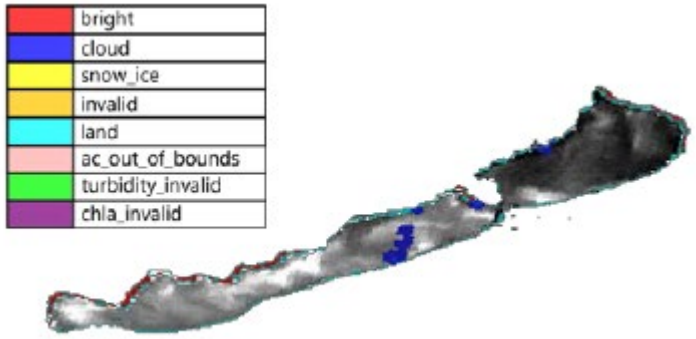
Provides semi-continuous observations for a large number of medium and large-sized lakes, according to the Global Lakes and Wetlands Database (GLWD) or otherwise of specific environmental monitoring interest. 10-daily observations are available in near real time in the spatial resolution of 100 m and and with the temporal extent from 2019 to present.

View more | Download



Lake Water Quality 2016-present (raster 300 m), global, 10-daily – version 1

Provides semi-continuous observations for a large number of medium and large-sized



Lake Water Quality – product layers

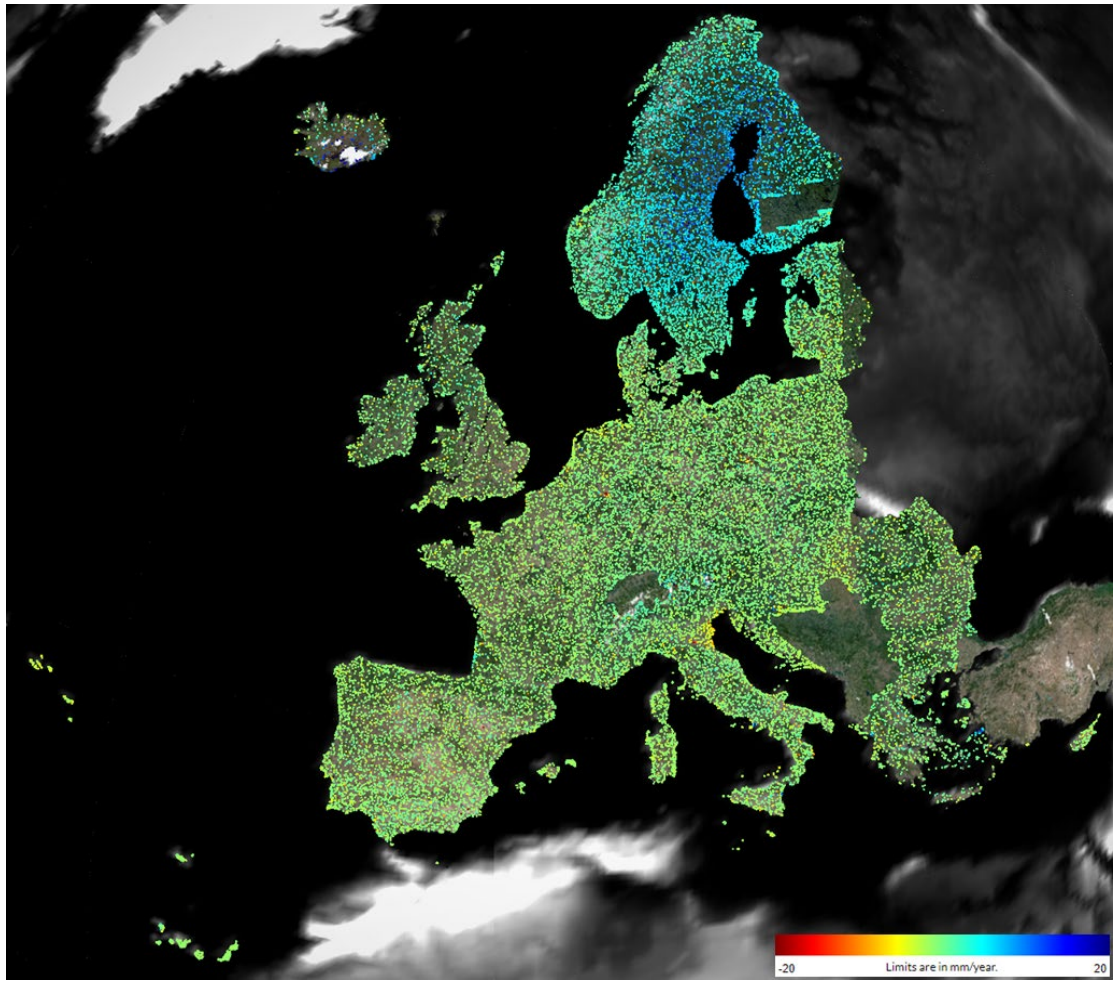
Lake Water Quality

AVAIL.	GEOGR. COVERAGE	TEMP. RESOL.	SPATIAL RESOL.	EO DATA SOURCES
2019 - present	Global	10-daily	100 m	Sentinel-2 MSI
2016 - present	Global	10-daily	300 m	Sentinel-3 OLCI

- **Mean turbidity**
- **Trophic state index (TSI)** obtained from chlorophyll-a observations, averaged over the observation period
- Fully normalized **water leaving reflectances** at different waveband
- Ancillary layers – number of (valid) observations
- **Future: v2**, with accuracy estimations

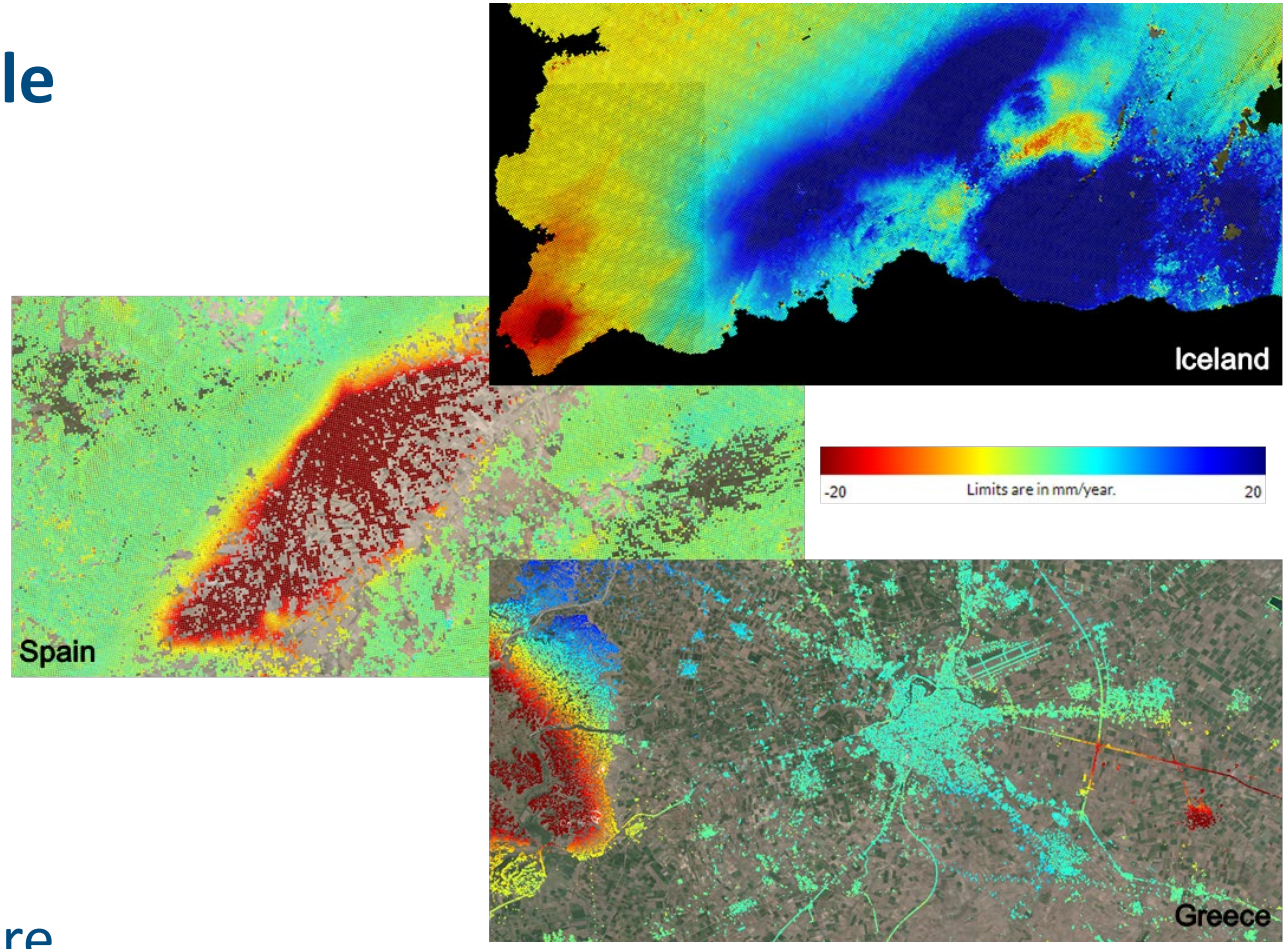
EGMS

- The EGMS products provide a high-density, continental-scale map of ground motion
- It is produced using data collected by the Sentinel-1 radar satellite mission
- Each measurement point has a value of ground motion velocity and a time series
- It covers the Copernicus participating countries

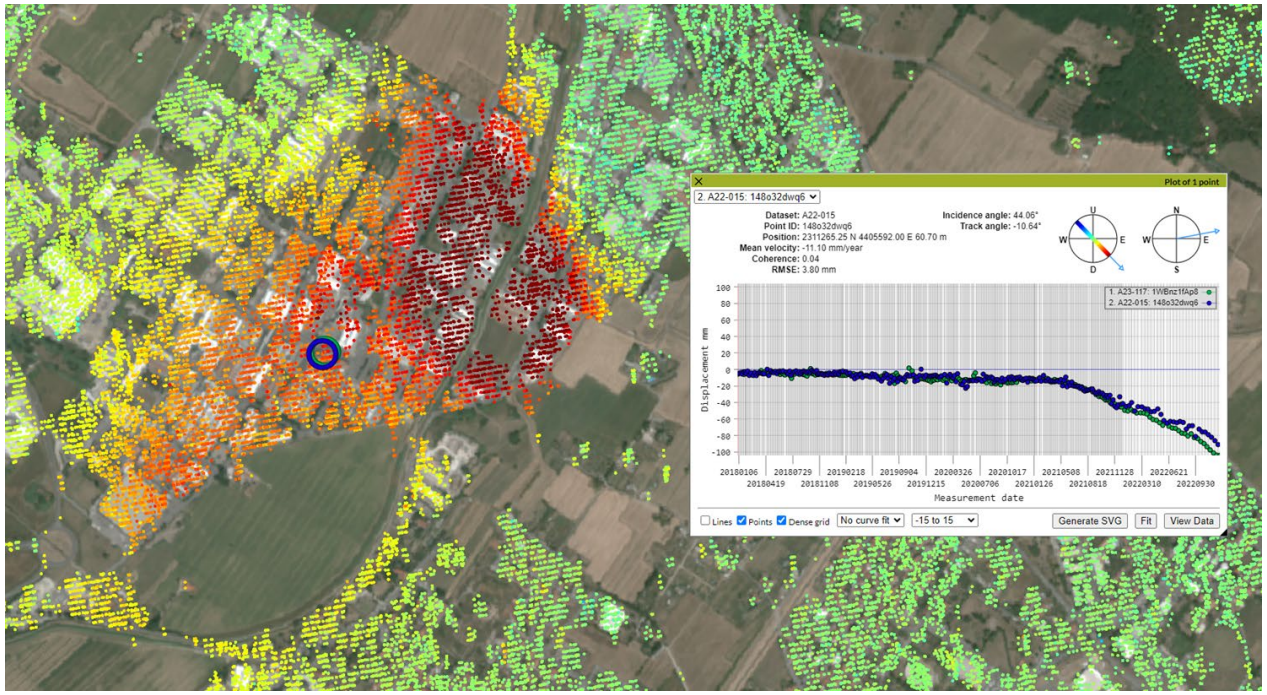


What does the EGMS measure?

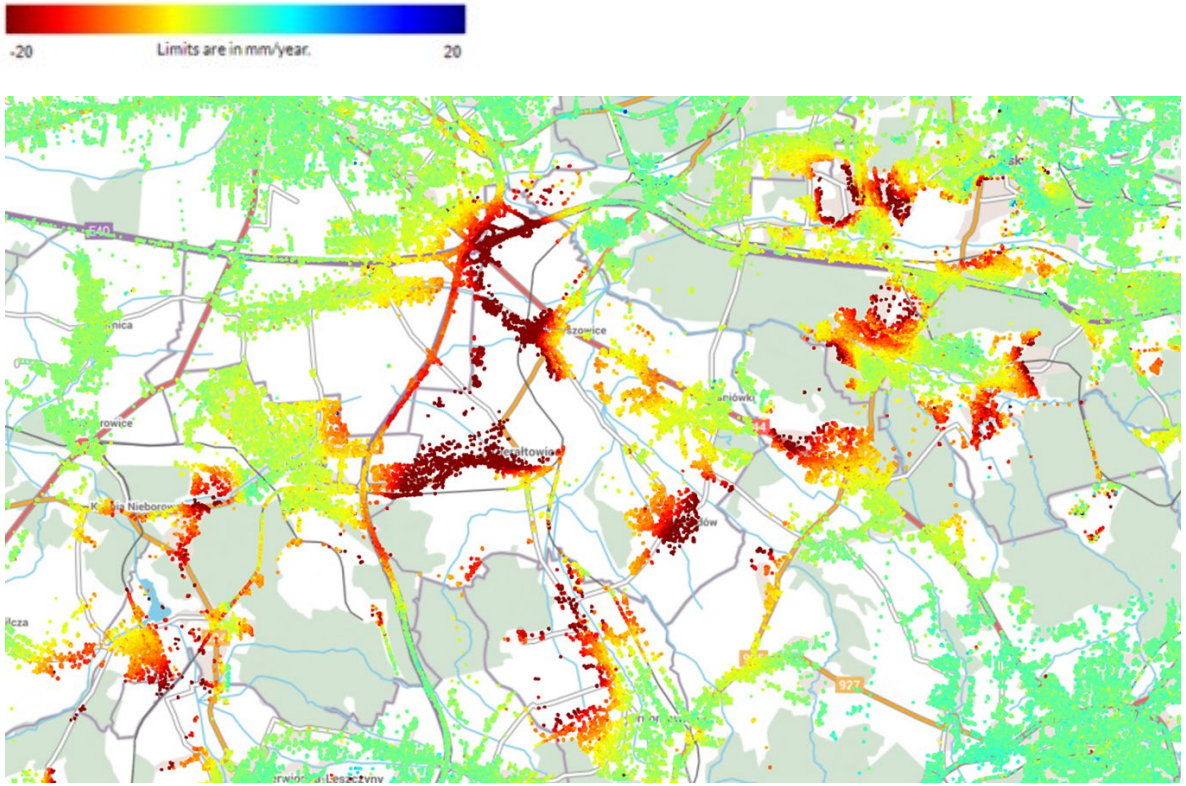
- EGMS measures the **millimetric-scale** motion, over-time, of ground reflecting features.
- **Reflecting features** may be natural, like bare rocks, or anthropogenic structures.
- This allows for **measuring** and **mapping**:
  - Land subsidence
  - Landslides and slope phenomena
  - Uplift (natural or anthropogenic)
  - Movement of larger-scale infrastructure



EGMS use cases



Unreported groundwater exploitation, Italy



Effects of underground mining, South Poland

CLMS – Support to environment compliance assurance

- Capacity:
  - Trust, continuity/stability, reliability
  - Variety of themes
  - Continuous monitoring
  - NRT products
  - Time-series
- Needs:
  - Storage and processing challenge
  - Timeliness
  - F4P: JRC dashboard
  - Downstream applications/services

Thank you!

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