



Earth Observation in Hungary

Overview and examples

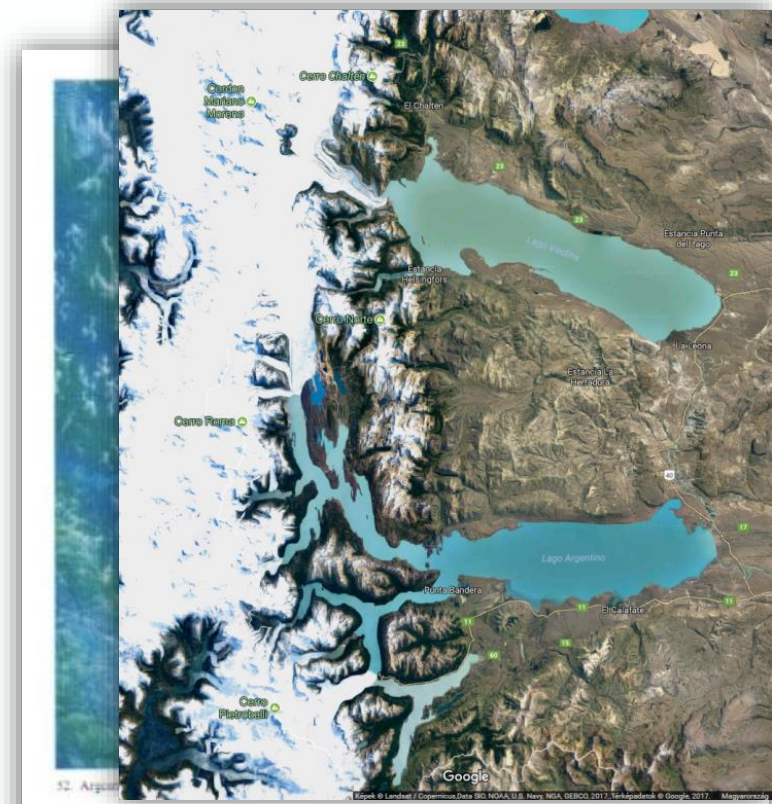
Dániel Kristóf

Lechner Knowledge Centre, EO Unit
& MFA - Hungarian ESA Delegation



The beginnings

- Preparation of Hungarian cosmonauts for Earth Observation tasks (1978-80) at the Satellite Geodetic Observatory (SGO), Penc



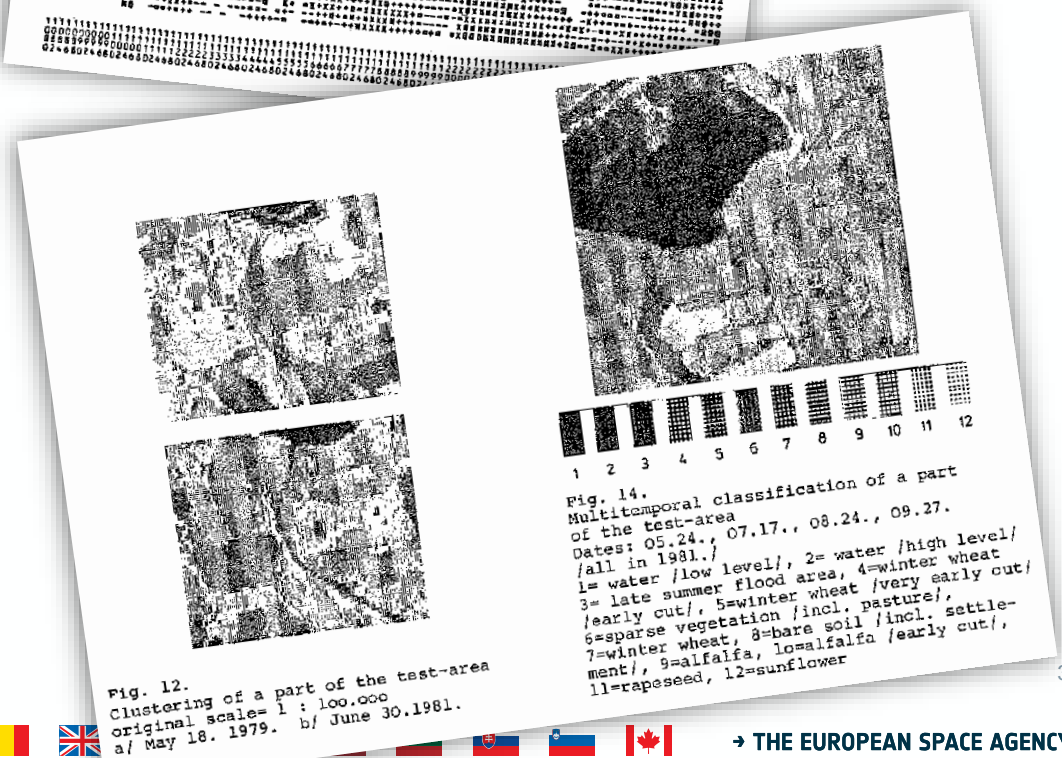
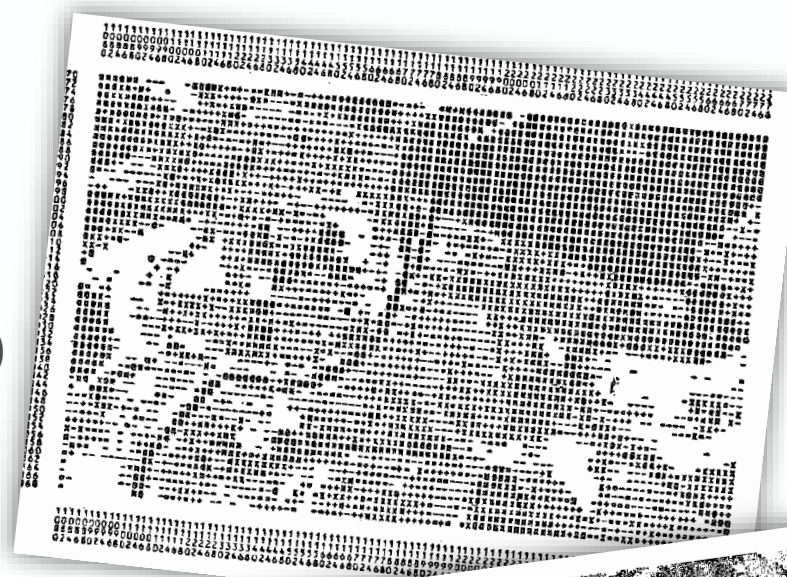
Landsat image from Google Maps

Arg (Ar

javas alkalmazásaink használata során a szerzők földrajzi szélességen lévő nyugati, enyhe, óceáni klímájú szigeteken és hegyoldalakon, ahol a hó még csak 600 ... 850 m felett maradt meg. A Delli Andok utolsó, nagy magasságba emelkedő csúcsai (Cerro Marillón 3600 m, Cerro Bermejo 3370 m) jól kirajzolódnak. Az úrfelvételek egyik legjobban értékelhető területe a hegyes táj. A csaknem össze-

Early developments

- 1980: FÖMI declared responsible for RS activities by law
 - For resolutions < 80m (below 50m: classified)
 - >80m: Hungarian Meteorological Service (OMSz)
- FÖMI Department of Remote Sensing
 - From former FÖMI / KGO personnel and other institutions (SZTAKI, ELTE)
 - Own developments - due to restrictions
- Long-term RS strategy, operational developments
 - Hungarian Agricultural Remote Sensing Program (MTP/HARSP)
 - Long-term contracts among FÖMI, Ministry of Agriculture and the Comm. for Technolog. Dev.



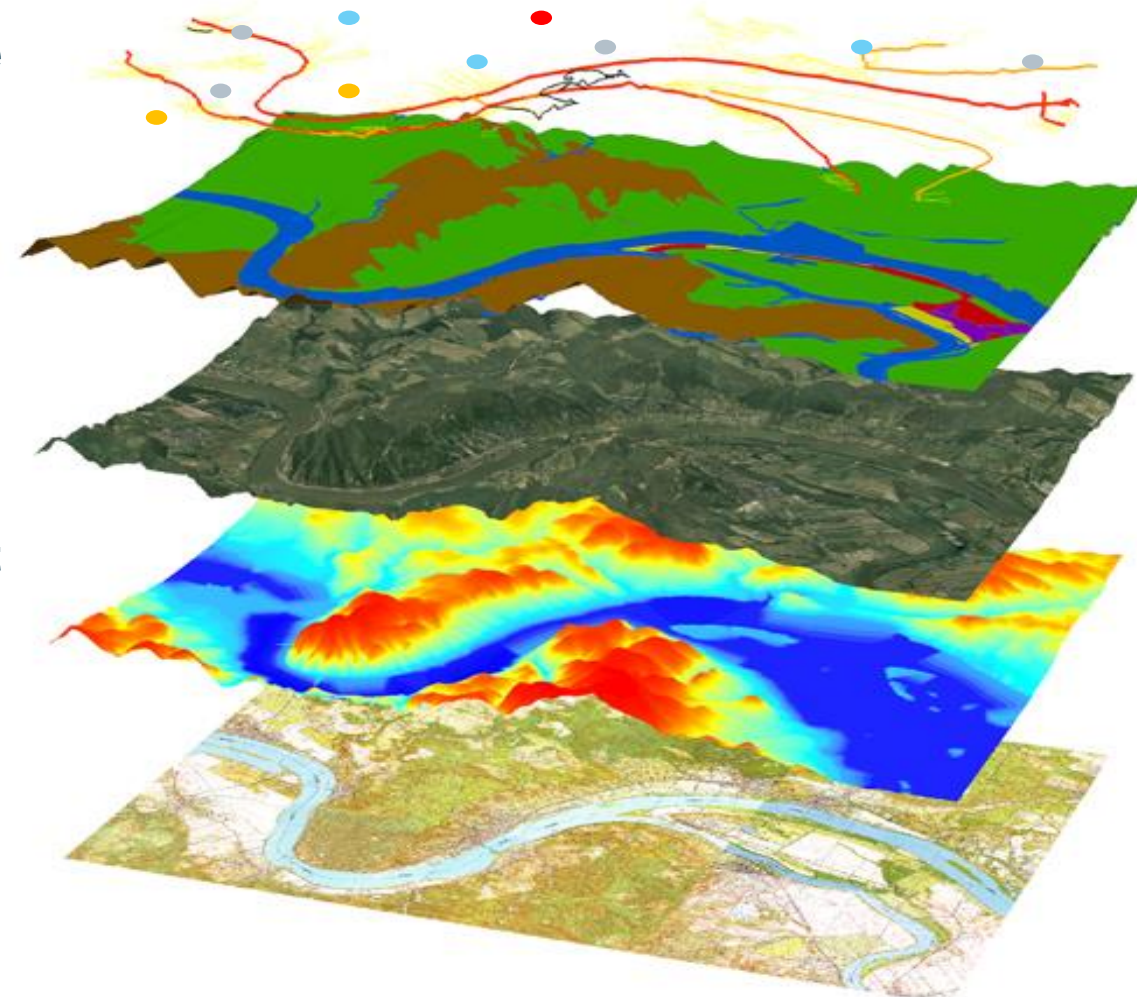
Today: EO community in Hungary



- Hungary is a full ESA Member State since 2015 (cooperation since 1991)
- Joined Earth Observation programmes in 2019
- Earth Observation Community
 - Science:
 - Important institutions and activities in basic research, e.g.: material science, physics, geodesy, geophysics, Earth system science
 - Large and heterogeneous landscape of applied research, e.g.: soil science, hydrology, ecology, plant science, forestry, agricultural sciences, meteorology, remote sensing, photogrammetry, AI / ML / information science
 - Industry:
 - Upstream: Important capabilities, some companies already internationally integrated as prime contractors or suppliers (material science, telecommunications, integrated systems, small sats / cubesats, etc.)
 - Downstream: Large number of companies specialized in multiple fields (agriculture, civil engineering, ML/AI etc.)
 - Government:
 - EO solutions integrated in a number of govt. Sectors
 - Prime Minister's Office responsible for EO/RS, Ministry of Agriculture for agricultural EO/RS
 - Earth Observation Information System (EOIS/FIR) now operational (*see later*)



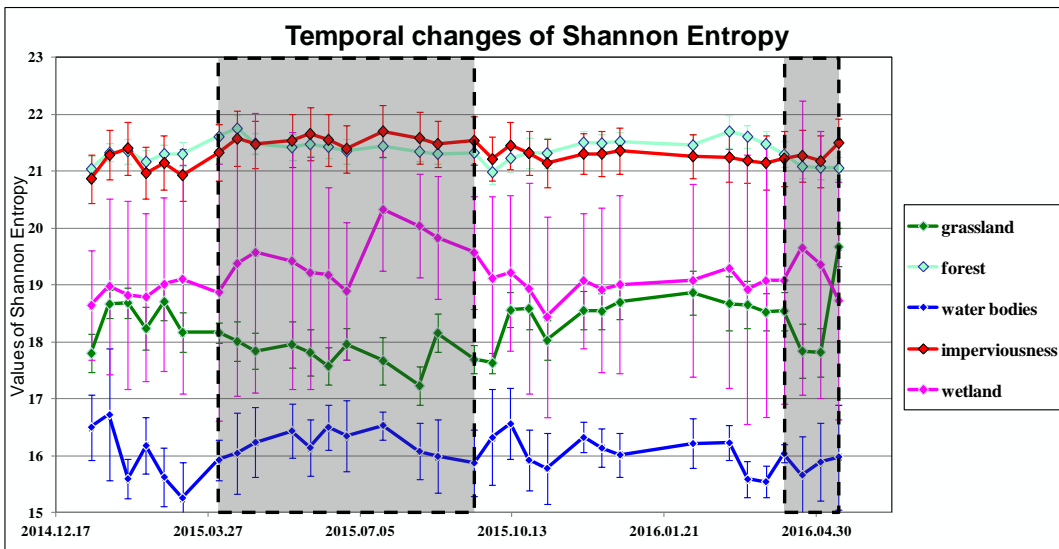
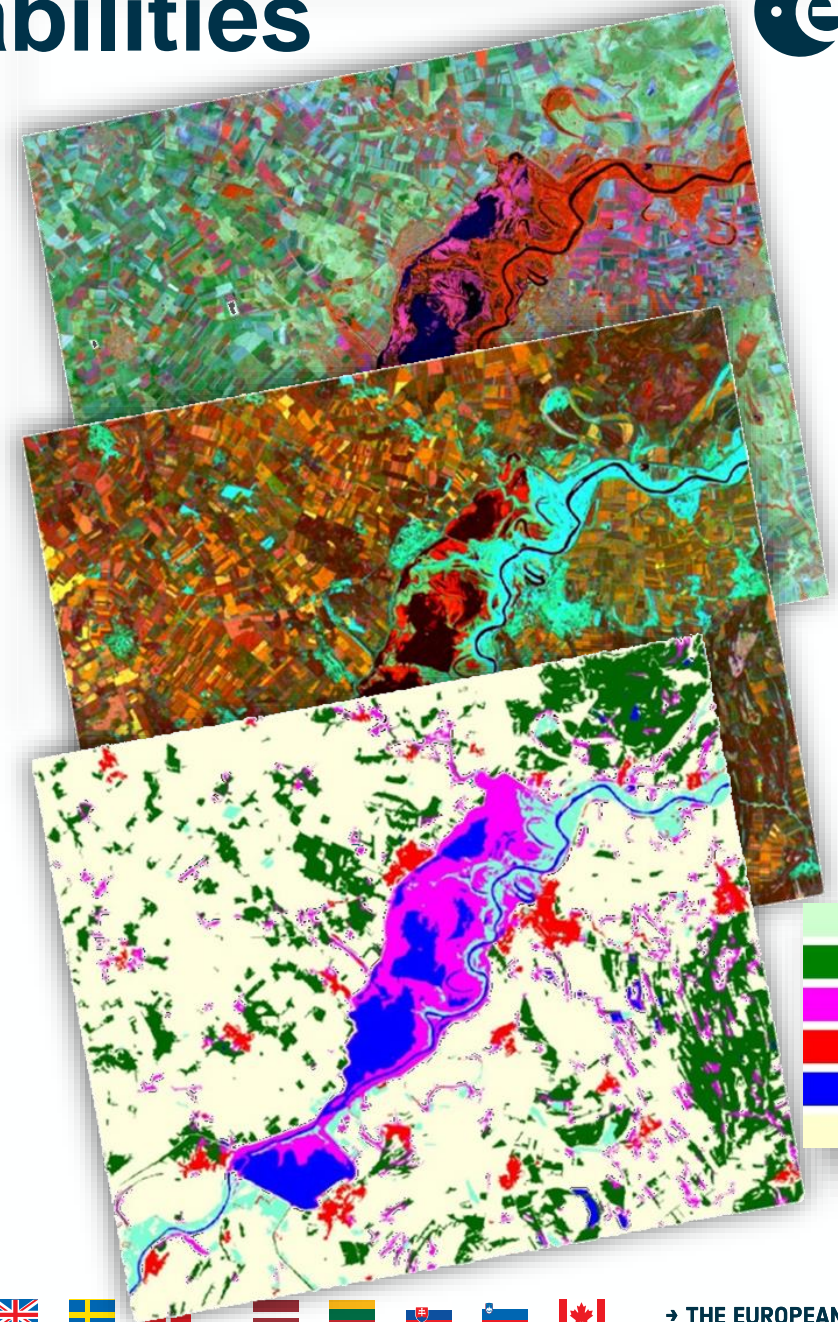
- background institution to the **Prime Minister's Office**
- managing the largest and **most complete collection of spatial data** sets in Hungary
- spatial data related to the **natural environment**
- official records related to the **built environment**
- tasks related to the protection of **cultural heritage**
- specific **processing, analysis and IT development** skills and activities in-house
- up-to-date **geospatial solutions** supporting government, authorities and the public
- **sharing and dissemination of knowledge**



Remote Sensing capabilities



- Balanced use of quantitative and visual methods
- Combined use of different data sources
 - RS:
 - airborne/space-borne
 - optical and radar (**fusion, polarimetry**)
 - Field surveys
 - Official: LPIS, cadastre, topography
- Processing of big geospatial data (national, EU)



Earth Observation Operations Centre (FOK)

- **Activities:**
 - Maintenance and operation of the Earth Observation Information System
 - Remote sensing processing and analysis
 - Coordination of application and service development
 - Professional coordination and consultancy
 - Education and dissemination
- Hosted by Lechner Knowledge Centre (LTK)
- **Distribution of tasks:**
 - Coordination, maintenance and operation of applications: LTK
 - Maintenance and operation of IT infrastructure:
 - Software: KIFÜ (Govt. IT development agency)
 - Hardware: NISZ (National Infocommunications Service Company)



Üdvözöljük a Földmegfigyelési Információs Rendszer eFöld űrtávérzékelési portálján!

Fedezze fel Magyarországot egy különleges perspektívából, az Európai Űrügynökség műholdjai szemszögéből!

Üdvözöljük!

Lépjen be az eFöld Portálra az alábbi lehetőségeket használva és böngésszen a műholdfelvételek között, vagy kattintson az ügyindításra és intézze elektronikusan a légtérkijelöléshez és légi távérzékeléshez kapcsolódó engedélyeket, valamint az előzetes honvédelmi építésügyi szakhatósági eljárást!

Térkép elérése

Ezzel a belépési móddal szabadon böngészhet a felvételek között, de adat letöltésre nincs lehetősége.

[eFöld Portál belépés regisztráció nélkül](#)

Térkép elérése belépéssel

Ügyfélkapu, eduID vagy FIR rendszer regisztrációval rendelkezők lementhetik a kiválasztott felvételeket a saját gépükön.

[eFöld Portál belépés](#)

Elektronikus ügyintézés

Az eseti légtérhasználati és légi távérzékelési engedély kéréséhez Ügyfélkapu használatával itt tud belépni.

[Elektronikus ügyintézés](#)

Public portal: e-Föld („e-Globe”)

The screenshot displays the e-Föld Portal interface. At the top, the logo for FÖLDMEGFIGYELÉSI INFORMÁCIÓS RENDSZER (Earth Observation Information System) is visible, along with the text "Indítópult Súlyó v0.0.189" and "eFöld Portál". The user profile "DR. MIKUS GÁBOR GYULA" is shown in the top right corner.

The main content area features a satellite map of a rural landscape. On the left, a sidebar titled "Műholdkép keresés" (Satellite image search) is open. It includes a search bar with the selected product "S2A_MSIL2A_20190627T095031_N02". Below the search bar, there are tabs for "Sávkombinációk", "Indexek", and "Képbeállítások". The "Indexek" tab is active, showing a list of indices:

- NDVI**: Normalizált vegetációs Index
- EVI**: Kiterjesztett vegetációs Index
- NDWI**: Normalizált vízfelület Index
- NDSI**: Normalizált hófelület Index

Each index entry includes a small thumbnail image and icons for information, list, and add. On the right side of the map, there are standard map navigation controls such as zoom in (+), zoom out (-), and a search icon.

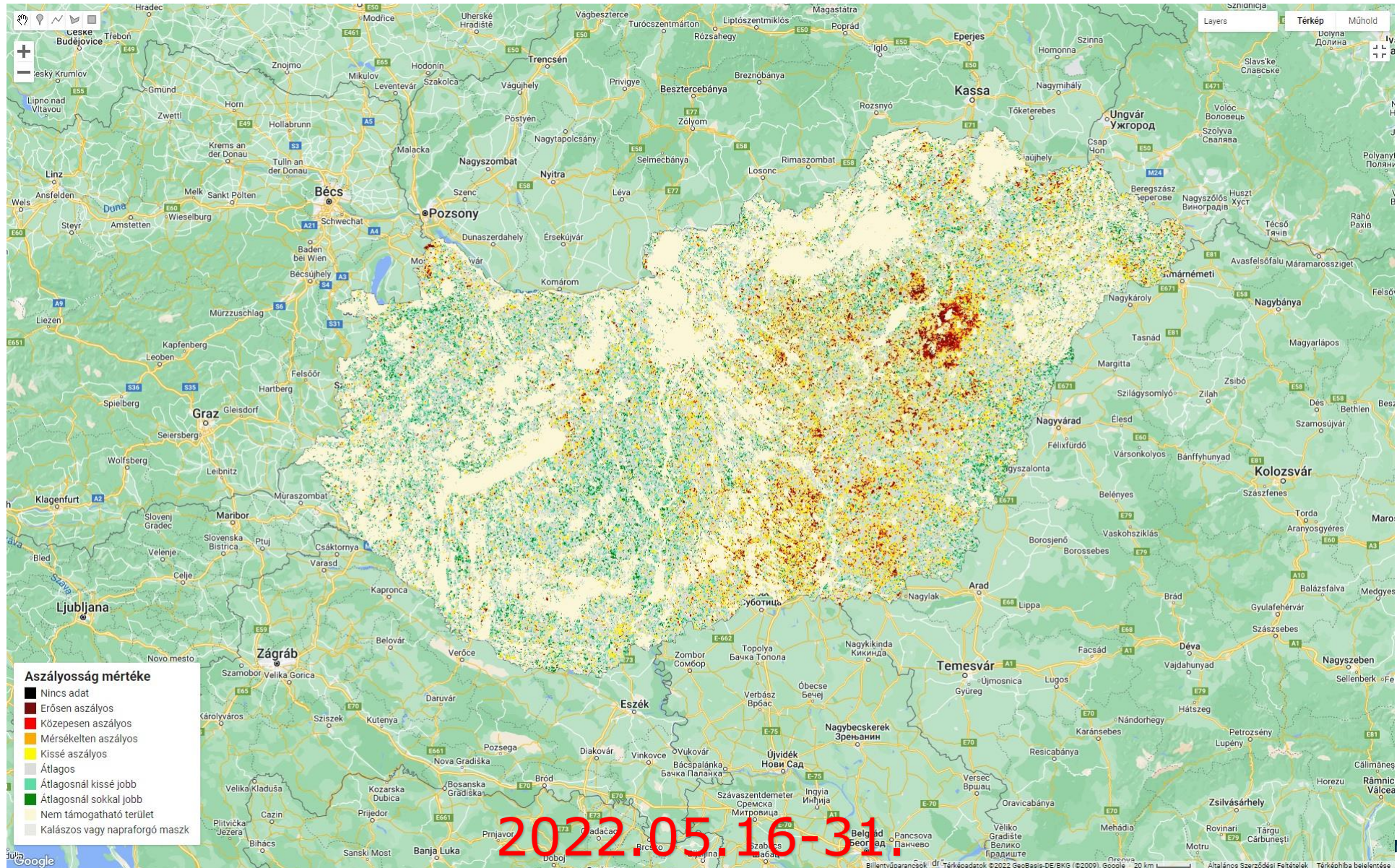


Exploring the 2022 drought with EO

Agricultural Risk Management System (MKR)



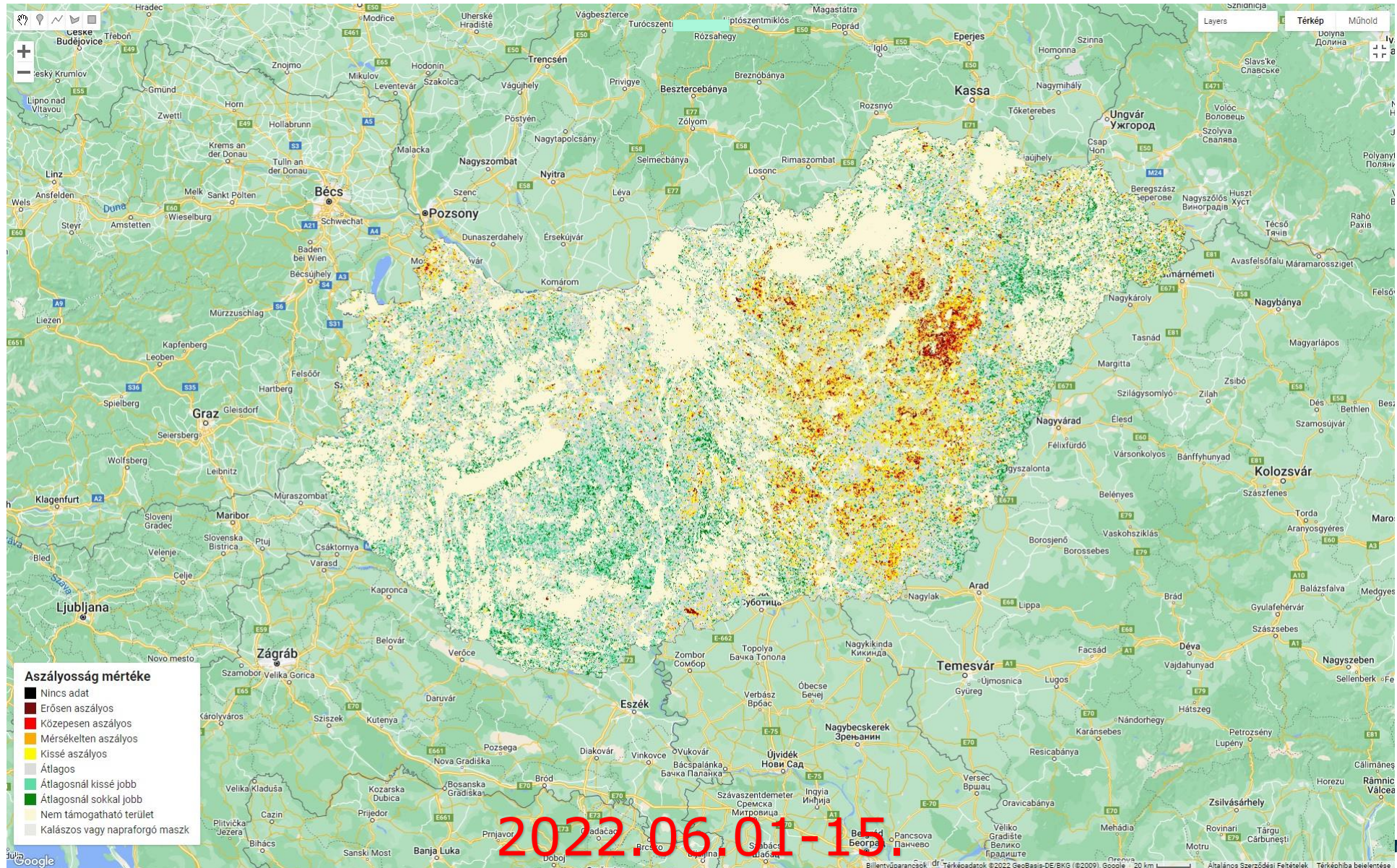
Country-wide drought mapping: MODIS NDVI anomaly



Agricultural Risk Management System (MKR)

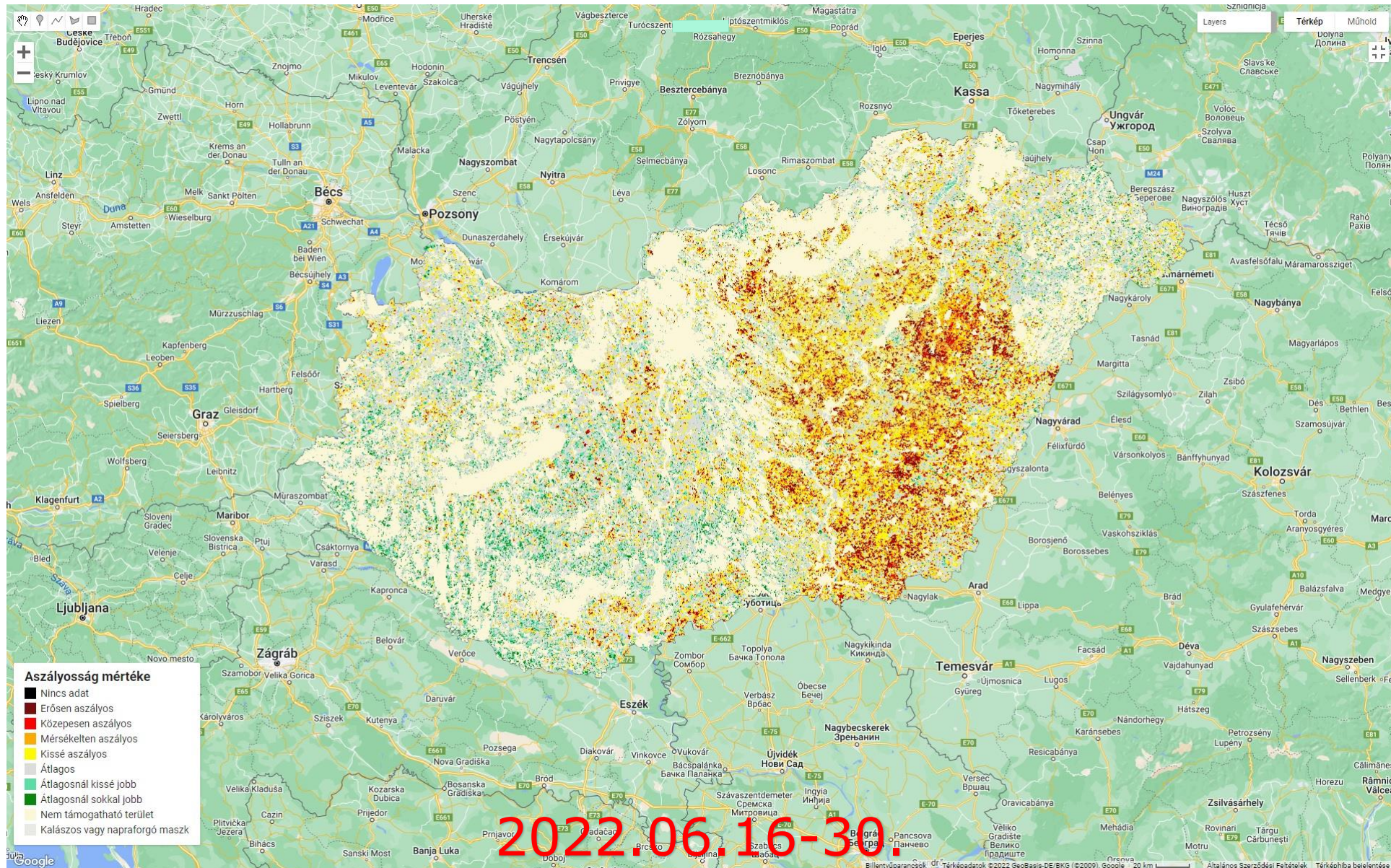


Country-wide drought mapping: MODIS NDVI anomaly



Agricultural Risk Management System (MKR)

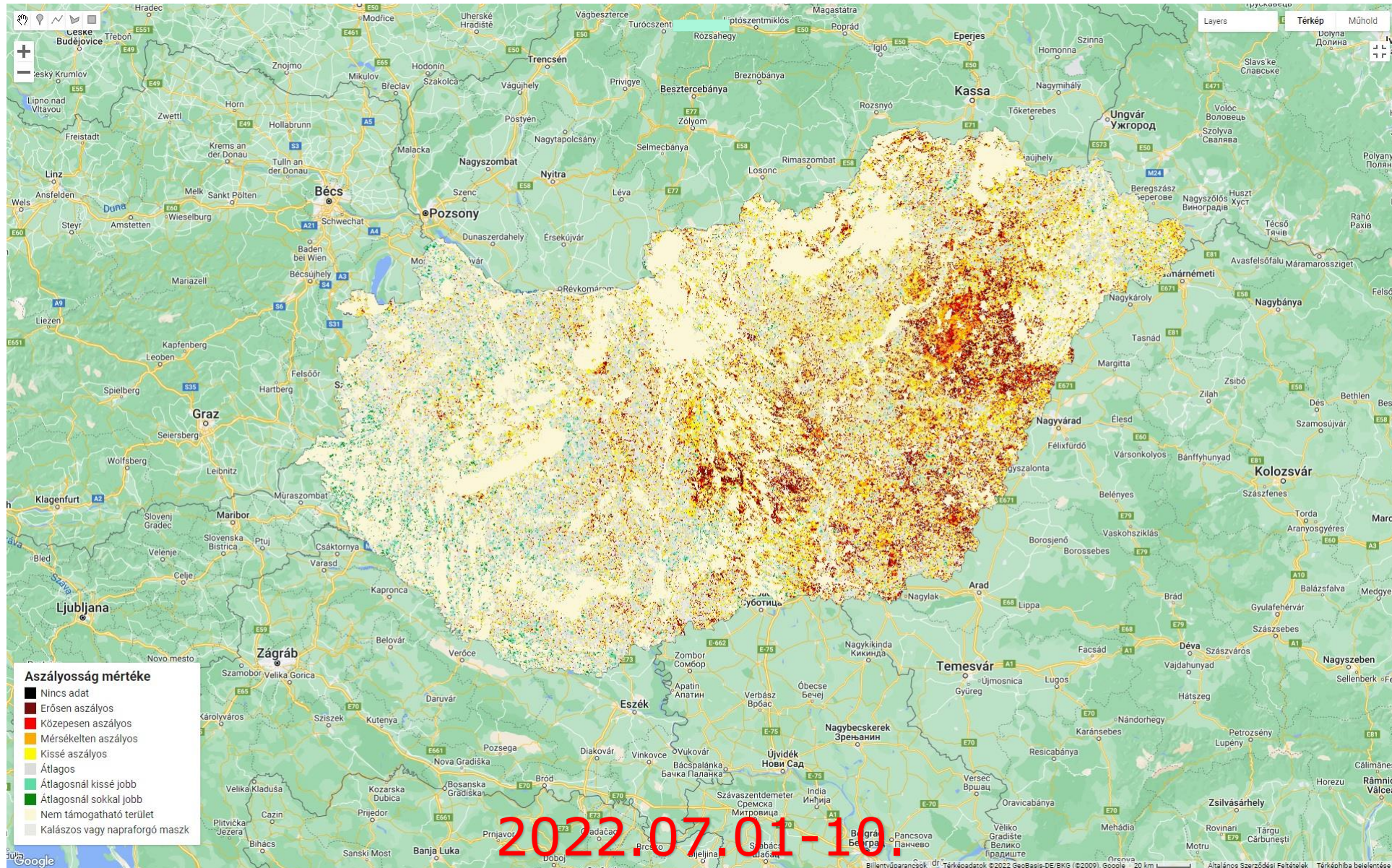
Country-wide drought mapping: MODIS NDVI anomaly



Agricultural Risk Management System (MKR)



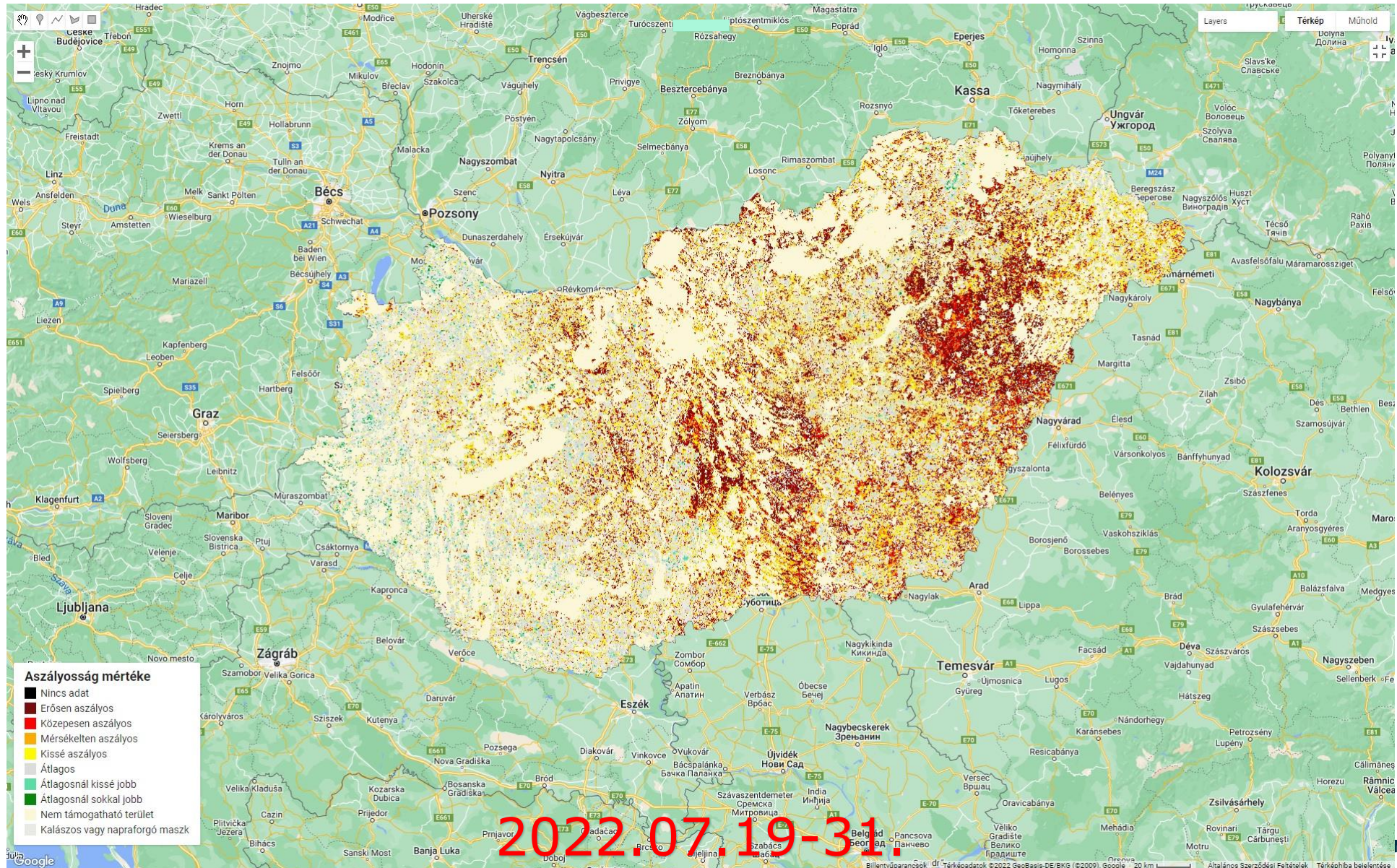
Country-wide drought mapping: MODIS NDVI anomaly



Agricultural Risk Management System (MKR)

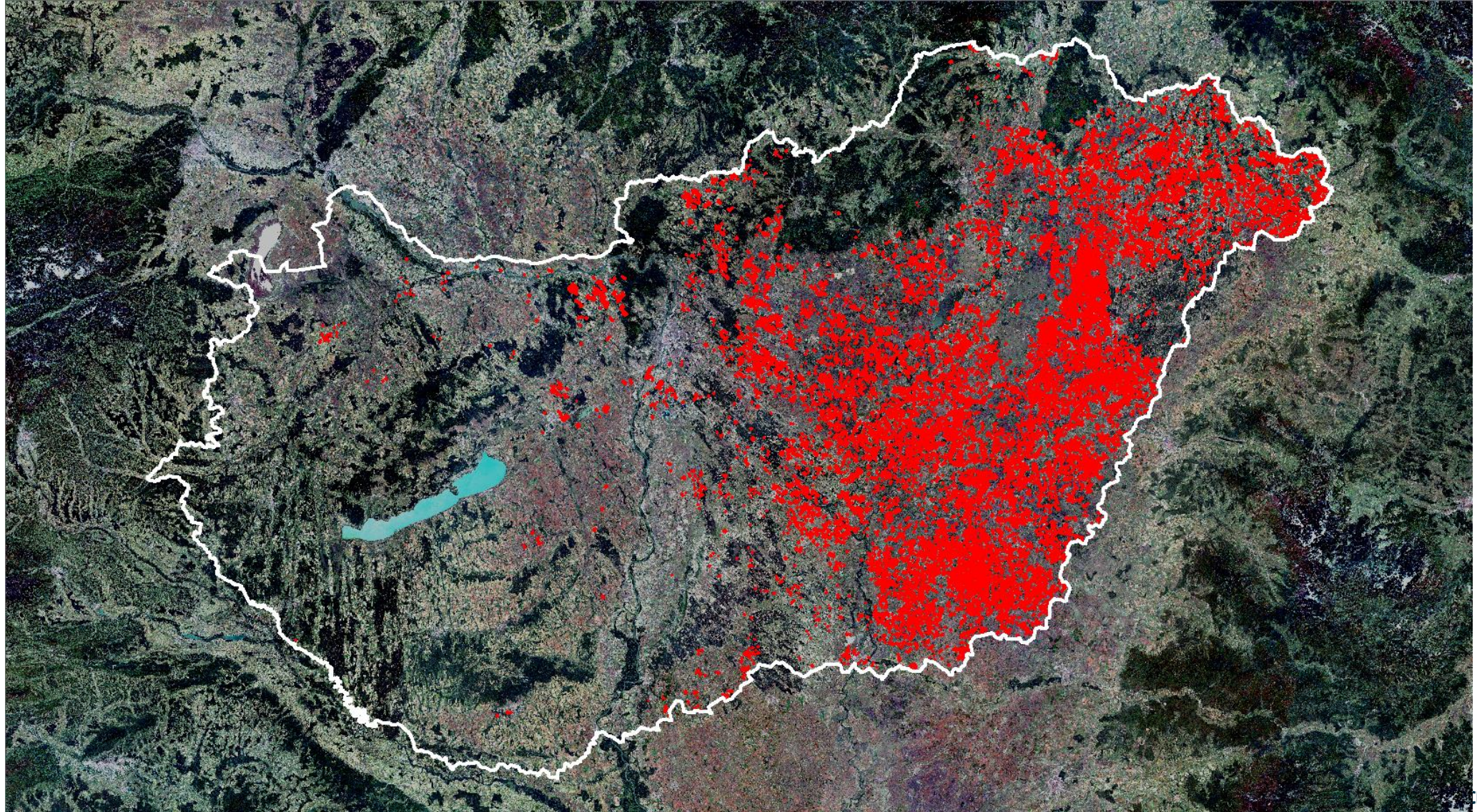


Country-wide drought mapping: MODIS NDVI anomaly



Agricultural Risk Management System (MKR)

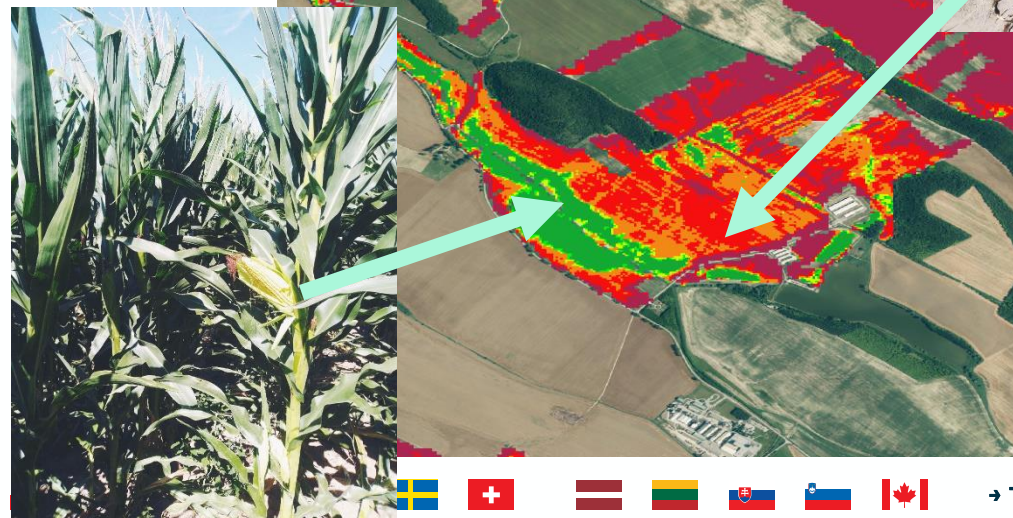
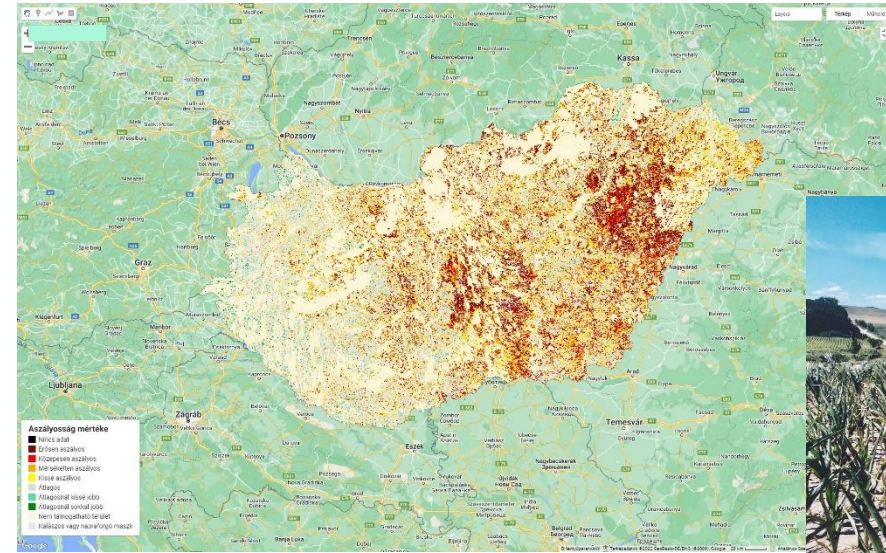
Farmers' drought compensation claims as of 30/07/2022



Agricultural Risk Management System (MKR)

High-resolution crop condition maps

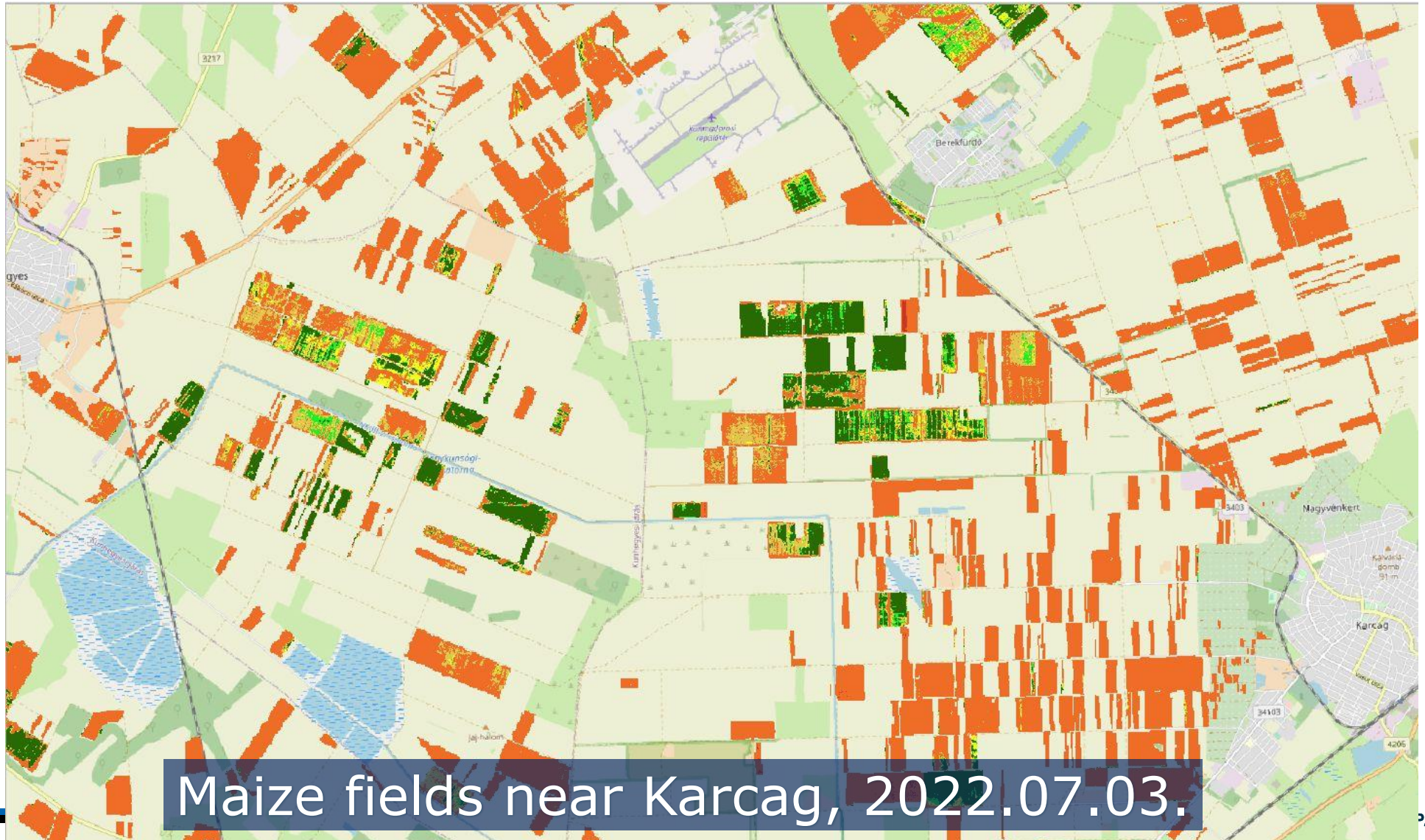
- Authorities asked for emergency help due to the huge number of compensation claims
- New methodology based on Sentinel-2 time series and spectral indices introduced
- Crop- and site-specific anomalies in vegetation vitality (kNDVI, NDVI, EVI), senescence (PSRI) and moisture (NDMI) for multiple time ranges
- Resulting maps instantly provided to authorities for decision support
- Complemented with in situ data collection
- Validation still ongoing, but very positive preliminary feedback from authorities and promising correlation with field results



Agricultural Risk Management System (MKR)

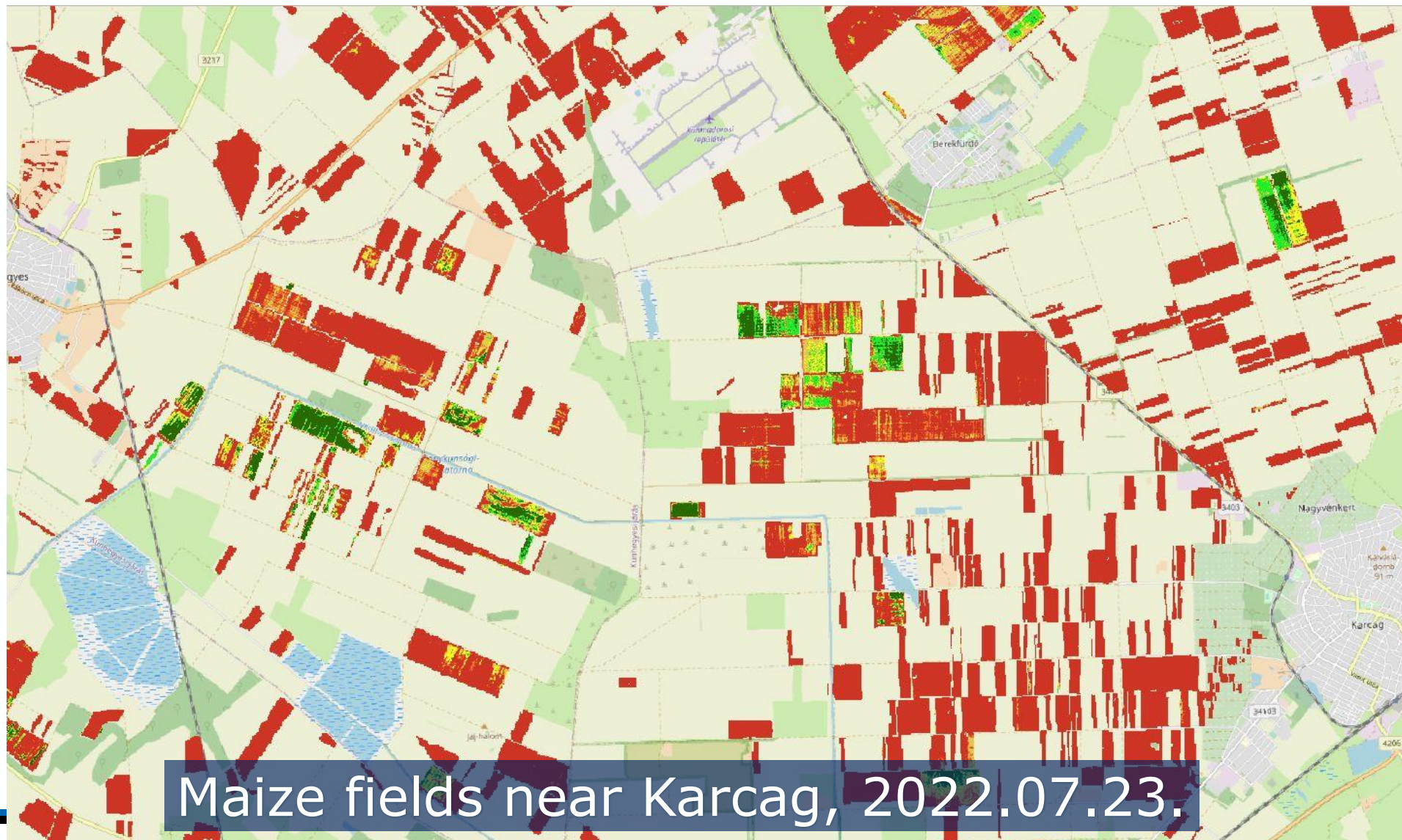


High-resolution crop condition maps



Agricultural Risk Management System (MKR)

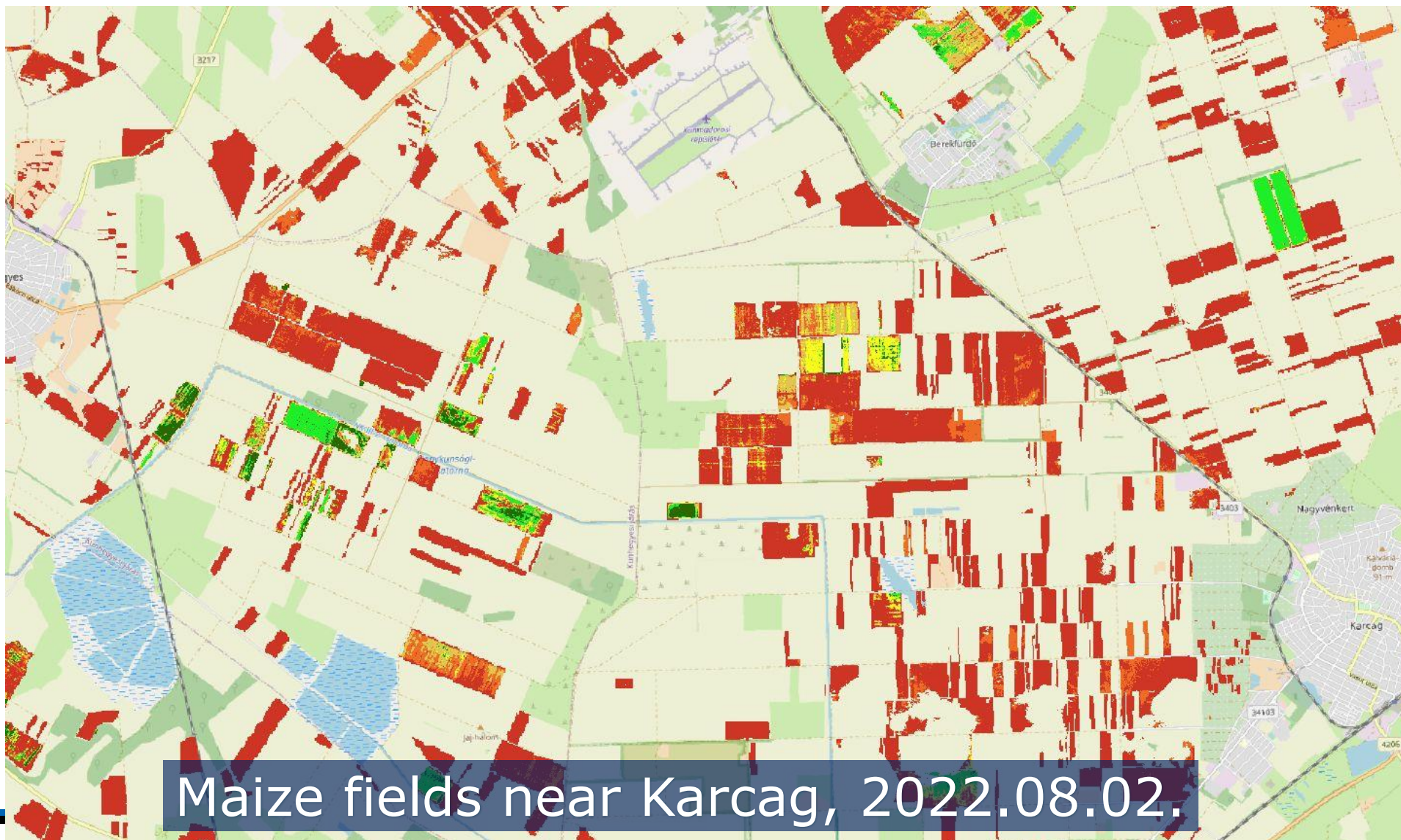
High-resolution crop condition maps



Agricultural Risk Management System (MKR)



High-resolution crop condition maps



Agricultural Risk Management System (MKR)

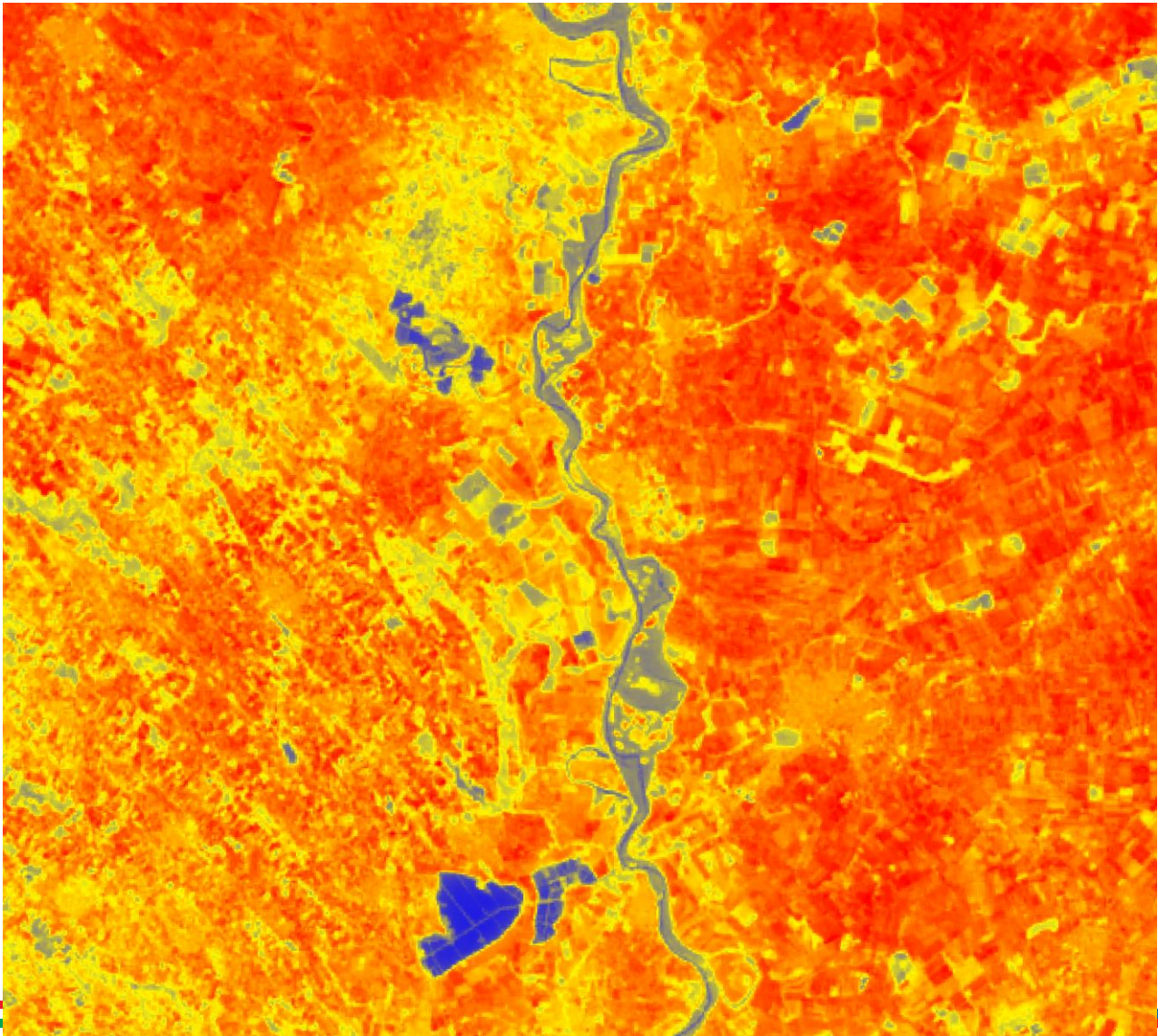
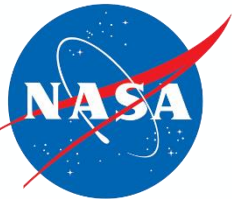
Irrigation at the time of Sentinel-2 overpass

The screenshot shows the 'eFöld Portál' web interface. On the left, there is a search panel with the following sections:

- Műholdkép keresés: Search, Results, Selection, Cart
- Kiválasztott termék: SZA_MSIL2A_20220817T093601_N04
- Sáv kombinációk: Mezőgazdasági területek (B11, B8A, B02), Légköri áthatolás (B12, B11, B3A), Vegetáció aktivitás (B11, B8A, B04), Viz és szárazföld megkülönböztetés (B0A, B11, B04), Légköri elnyelés (B12, B8A, B02), Közel infravörös (B12, B8A, B04)

A yellow arrow points from the search results to a specific location on the satellite map, with coordinates 47,0340199; 20,3251. An inset image shows a large center pivot irrigation system over a cornfield under a blue sky with clouds.

Land surface temperature from Landsat satellite image (2022.06.30.)



25 40 55

Felszíni hőmérséklet [°C]

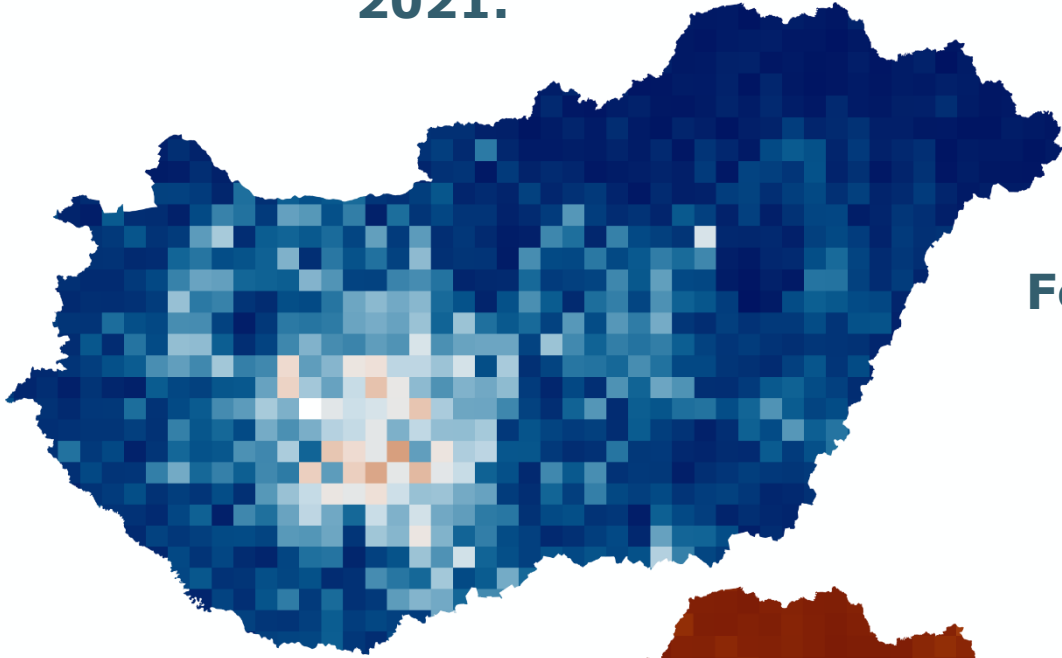


SMAP soil moisture

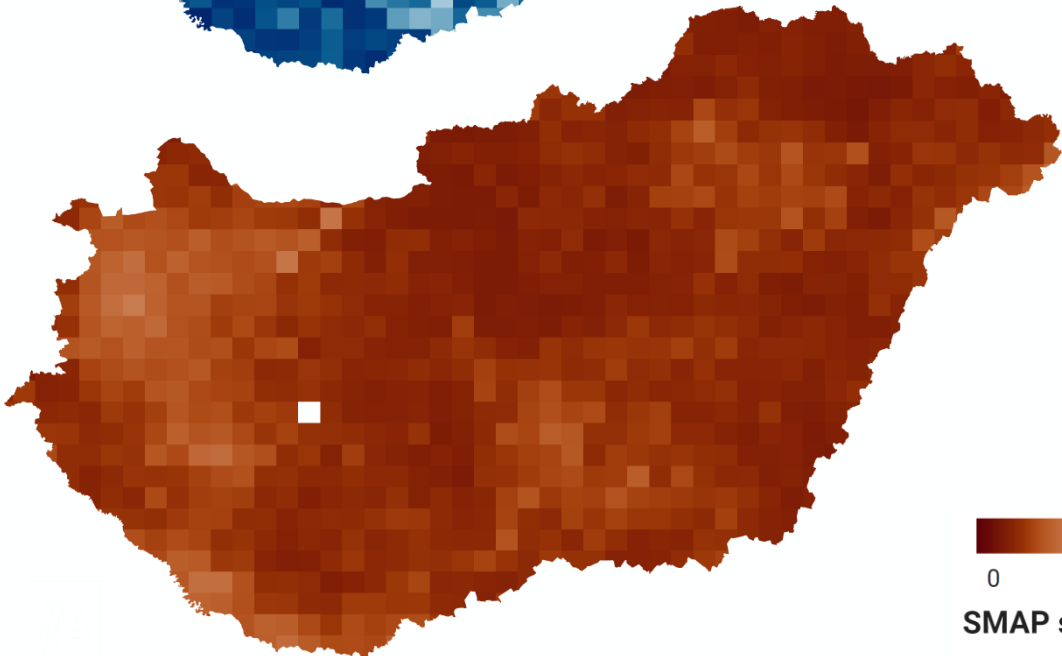
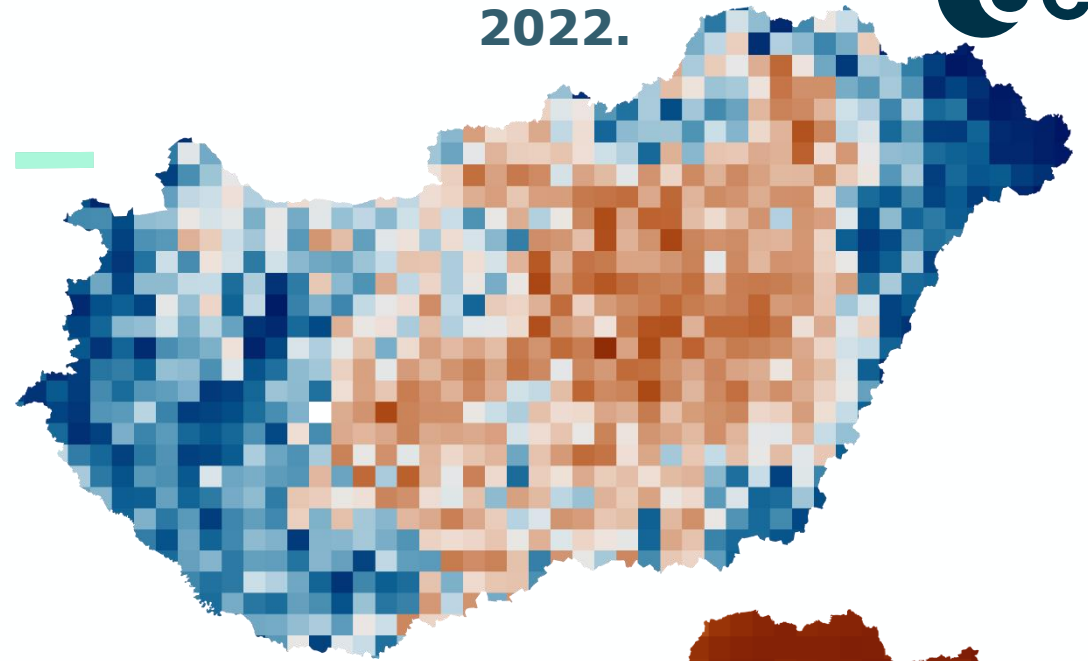


2021.

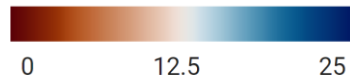
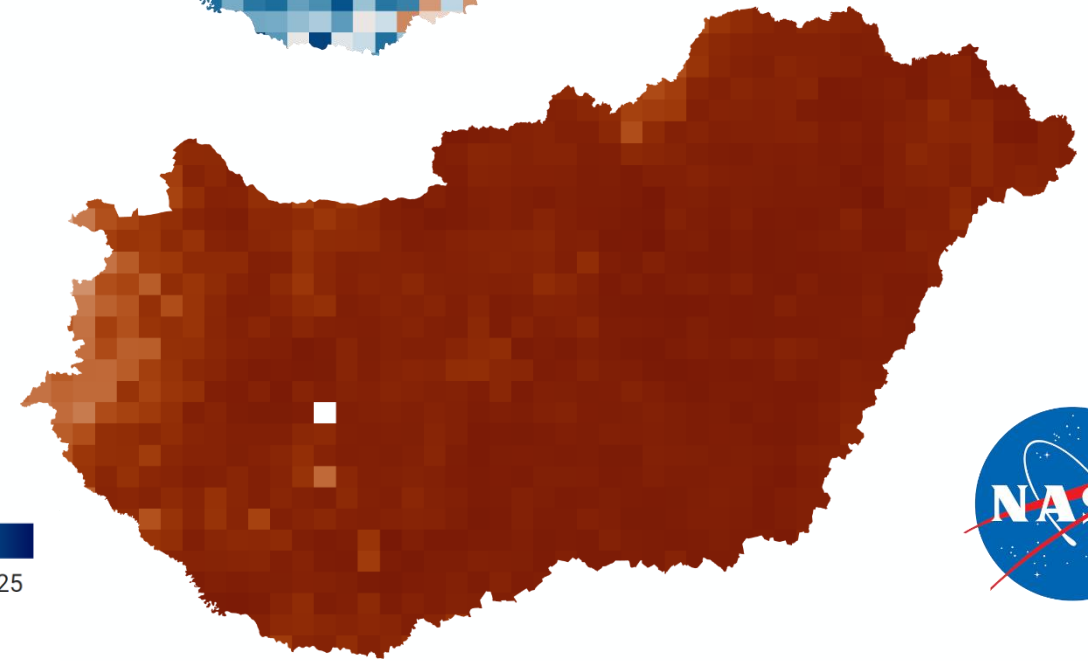
2022.



February



July



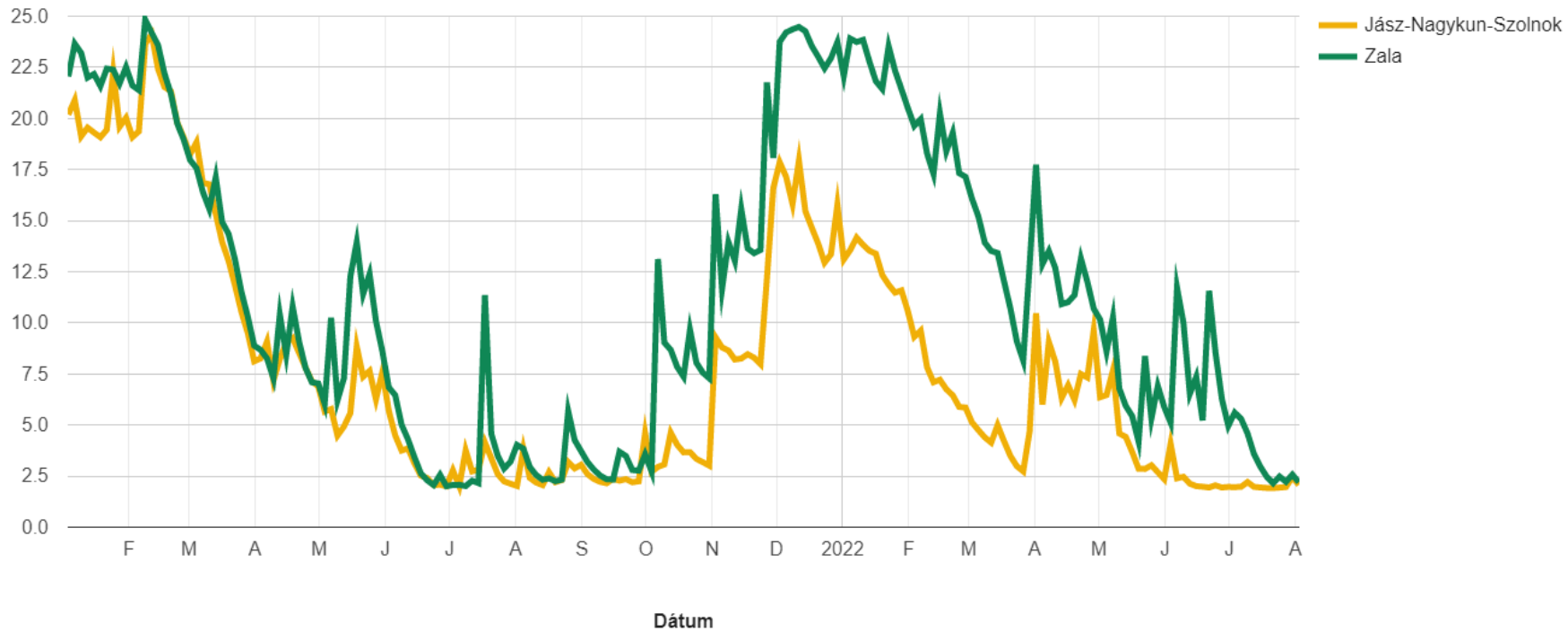
SMAP ssm [mm]



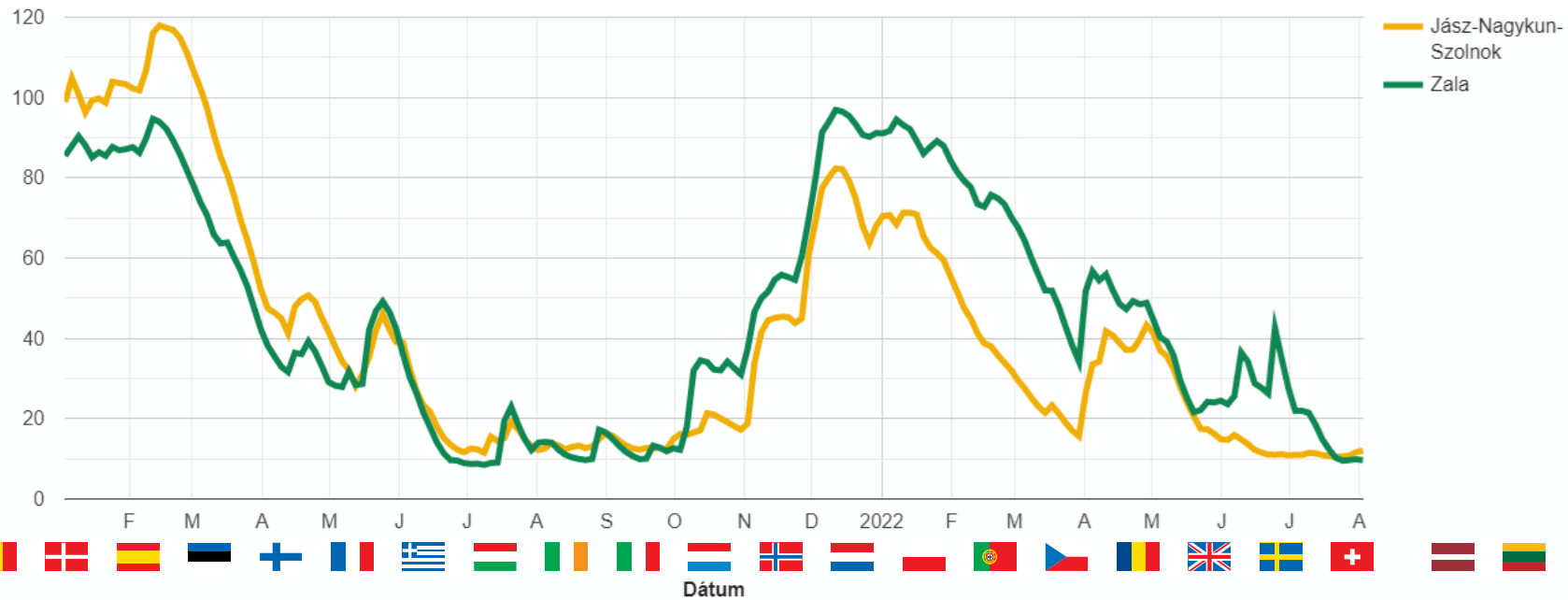
→ THE EUROPEAN SPACE AGENCY

SMAP soil moisture

SMAP Felszíni talajnedvesség



SMAP Felszín alatti talajnedvesség



DANUBE DATA CUBE



A Regional Data Exploitation Platform

The DDC project

DANUBE DATA CUBE

www.danubedatacube.com



The Danube Data Cube consortium works as part of the Euro Data Cube project:



Sinergise Ltd, Slovenia (Lead Partner EDC)



Hungarian University of Agriculture and Life Sciences, Hungary (Lead Partner DDC)



CropOM, Austria



EOX IT Services, Austria



Hungarian Meteorological Service, Hungary



Institute for Soil Sciences, Centre for Agricultural Research, Hungary



Lechner Knowledge Centre, Hungary



University of Szeged, Hungary



4iG, Hungary

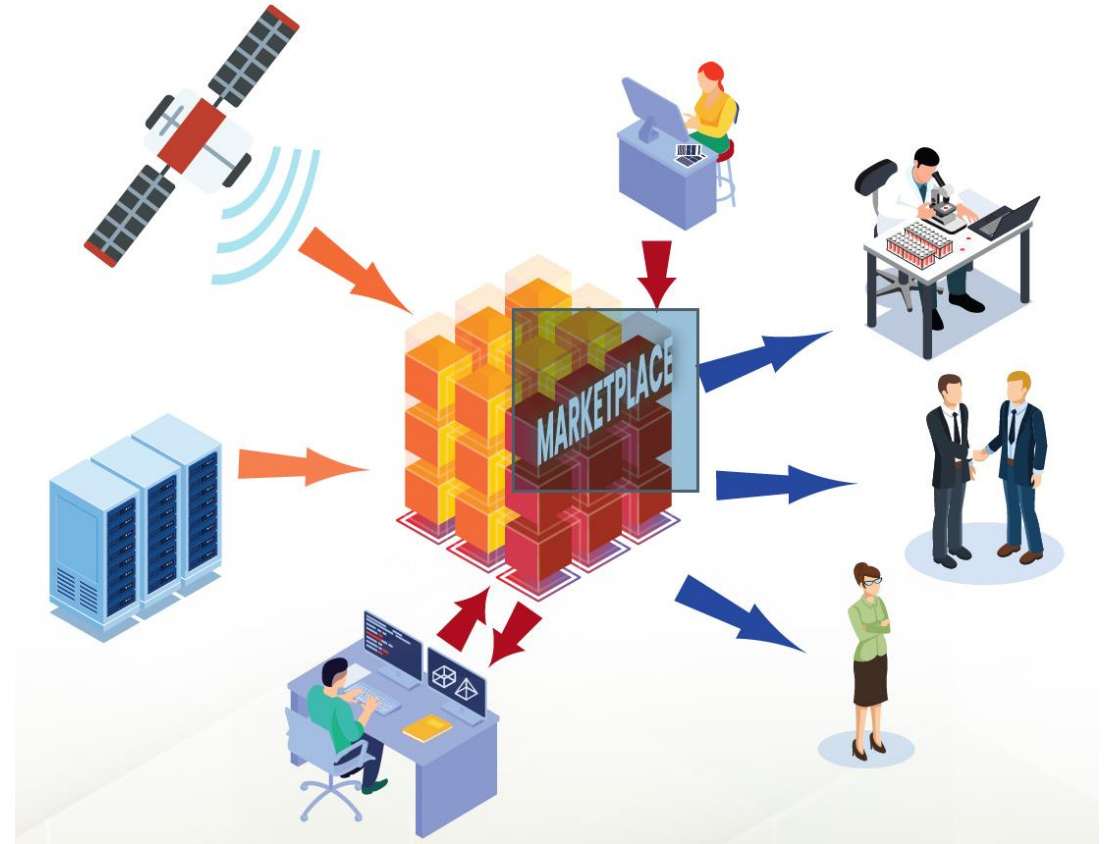


EURO DATA CUBE



What is Danube Data Cube?

- Cloud-based data exploitation platform with data, ML and analytical tools
- Data cube technology and synergy between EO, GIS and Geophysical data
- Reflects the Digital Twin Earth concept of ESA to support sustainable development
- Support for two types of users:
 - Users for value added information (agriculture, water management etc.)
 - Service developers deploying value-added services on the platform



DDC Services

Three main components:

1. Regional Data Service
2. Regional Use Case (Drought Explorer)
3. Field-level Use Case (AquaCrop)

The Regional Data Service

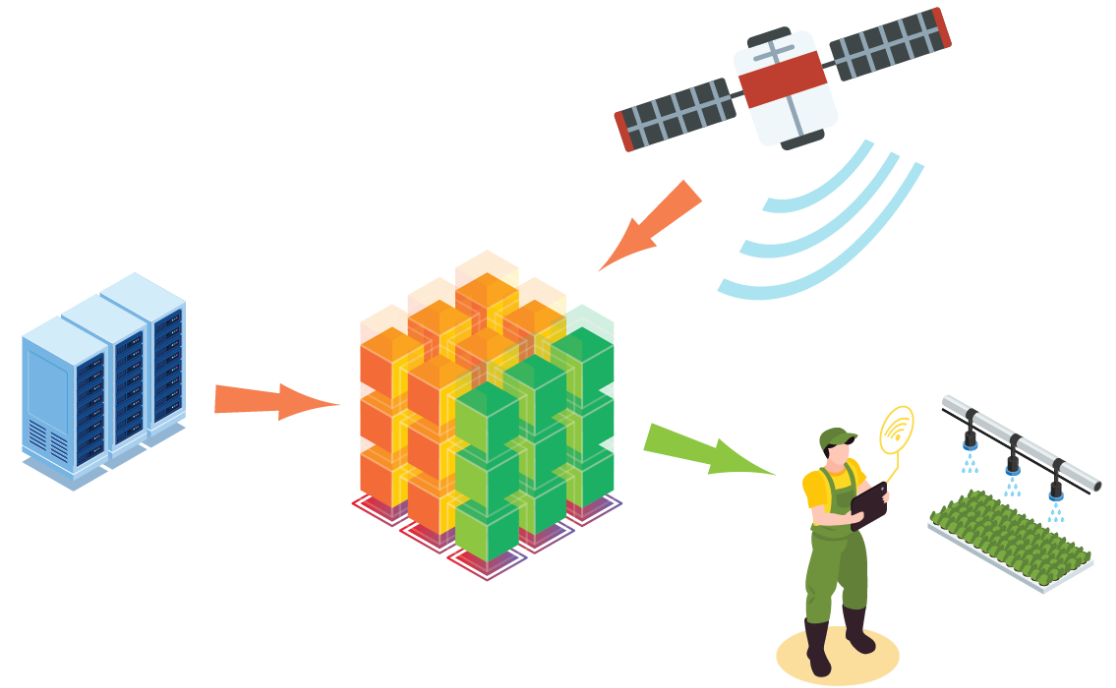
- Services for value adders and app developers for seamless data access, dynamic data gathering, storage & compute services, essential GIS functionalities
- **AOI Manager** for creating and storing custom geometries e.g. agricultural parcels
- **Dynamic Data Cube** for automatically gathering, storing and updating user defined data cubes
- **Third-party API services** for accessing sensitive data e.g. Cadastre geometries
- Users can focus on their domain and application rather than data gathering and processing
- **DDC Marketplace** for datasets and applications to be sold

The Regional Use Case – Drought Explorer

- A regional use case demonstrating the capabilities of apps deployed on DDC and also serving as a drought analysis tool
- Web GIS interface with satellite and meteorological time series and derived indices
- Interactive visualization
- Helps to investigate the development of drought over time and detect spatial and temporal patterns

The Field-level Use Case – AquaCrop Sandbox

- Online, interactive irrigation planning tool
- Historical and prediction data to test irrigation strategies
- Using the Dynamic Data Cube service and the FAO's AquaCrop model to run „what-if” scenarios
- The sandbox provides precise biomass and yield forecast based on the given irrigation schedule and user defined parameters



AOI Manager

- Documentation
- AOI Manager
- JupyterLab
- Explorer
- Aquacrop Sandbox

AOI Manager / Create New AOI

Create AOI



MyAOI_1

Time-series start date: 01/01/2022

Time-series start date: 11/18/2022

Dynamic

Initial cost
161.00 €

Monthly cost
15.50 €

Data Sources

Sentinel-2

B01 B02 B03 B04 B05 B06 B07 B08 B8A B09
 B10 B11 B12

NDVI

Meteorology

Temp Min Temp Max Temp Avg ETO Prec

AquaCrop Sandbox

DANUBE DATA CUBE

Log out

- ABOUT
- DOCUMENTATION
- MARKETPLACE
- JupyterLab
- AQUACROP SANDBOX



Test Field 1 - Corn

18.02 ha

Irrigation schedule:

05/17/2019

06/17/2019

06/30/2019

07/17/2019

Run Model

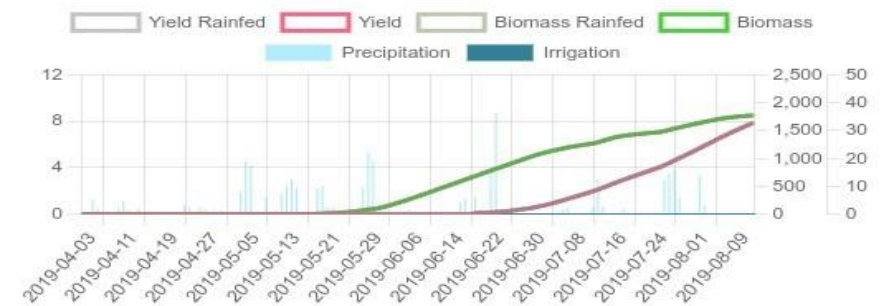
Rainfed

Yield **7.83 t/ha**
Biomass **1771 g/m²**

Irrigated

Yield **7.83 t/ha**
Biomass **1771 g/m²**

Chart.js Line Chart



Integrated Jupyter Lab

The screenshot displays the Integrated Jupyter Lab interface. The top menu bar includes File, Edit, View, Run, Kernel, Git, Tabs, Settings, and Help. The current notebook is titled 'demo-1109.ipynb' and is running in a Python environment named 'conda env: ddc-env-lechner'. The notebook content is as follows:

Danube Data Cube Toolkits

This notebook presents an example on how a user can exploit the DDC client library to access and analyse data served via Danube Data Cube service API.

Thematically, this notebook illustrates how to generate various indices, including meteorological and optical, in order to analyse drought.

Specifically, following actions are demonstrated by this notebook:

1. Defining a new data cube for a given time range, region and dataset.
2. Requesting data from the Danube Data Cube API.
3. Calculating meteorological indices with the `ddc_met_indices` package.
4. Calculating NDVI time series from data fetched from sentinel hub. 5. Displaying imageries, time series and linear plots for selected bands, area-of-interest and time.

Importing dependancies

```
[1]: from ddc import DanubeDataCube
from config import CubeConfig
from cube import open_cube
from ddc_met_indices import DdcIndices
import os
import matplotlib.pyplot as plt
```

```
[2]: #os.environ['DDC_API_URL'] = ''
```

Get information about the datasets

Using inbuilt functions, we can easily gather information i.e. metadata, about the datasets available in DDC.

```
[3]: # Create a DDC class
DDC = DanubeDataCube()
```

```
[4]: # List the available datasets in DDC
DDC.dataset_names
```

The bottom status bar shows 'Simple' mode, 0 files, 2 kernels, Python [conda env: ddc-env-lechner] | Idle, Mem: 303.94 / 8192.00 MB, Mode: Command, Ln 1, Col 1, demo-1109.ipynb.

THANK YOU!



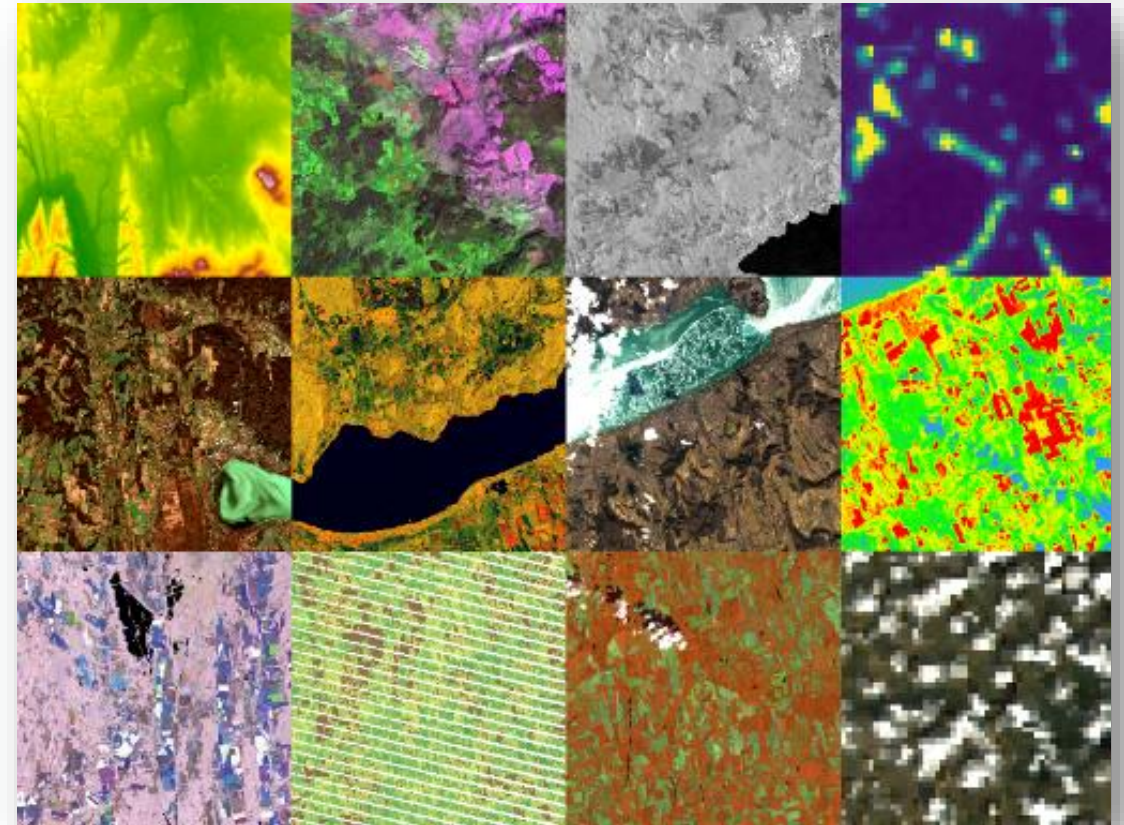
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Lechner Knowledge Centre

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mobile: +36 20 341 7079



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