

Earth Observation Data Analysis Library

Data, Software, Systems, and Tools
Third Space4Water Stakeholder Meeting
Lukas Valentin Graf, 24.10.2023

Who are we?

Gregor Perich

PhD Agricultural
sciences
ETH Zürich

MSc Agricultural
economics
ETH Zürich



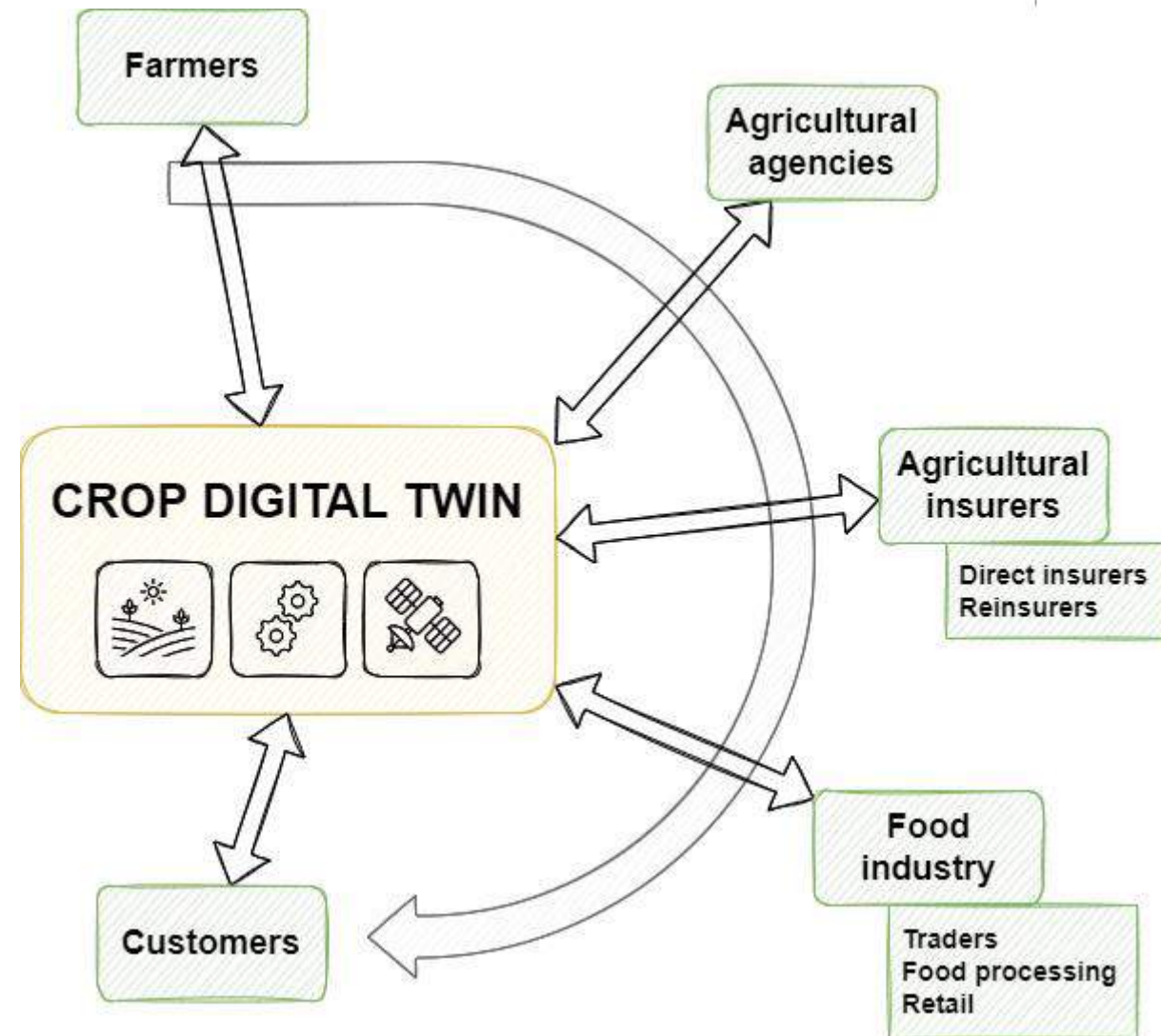
Lukas V. Graf

PhD student
Agricultural sciences
ETH Zürich

MSc Geoinformatics
University of Salzburg

Our ambition

- We develop a Crop Digital Twin (CDT) using:
 - Crop models
 - Satellite imagery
- With the CDT, we want to:
 - Democratize access to actionable insights in agriculture
 - Enable efficient information transfer
 - Connect actors in agriculture



Earth Observation

Great opportunities ...

- Gain actionable insights
- Near real-time information
- Traction through public (European Green Deal) and private incentives (Space 2.0)

But still difficult to use ...

- Datasets are complex, not easy to handle
- EO expert knowledge still required to make sense out of data
- Many solutions exist but most of them have major drawbacks (level of usability, complexity, openness, flexibility, scalability)

-> missed opportunities in research and business

-> high barrier to entry

-> unexploited potential (that's why we are here)

EOdal – Earth Observation for Everyone

The Earth Observation Data Analysis Library (EOdal) is

- A light-weight, modular **Python** package
- An **open-source (GPL v3)** tool to work with any kind of **Earth Observation (EO)** data
- Developed at **ETH Zurich** and **Agroscope Reckenholz**
- **Access to 50+ years of EO data**



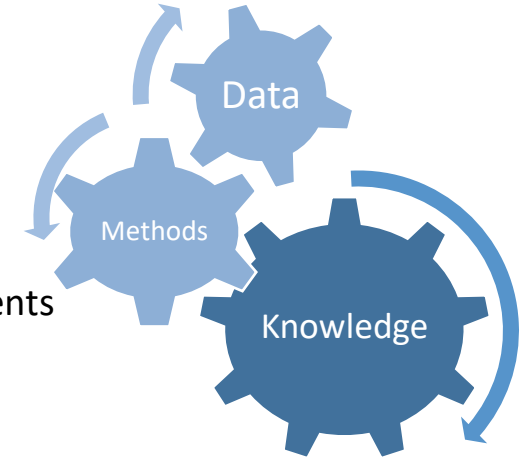
EOdal enables

- Reproducible, reliable, and **scalable EO workflows**
- Access to **TB of EO** data through SpatioTemporal Assets Catalogs (**STAC**)
- Generic **interfaces** to popular open-source libraries (**xarray**, **geopandas**, **numpy**, ...)

➡ **EOdal makes EO data available to non-experts.**



EOdal – Enables EO workflows



✓ Query

- Query **cloud (Planetary Computer) or local EO data archives** by time, area, EO platform and instruments
- Connectors to **STAC** or **PostGIS** databases

✓ Load

- Load **any EO data** format understood by GDAL (geoTiff, COG, JPEG2000, netCDF)
- Enhanced **support for EO satellites** (PlanetLabs, Sentinel-1, Sentinel-2, Landsat, more to come)

✓ Analyze

- Analyze data using pre-defined workflows and familiar Python (geo-spatial) libraries
- Tools for **visualization, statistics** and **data science**

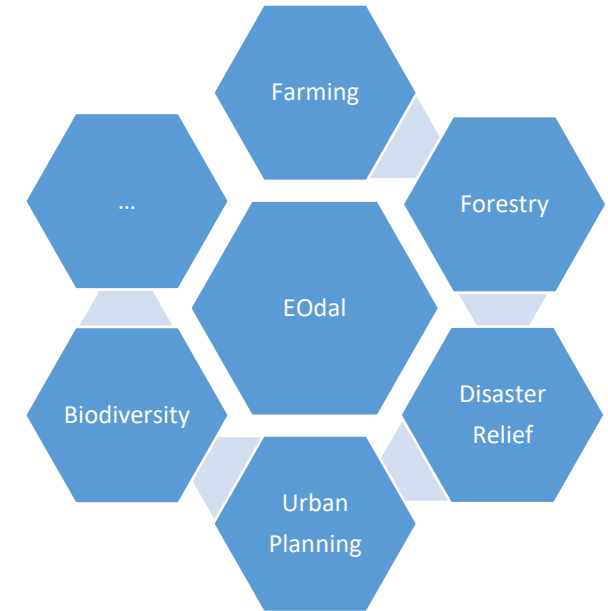
✓ Scale

- Deploy EOdal on **local premises, cloud environments** or in **hybrid setups**
- Bring your own data and models (open-source intelligence)



EOdal – An open-source EO ecosystem

- ✓ EOdal enables access to EO data
 - By application: agriculture, forestry, urban planning, disaster relief, ...
 - By sector: NGOs, governments, private sector
- ✓ Users can bring their own data and models
- ✓ Envisioned: **EOdal as the base for an open-source EO ecosystem**

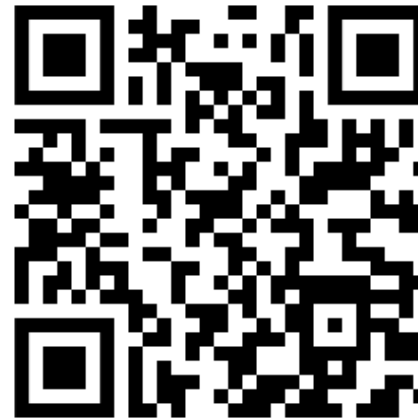


Example Jupyter notebooks



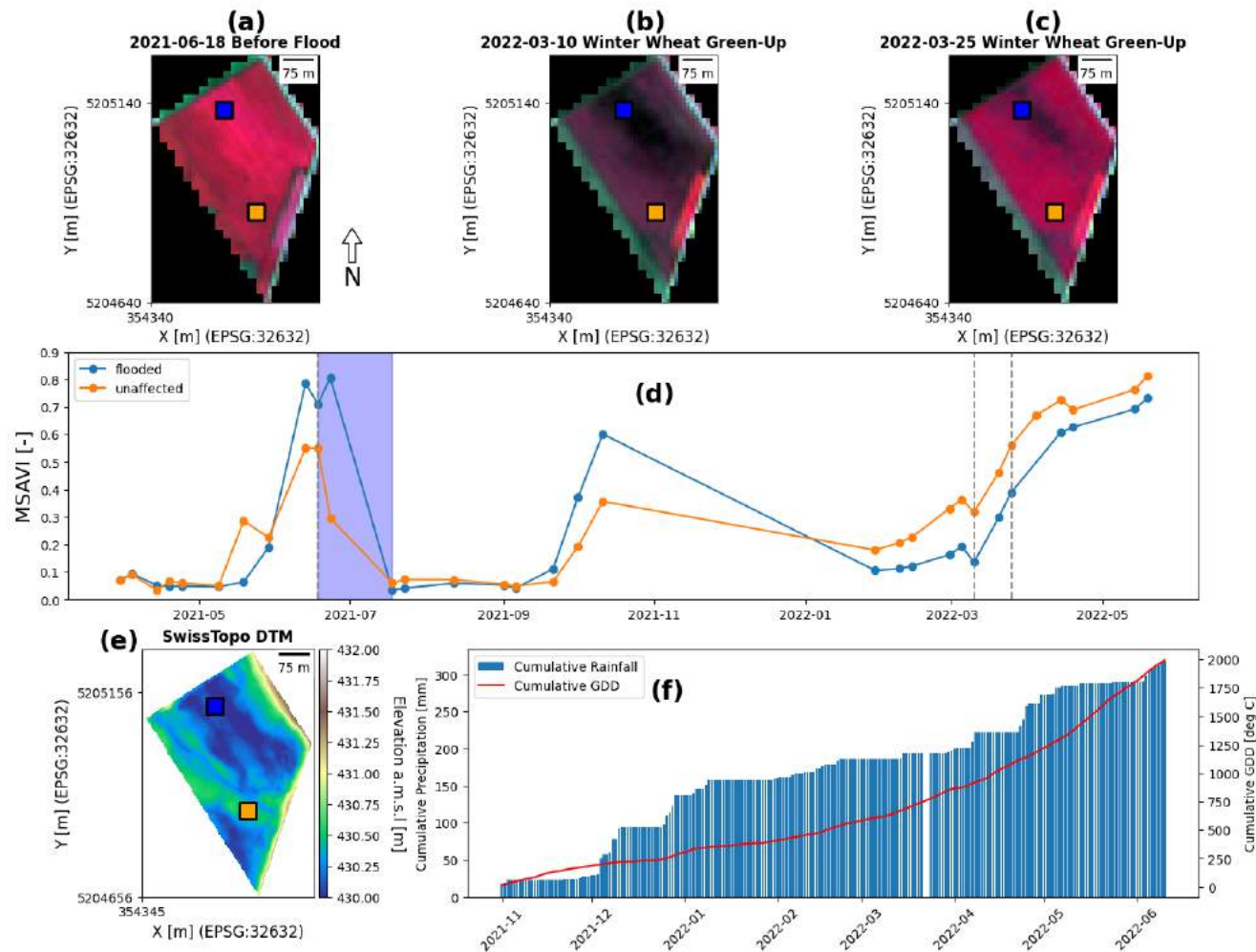
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Source Code on Github



EOdal - Open Source Earth Observation

Research example: agriculture



Understanding impacts of flooding
on crop productivity



Sentinel-2
Optical Imagery



SwissTopo
Digital Elevation Model

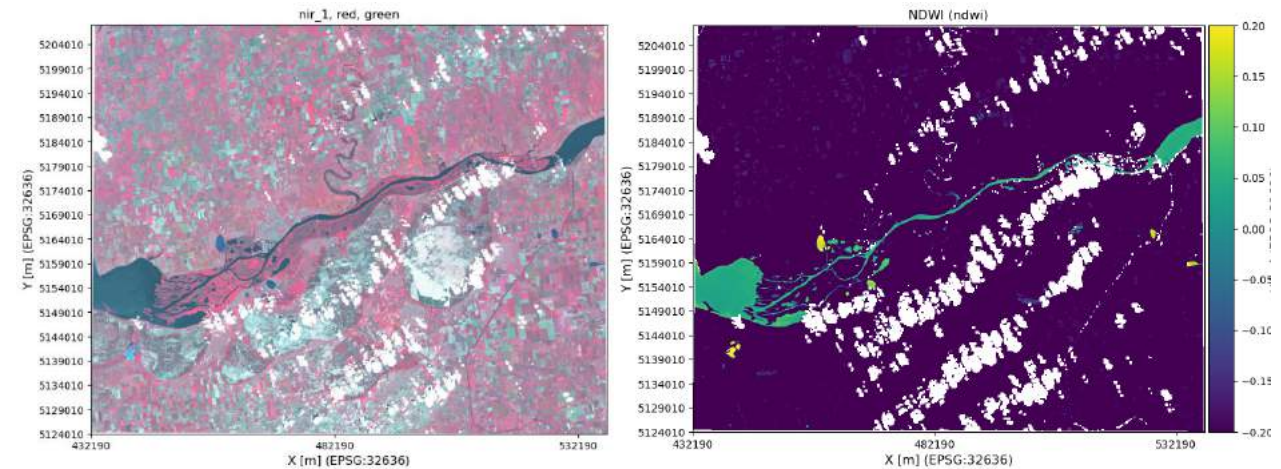
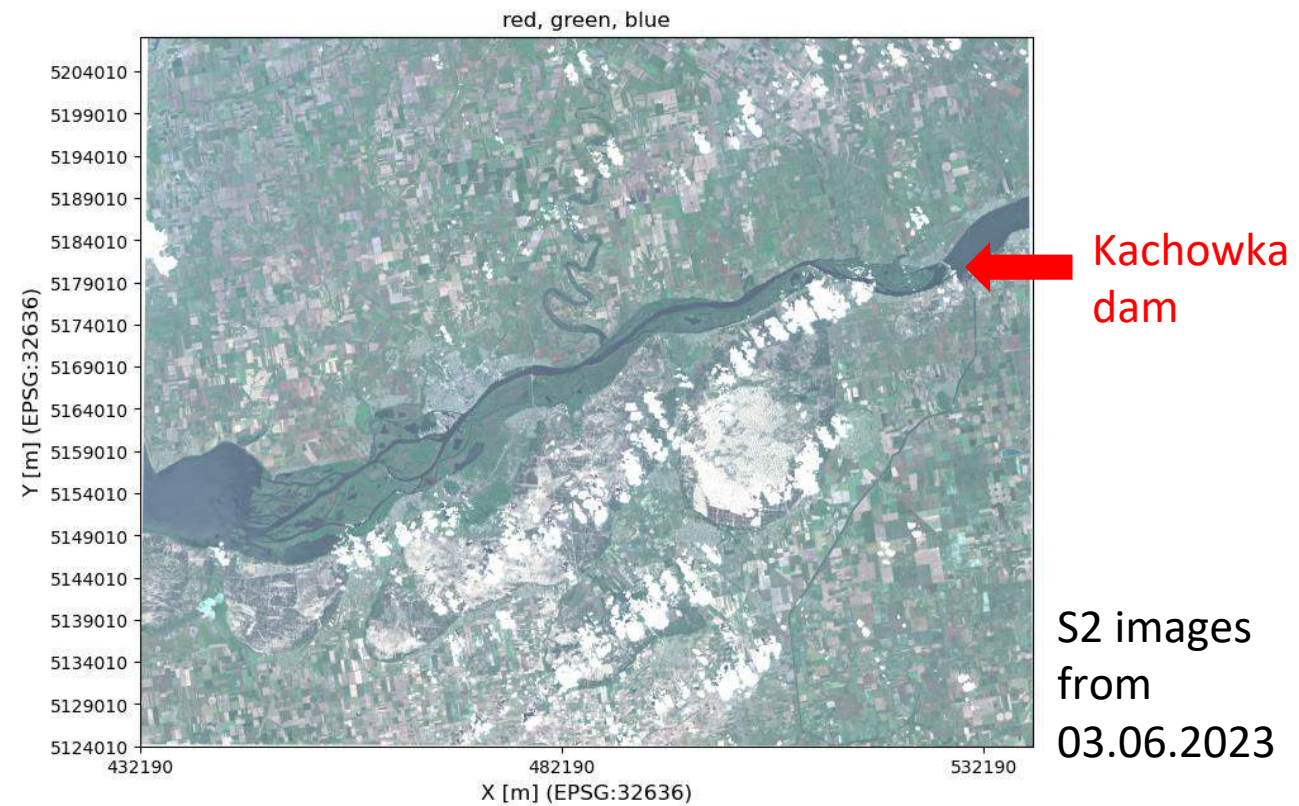
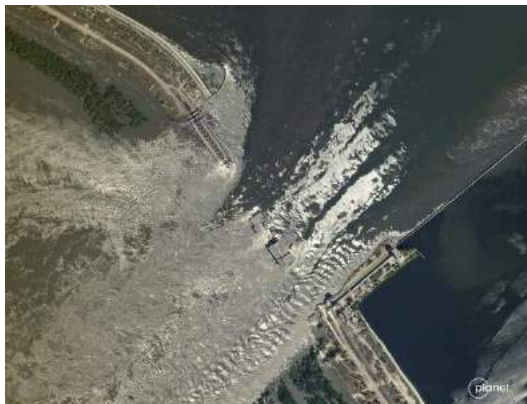


MeteoSwiss
Temperature and Precipitation

Rapid mapping

- Kachowka dam
 - Pre-dam-break (before 06.06.2023)
- S2 overpass this morning, data available in the evening
 - Map large-scale flooding
 - Assess impact on agriculture and local livelihoods

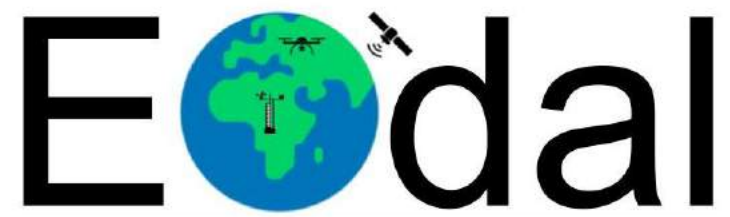
Destroyed
dam on
06.06.2023



EOdal – we want you!

- Contributions of all kind are very welcome!
- Coding
 - Expand functionality (new platforms, methods, ...)
 - Tests
 - Bugfix
 - Maintenance
- You don't need to code!
 - Tutorials
 - Improve the documentation
 - Got a good idea? Start a discussion on Github!



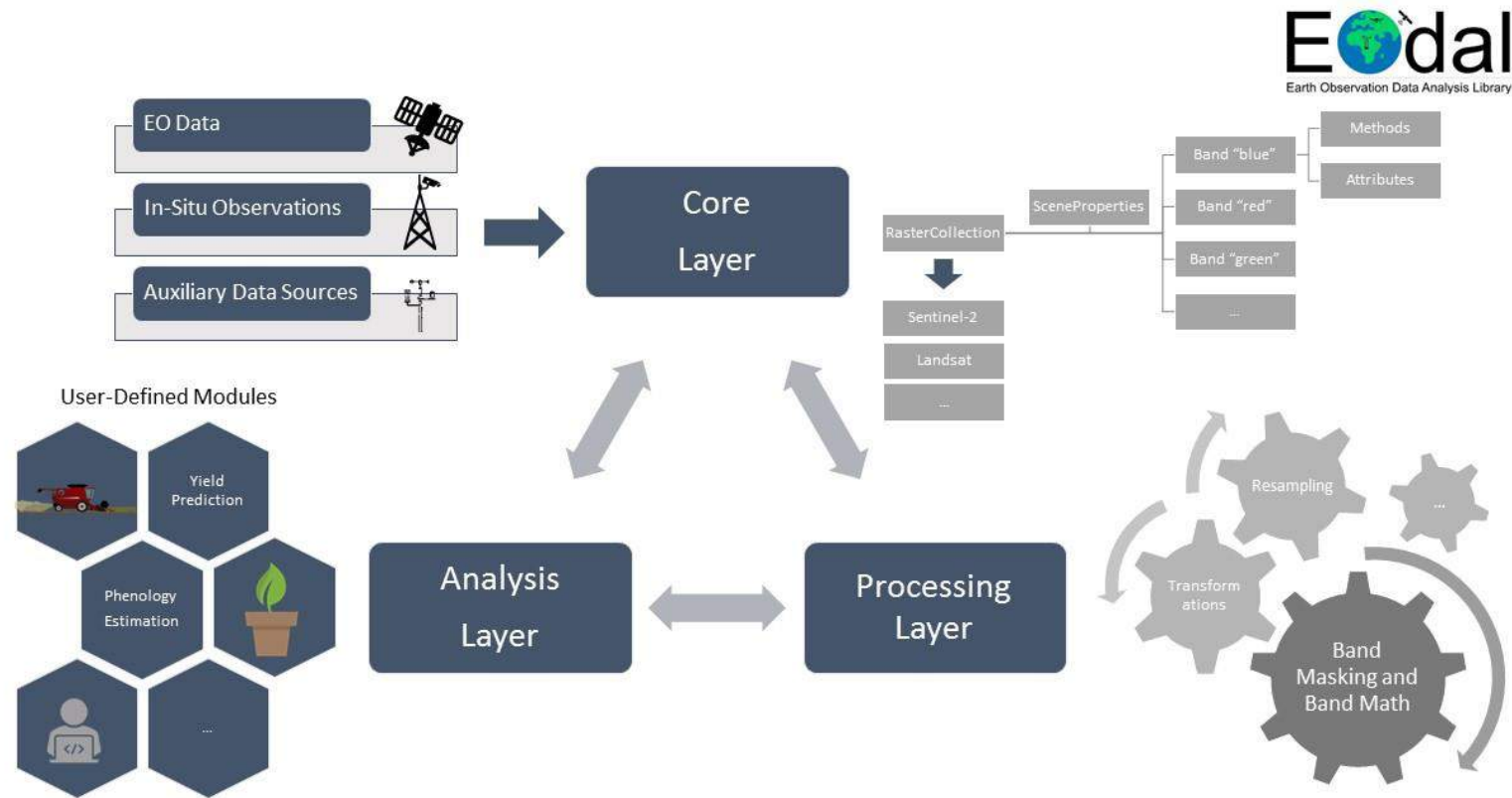


Earth Observation Data Analysis Library

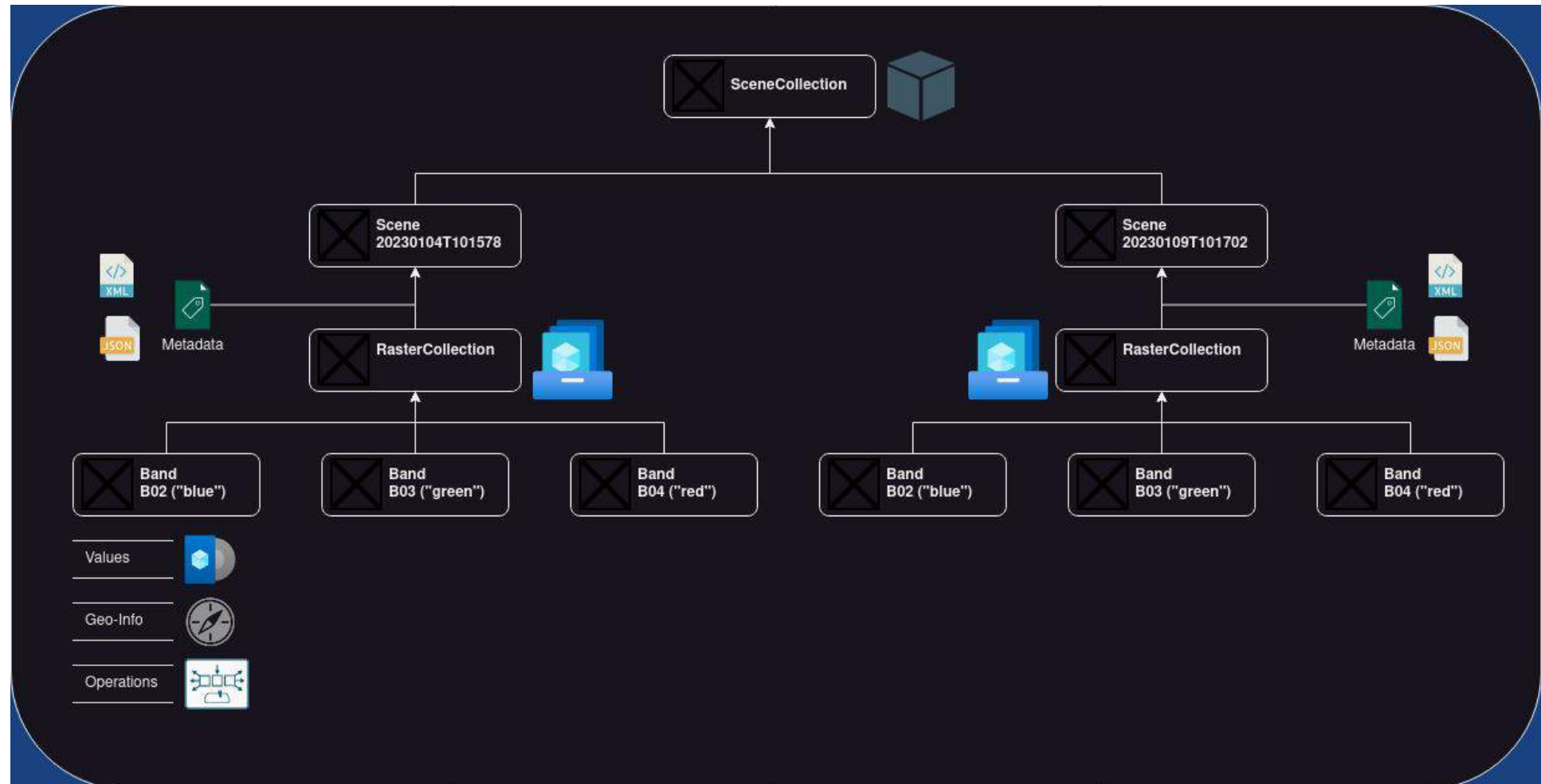
Thank you!

Technical Deck

EOdal – Modules (“Layers”)



EOdal – Data Model



EOdal – Support for EO Platforms

- ✓ Sentinel-1

- GRD
- RTC

- ✓ Sentinel-2

- Level 1C
- Level 2A (Sen2Cor)

- ✓ PlanetLabs

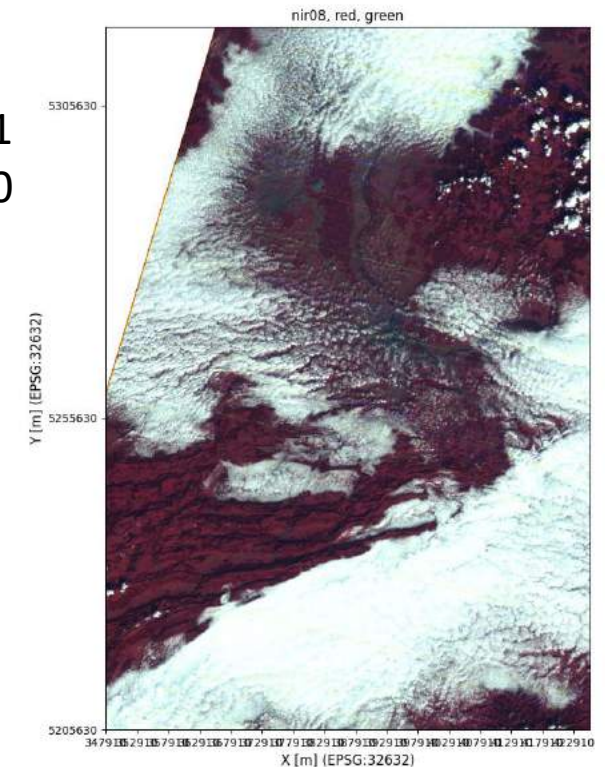
- ✓ Landsat

- Collection 2 Level 1+2

- ✓ Any data format understood by GDAL and dataset offered by STAC

- ✓ Adding new platforms and sensors easy and straight-forward thanks to the sensor-agnostic design of the core and mapper sub-packages and modularity

Landsat 1
1972-09-20



Why not ...

OpenDataCube (xarray)

- Highly complex setup
- Only datasets ingested can be used -> limited flexibility
- xarray mimics a file format (netCDF) -> does not provide a sophisticated EO data model
- API complex -> hard to learn

OpenEO

- Only supports (pre-defined) cloud-workflows -> limited flexibility
- Complex handling and setup
- Not lightweight -> maintenance questionable

Google Earth Engine

- Proprietary API -> locked-in effects -> high business risk
- “black-box” -> unclear what is going on

Scientific Deck



Contents lists available at [ScienceDirect](#)

Computers and Electronics in Agriculture

journal homepage: www.elsevier.com/locate/compag



EOdal: An open-source Python package for large-scale agroecological research using Earth Observation and gridded environmental data

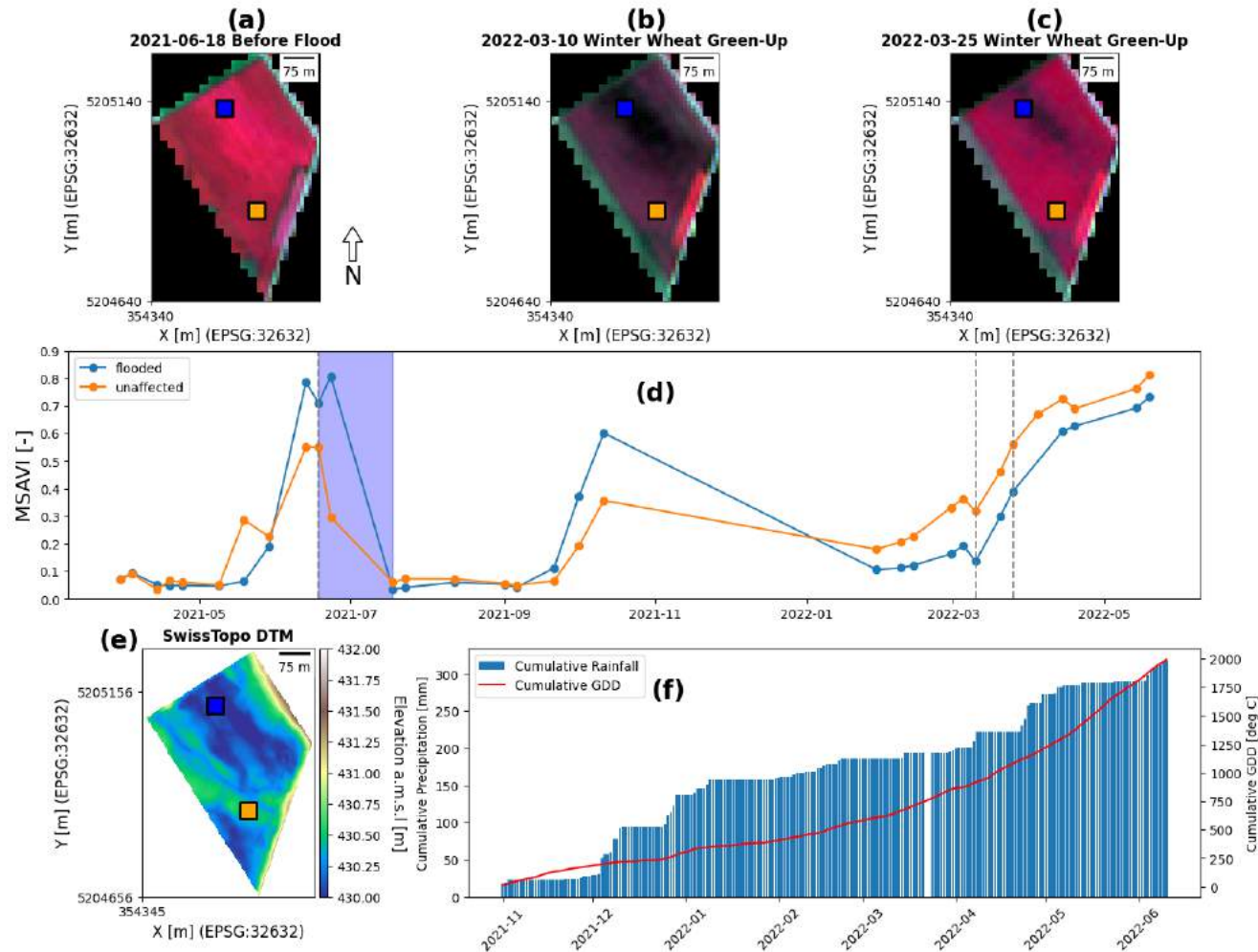
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<https://doi.org/10.1016/j.compag.2022.107487>

EOdal drives agricultural research



Understanding impacts of flooding
on crop productivity



Sentinel-2
Optical Imagery

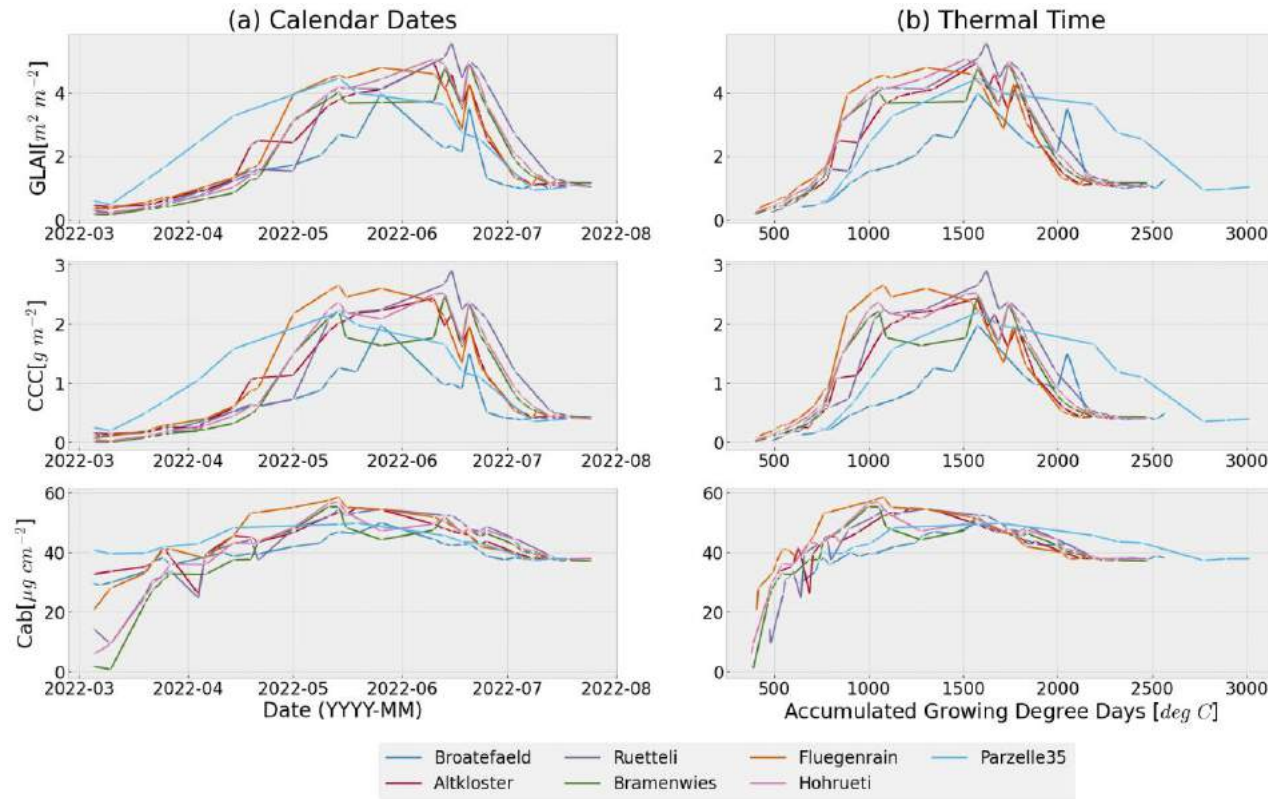


SwissTopo
Digital Elevation Model



MeteoSwiss
Temperature and Precipitation

EOdal drives agricultural research



Combining Sentinel-2 Imagery Time Series and Meteorological Data to Quantify Crop Growth and Development.

