Analysis of spatial data and communication of results

Hinrich Paulsen
(mundialis & terrestris)

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## Co-Founder of terrestris and mundialis

About terrestris

- **Founded in 2002**, located in Bonn, Germany
- 22 experts
  - Focus on Spatial Data Infrastructures and Geoportals
  - Open Source development
- Customers (excerpt): Federal Agency for Waterworks, *Federal Agency for Radiation Protection, German Telekom, German Railway, Van Oord Maritime Engineers, Province of Rhineland Palatinate, Cities of Aachen, Koblenz and Goettingen*

About mundialis
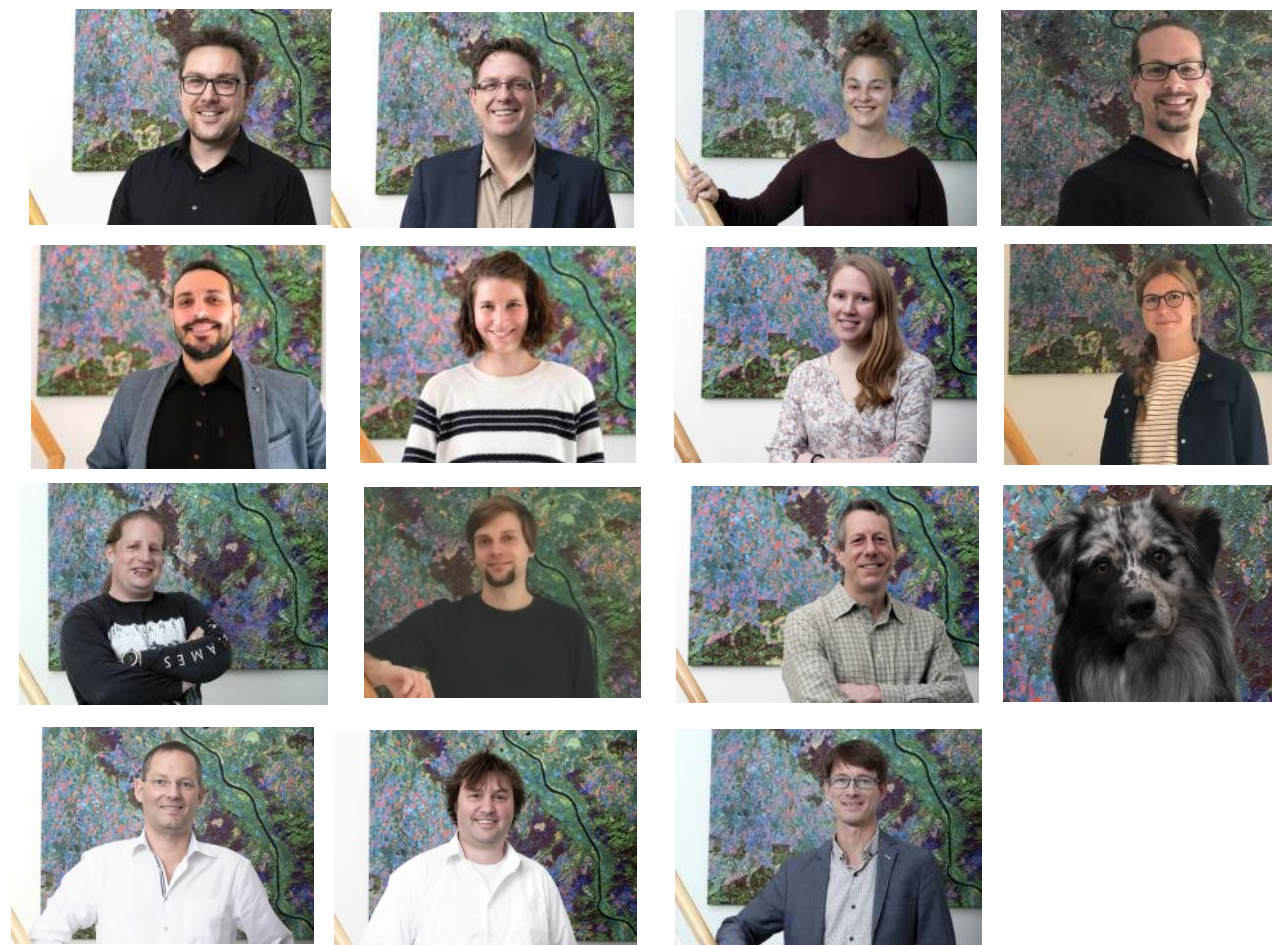
- **Founded in 2015**, located in Bonn, Germany
- 14 experts + 1 specialised in sleeping
  - Focus on Earth Observation and geospatial data analytics
  - Open Source and cloud development
- Customers (excerpt): *ESA, DLR, WHO, Deutsche Telekom, GIZ, Norwegian Env. Agency, Deutsche Bahn, German Archeological Institute*
- Research projects: numerous European (H2020, CEF) and nationally funded projects
  https://www.mundialis.de

mundialis expertise

Data and software products by mundialis

Data products

- **LST**, a dataset of seamless and gap-free daily European Land Surface temperature maps – https://www.mundialis.de/lst/

- **Landuse** maps – Change detection (Sentinel-2; aerial images)

- **Nightlight data**, visualization and analysis incl. zonal statistics – https://nightlight.mundialis.de/

- **Maps mundialis –** https://maps.mundialis.de/

- **Flood hazard (Sendai framework)**

Software products

- **actinia:** cloud based geoprocessing engine with REST API – https://actinia.mundialis.de/

- **QGIS** plugin development

- **GRASS GIS** software development – https://grass.osgeo.org/

From raw to Analysis Ready Data (ARD)

The majority of available data are not analysis-ready

- In mundialis, we develop "data interfaces" to many providers

- Data projection, pixel geometry, consistency, units, metadata, etc. are checked and corrected as needed

- For time series, we apply gap-filling

  - This requires research and analytical capabilities as well as automated processing

- From ARD, we then generate derived products (e.g., aggregated data)

Time series reconstruction: Temperature

Example: MODIS Land Surface Temperature

raw data
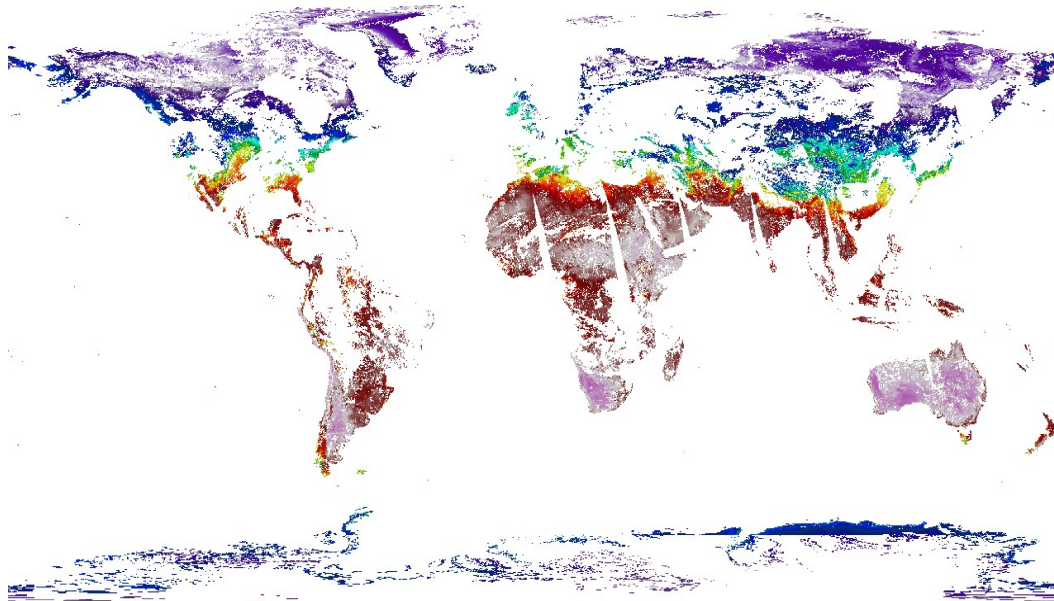
gap-filled data
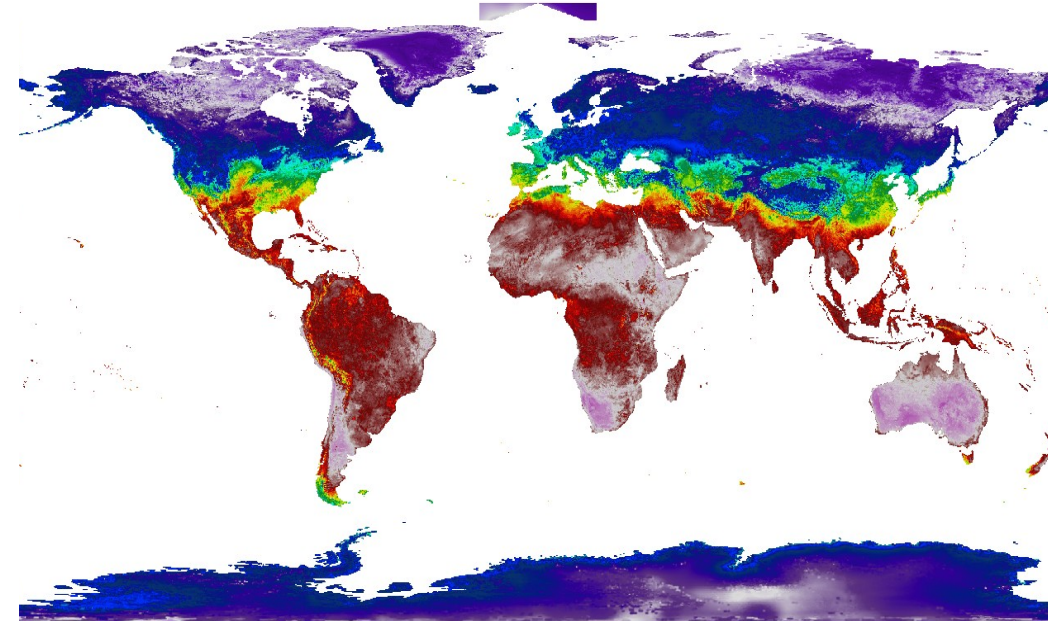
temporal + spatial processing

MODIS LST daily time series

Pixel-wise time series
(meteo stations versus
MODIS LST maps):

Arco monthly averages   • Meteo   • MODIS LST
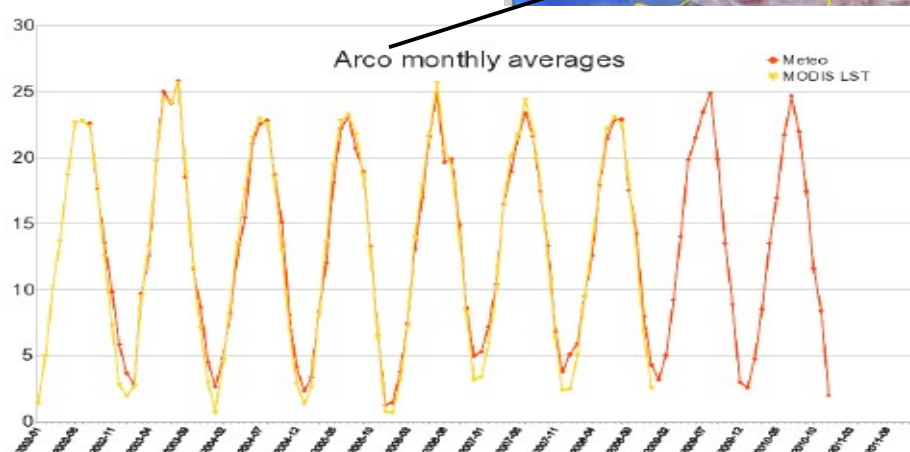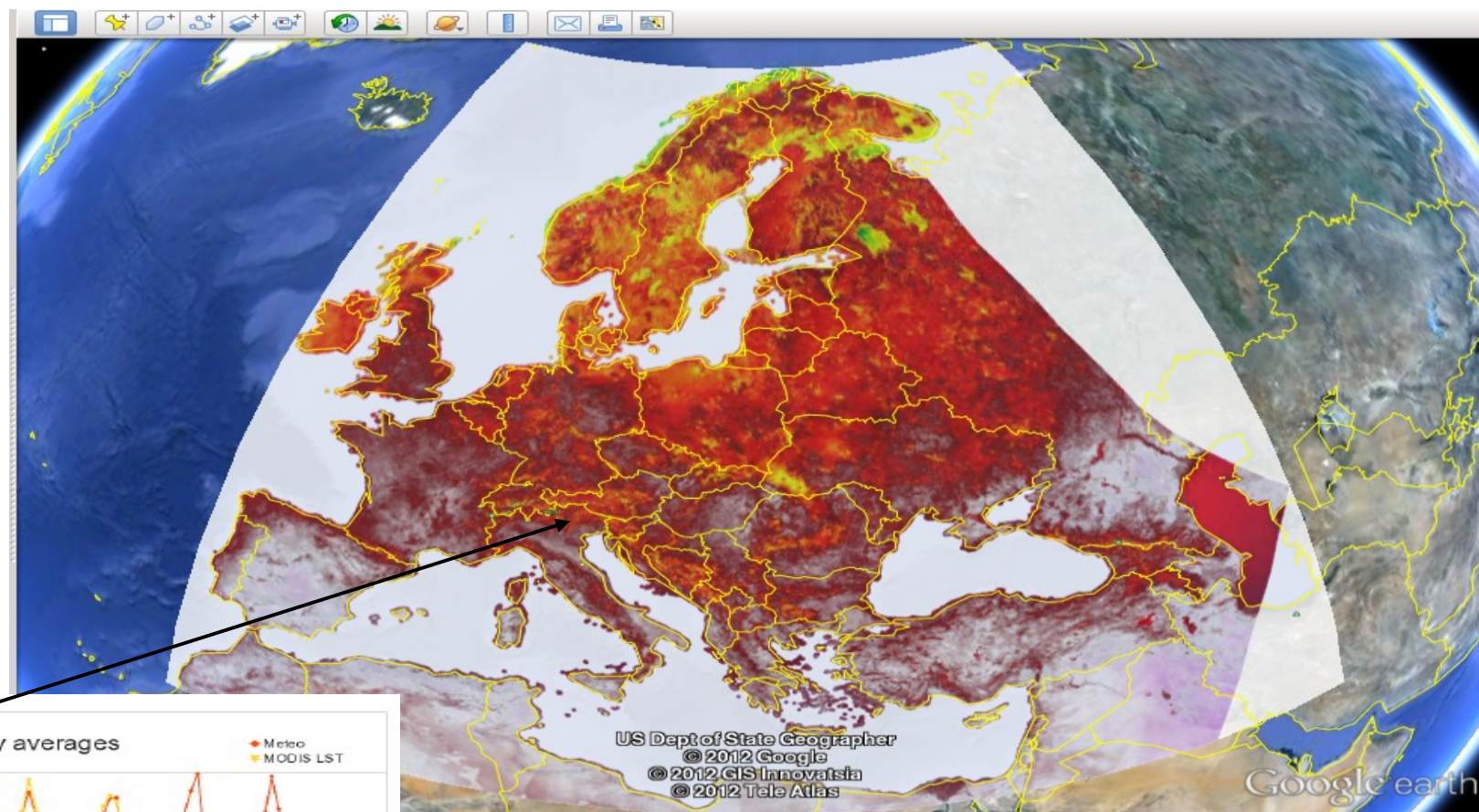
European LST mosaic

... usable as **virtual meteorological stations for temperature**

250m resolution,
4 maps per **day**,
data since 2000

Metz, Andreo & Neteler, 2017 [DOI]

*Neteler, M., 2010: Estimating daily LST...
Remote Sensing 2(1), 333-351 [PDF]*

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Land Surface Temperatures from Space

GDD as a heuristic tool in phenology

- Heat accumulation above the threshold value for predicting the development rates of plants and animals (flowering, insect development or time of plant maturity).
- Example: Determining the anniversary (DOY) when 440 GDD was reached in 2003 and 2006

Growing Degree Days from Meteo and MODIS LST
Station/position Trento Sud

440 GDD threshold
→ insect moulting

DOY 145

Drosophila suzukii

Day of year (DOY) for reaching 440 GDD, 2003

Grey: threshold not reached

2003

118   161   204   247   290

Day of year (DOY) for reaching 440 GDD, 2006

Grey: threshold not reached

2006

126   177   228   279   331
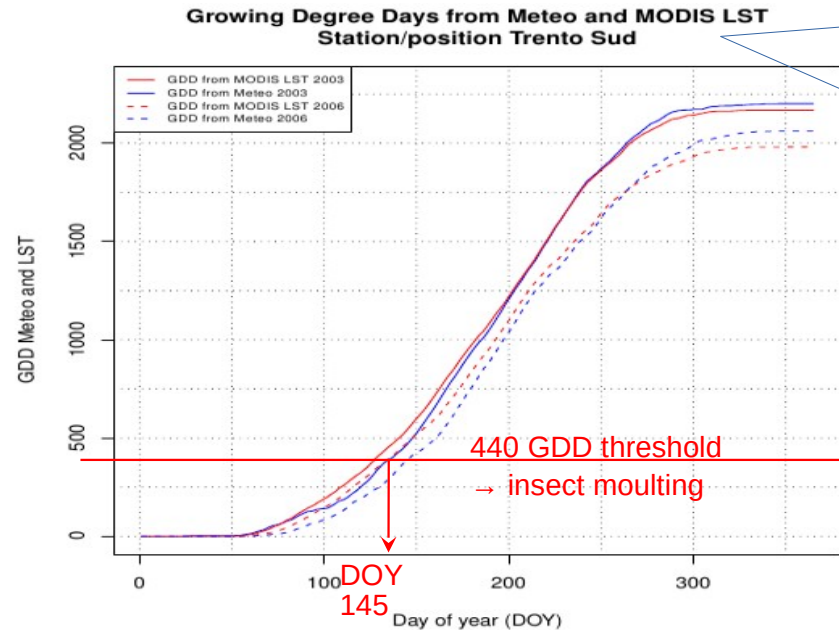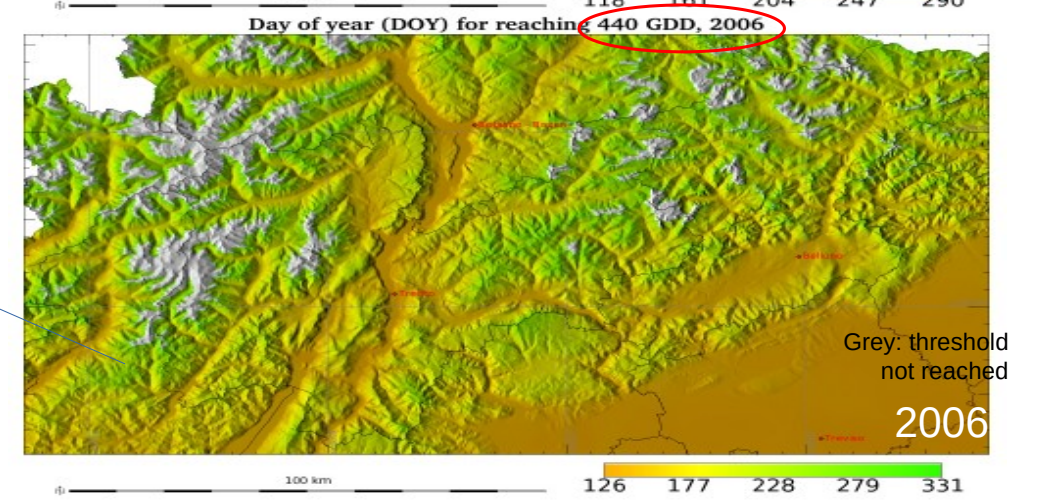
Data: EuroLST

MOOD H2020 EU project:
MOnitoring **O**utbreak events for **D**isease surveillance
in a data science context

MOOD H2020 EU project:
MOnitoring **O**utbreak events for **D**isease surveillance in a data science context

Diseases and vectors

- **Viruses**
  - Influenza: Seasonal Influenza + Avian Influenza
  - Tick-Borne Encephalitis (TBE) virus
  - Chikungunya virus | mosquito-borne
  - Dengue virus | mosquito-borne
  - Zika virus | mosquito-borne
  - West Nile Fever (WNV) flavivirus | mosquito-borne
  - Usutu flavivirus | mosquito-borne
  - COVID-19 virus | mode of transmission
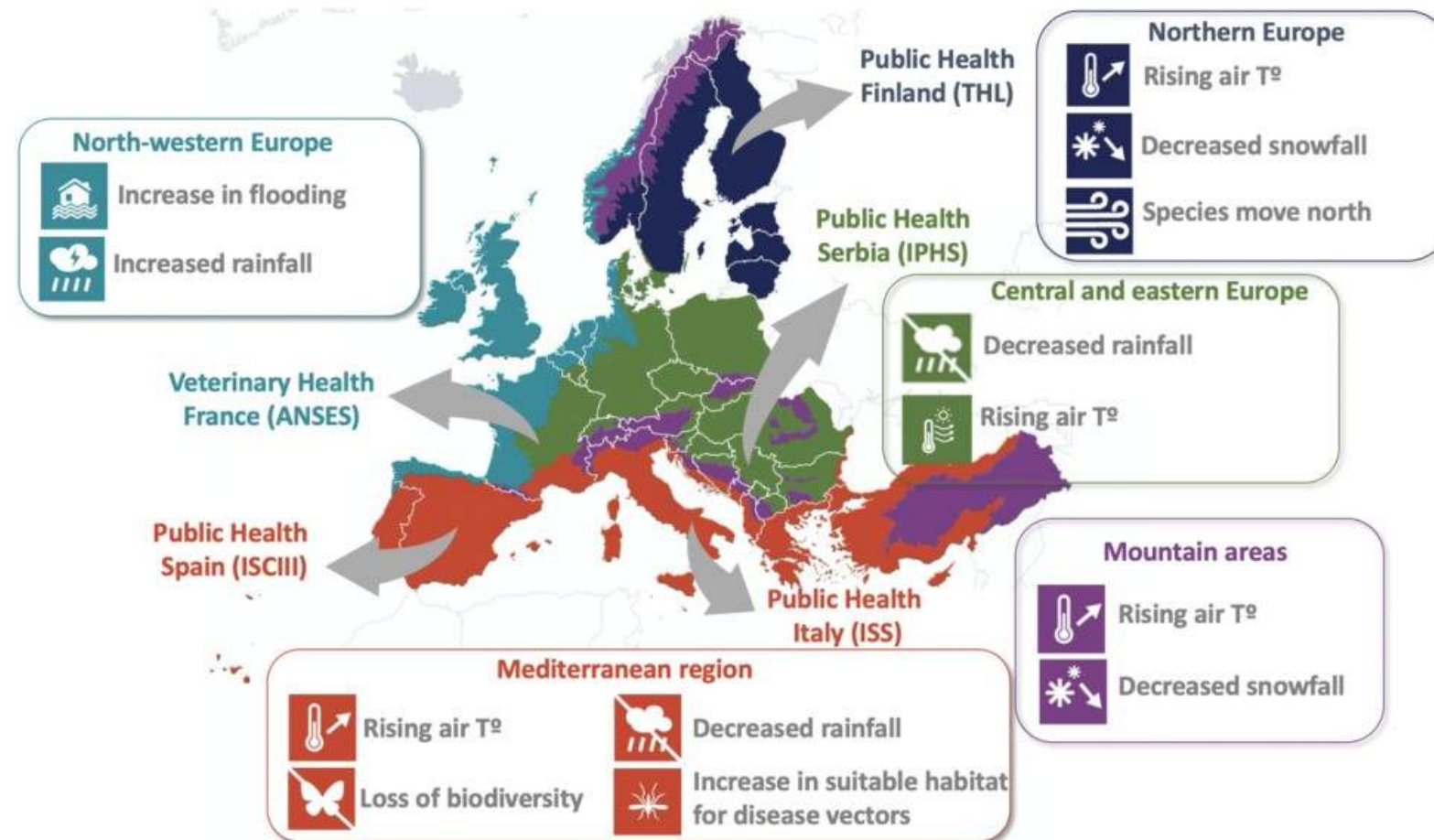
- **Bacteria**
  - Tularaemia (rabbit fever) - bacterium Francisella tularensis | spread by ticks, deer flies, or contact with infected animals
  - Leptospirosis - bacterium Leptospira | mode of transmission
  - Lyme - bacterium Borrelia | tick-borne

- **AMR** - Antimicrobial resistance

- **Disease X**

Anomalies from LST   Precipitation   NDWI   NDVI   Globcover: land use   Biomes: Anthromes
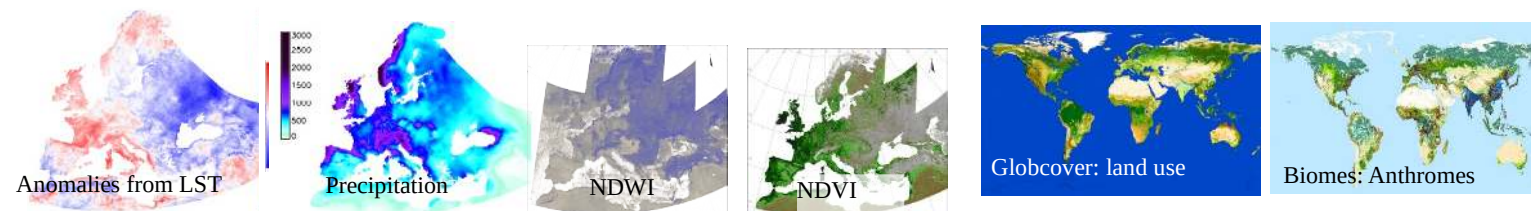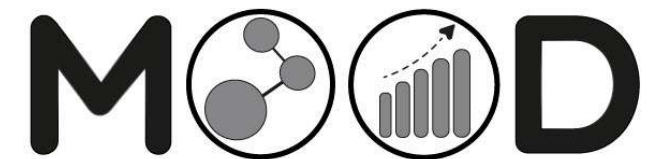
The problem: Emerging infectious diseases

Focus on zoonotic diseases

- transmitted from animals to humans, usually by a vector (e.g., ticks, mosquitoes)

- reservoir hosts: wildlife and domestic animals

- zoonoses involve all types of agents (bacteria, parasites, viruses and others)

- Zoonotic diseases cause major health problems in many countries.

- They are driven by environmental and pathogen changes as well as political and cultural changes.

https://healthmap.org/
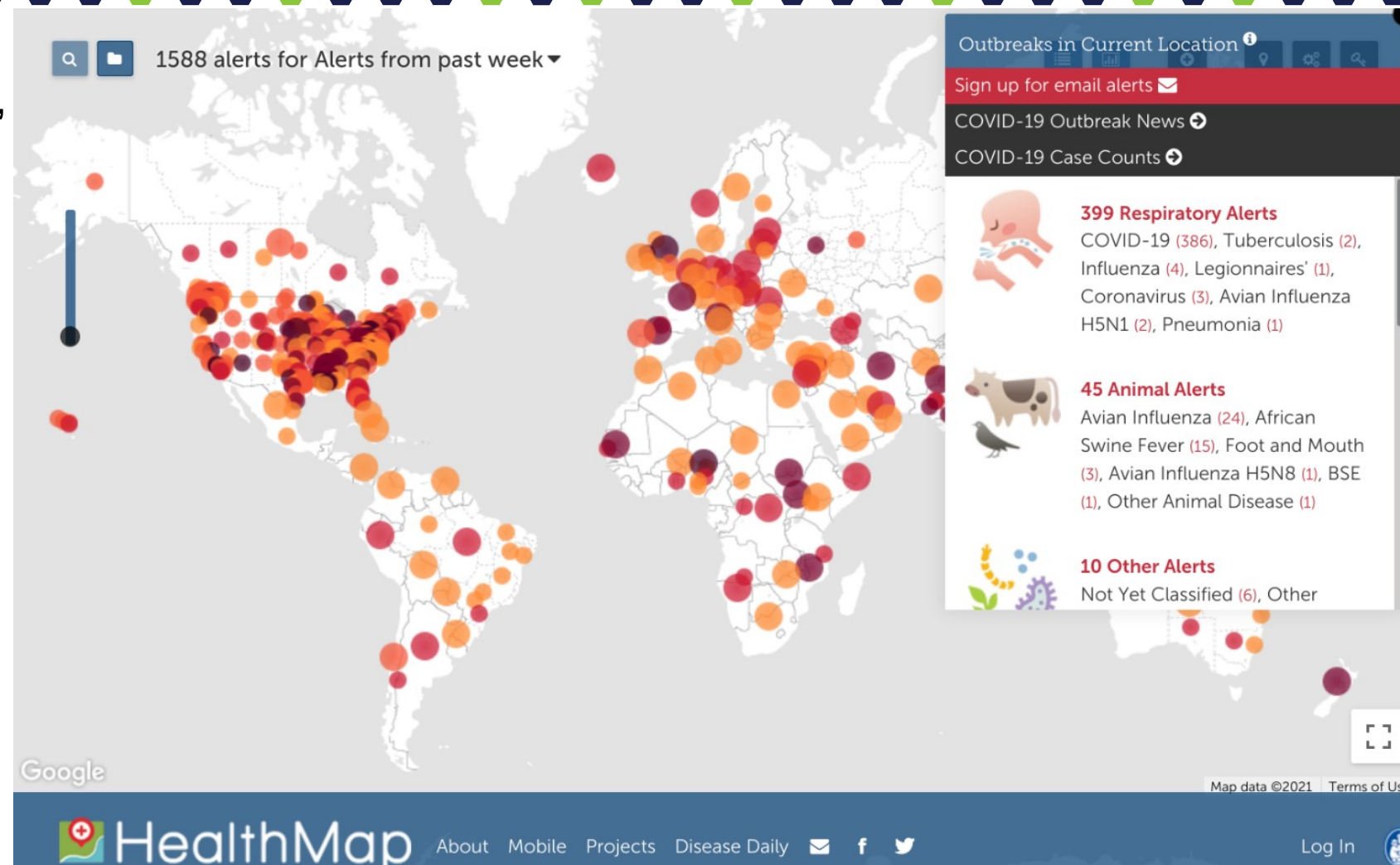
Environmental factors derived from satellite data

(incomplete view)

Pathogens

Vectors

Hosts

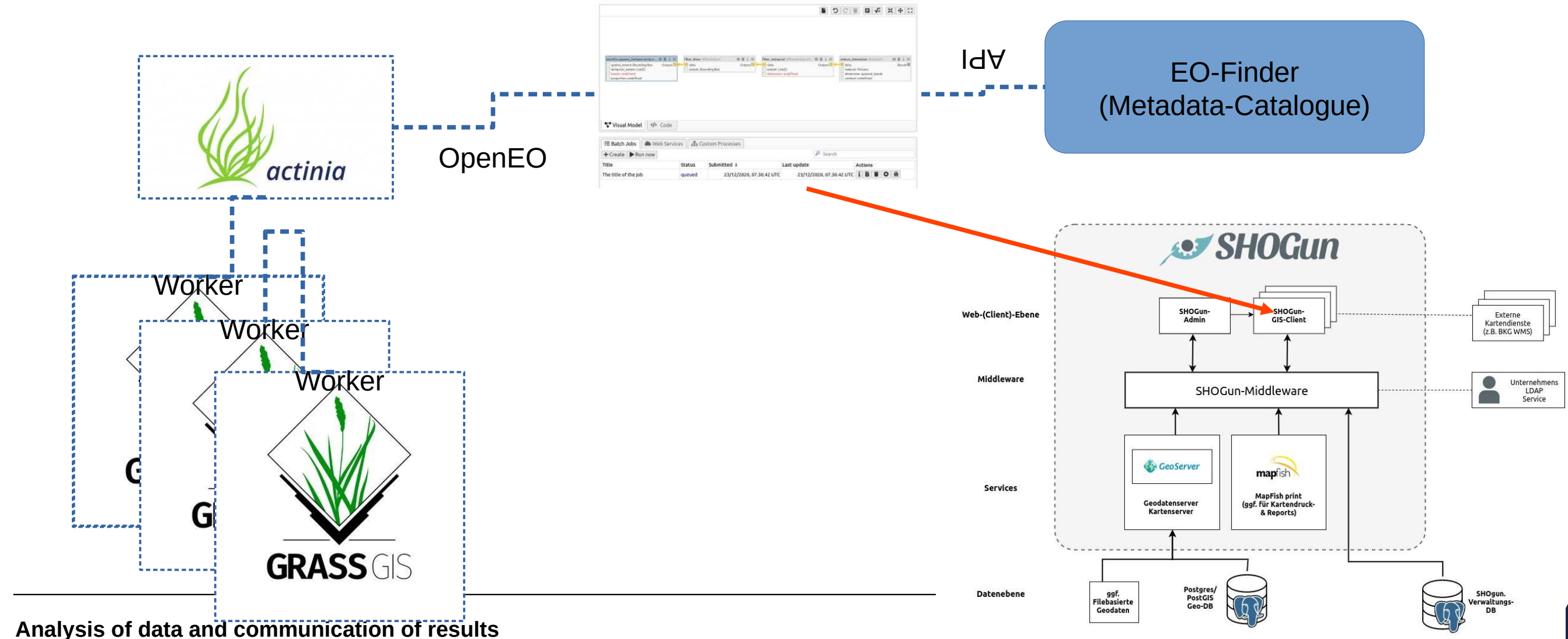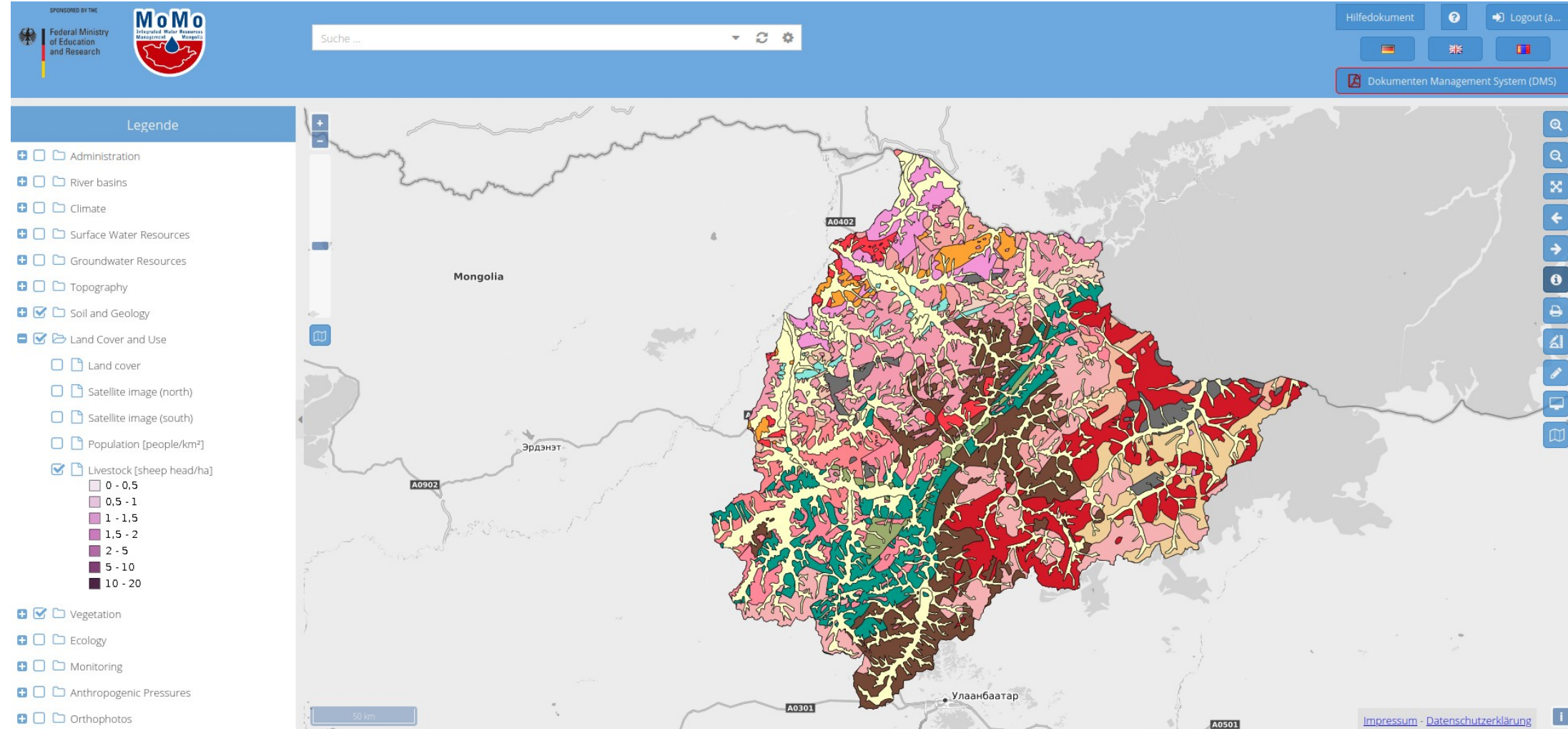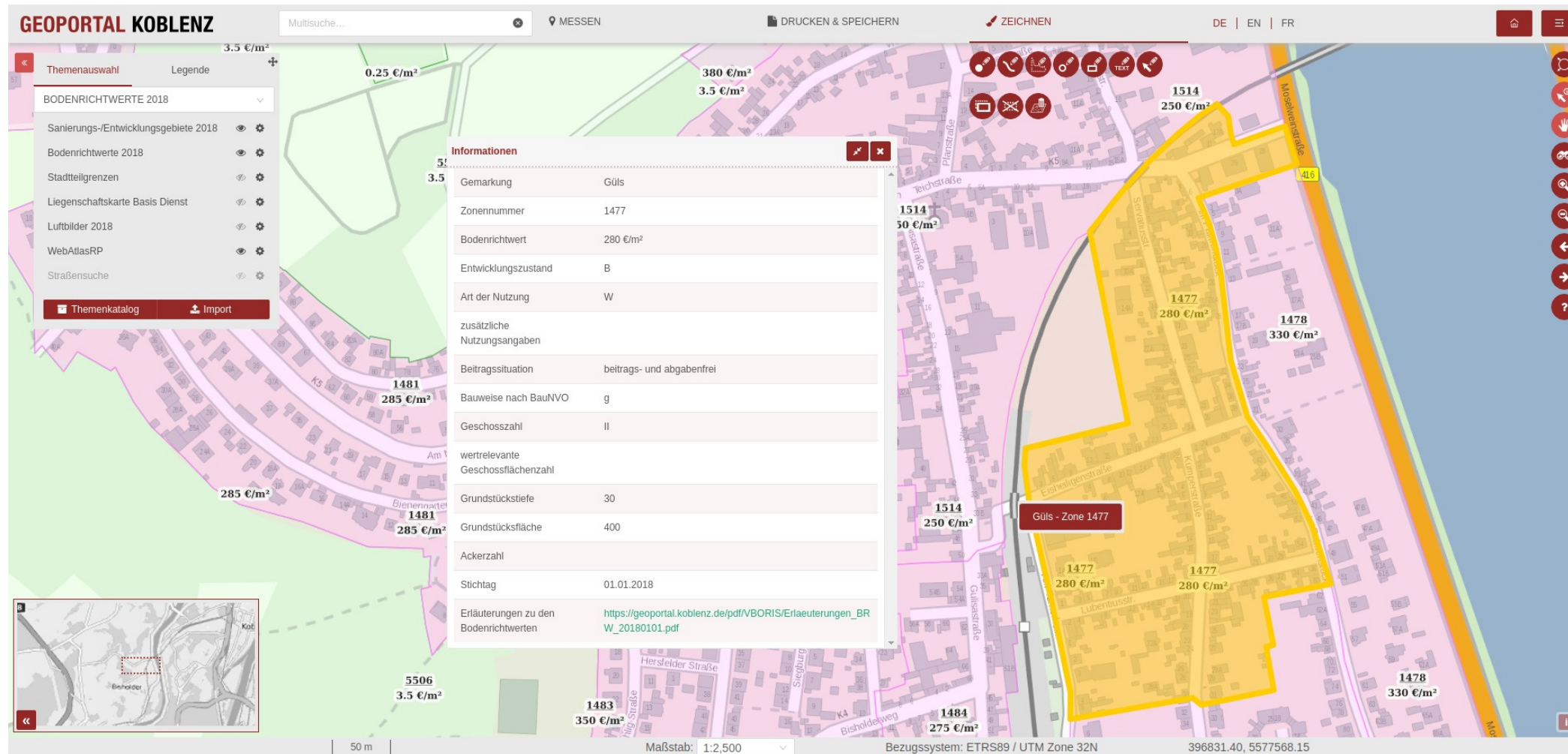| Temperature | e.g. MODIS LST |
Precipitation	e.g. CHMORP
Moisture / Humidity proxies	e.g. ASCAR
Topography	SRTM, ASTER GDEM
Vegetation cover	e.g. MODIS based
Land use	e.g. MODIS based

terrestris expertise:
Spatial Data Infrastructures (SDI)

EO-Finder
(Metadata-Catalogue)

OpenEO

API

Worker

Worker

Worker

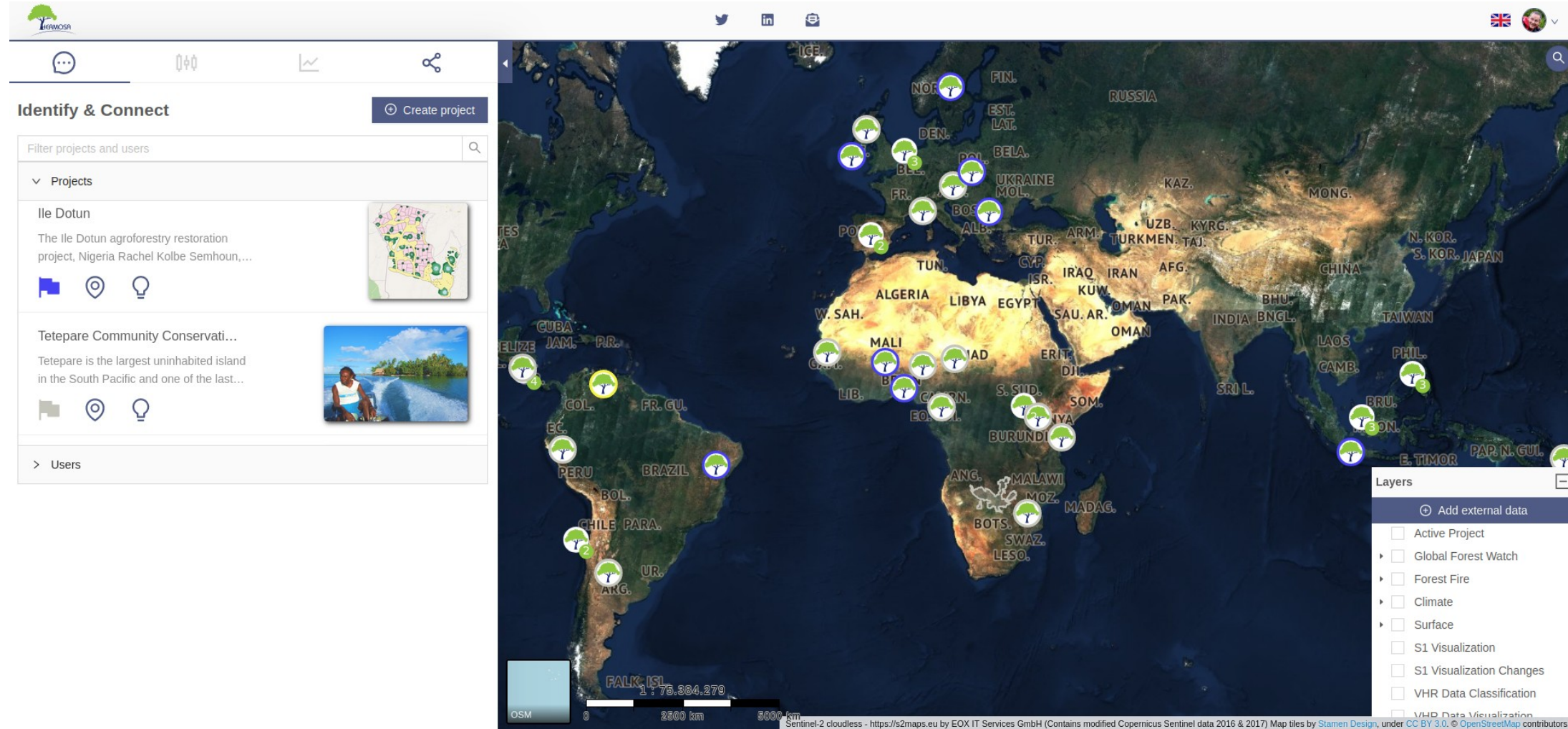Analysis of data and communication of results

Environmental and anthropogenic data from our Mongolia project 2010 – 2018
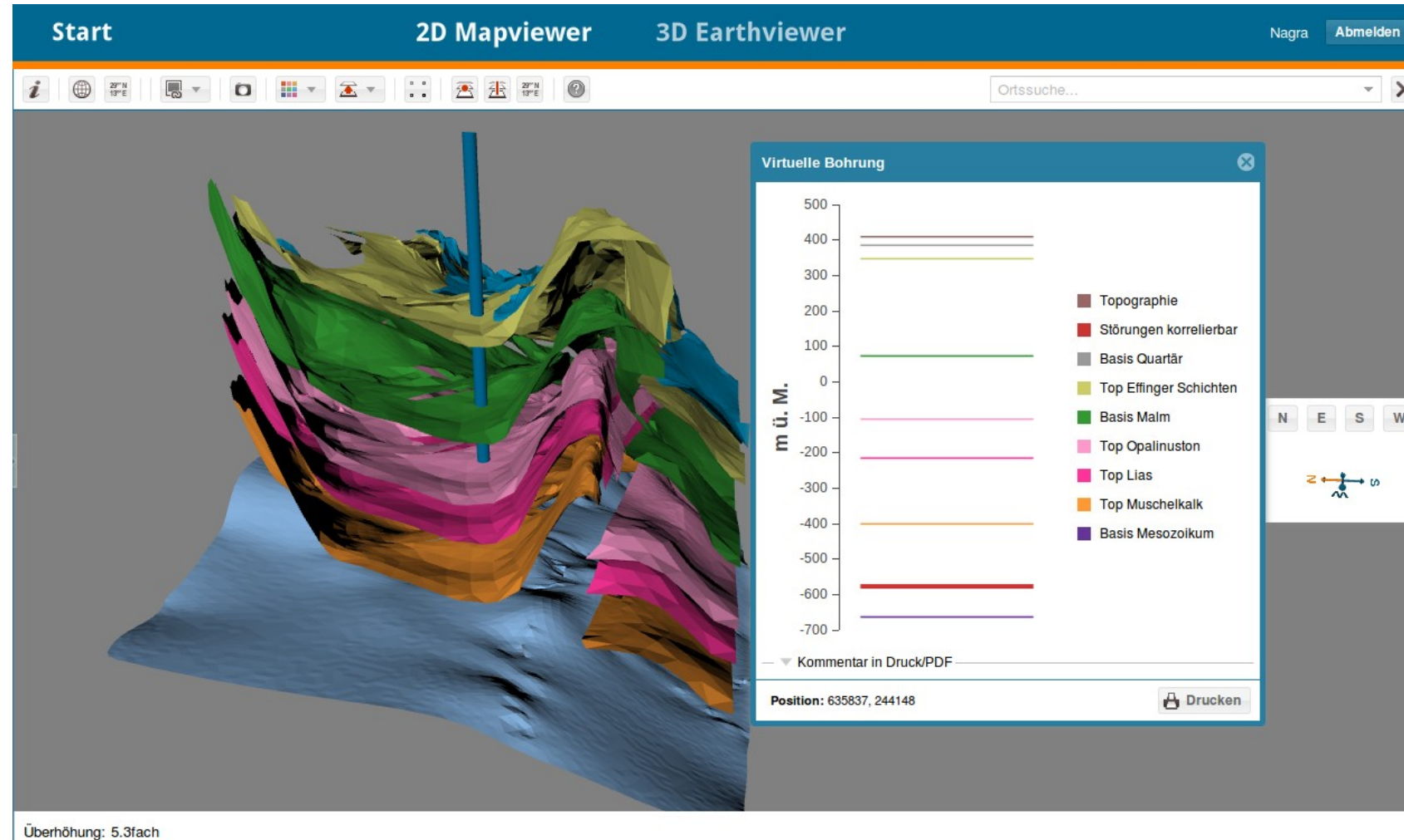
Geoportal Koblenz

Portal for Ecosystem Restoration

3D visualisation of geological strata

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