Soil sealing Identification and Monitoring System

SIMS

Automated identification of soil sealing hotspots based on Sentinel-2 time-series

EODC Forum 2022

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spatialservices

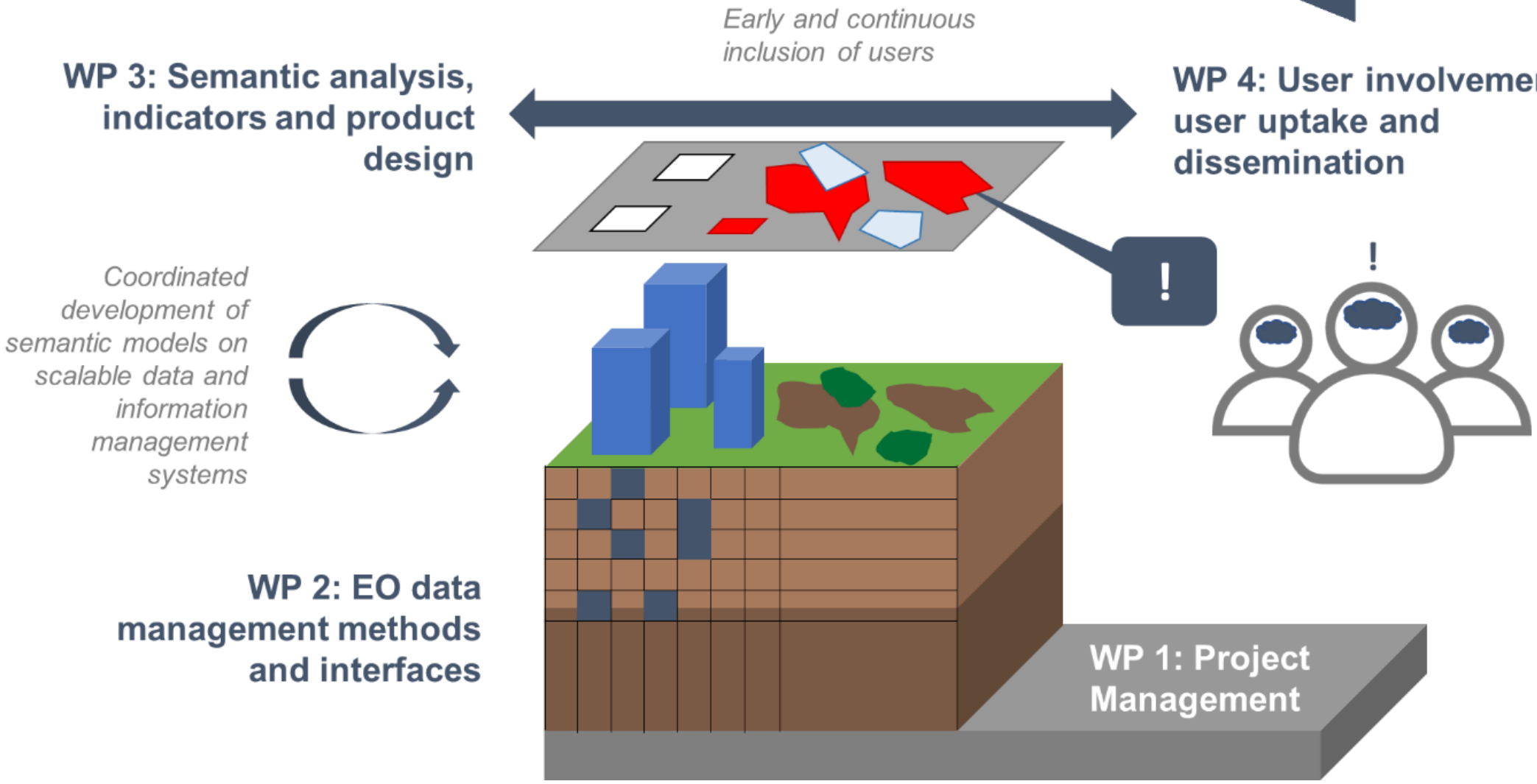
WHERE GEOINFORMATION MEETS TECHNOLOGY

The SIMS project

SIMS - Soil sealing identification and monitoring system

- Technological progress of Earth observation and cloud infrastructure offer new options to detect changes regularly
- Challenges:
  - Easy-to-use workflows, which are adapted to the technological progress
  - Include Copernicus data into existing workflows at institutions
- SIMS: Use Sentinel-2 time series to indicate soil sealing and offer it as **complementarily with integrations into existing workflows**, e.g. with dynamic analyses (i.e. not replacing existing workflows)

The SIMS project



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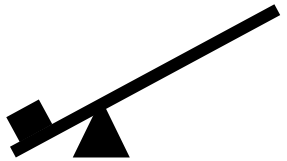
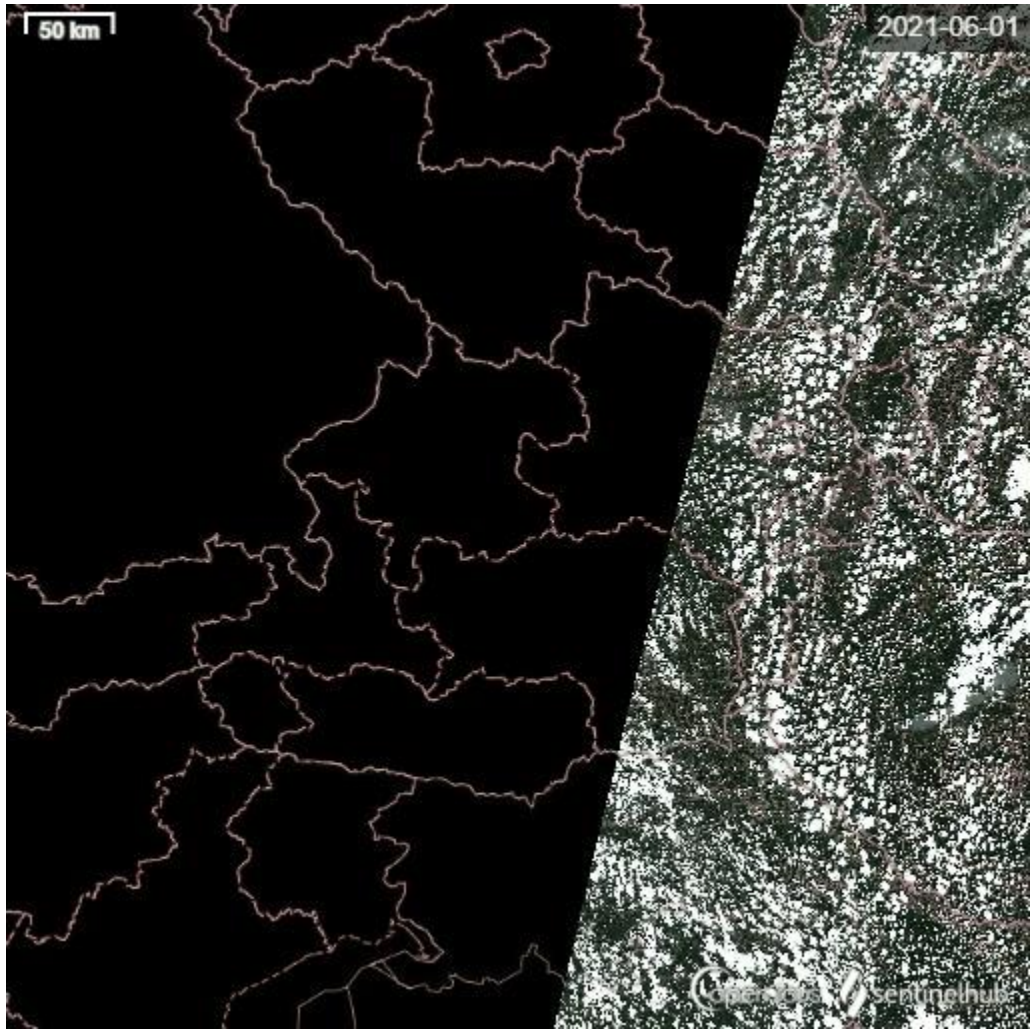
EODC

Our Sen2Cube.at semantic EO data cube for Austria uses EODC infrastructure & supports downstream research projects:

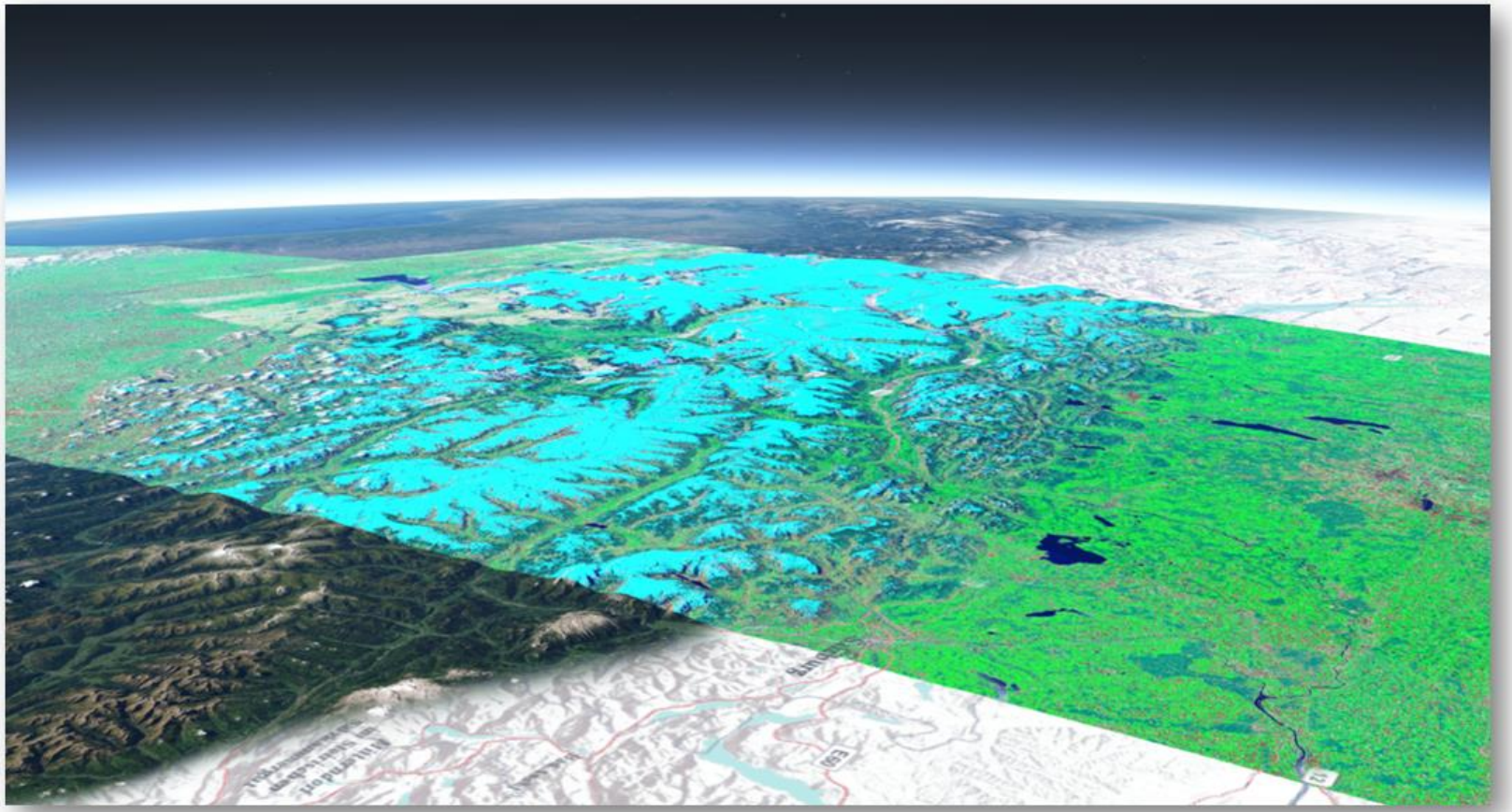
1. We are a **small team** at a University (4 + students) with limited resources
2. The **data access** provides access to all Sentinel-2 images that are required for out tasks
3. The **computational resources** provided to us allow conducting **significant analysis** and be part of a wider big EO data community
4. The **infrastructure and services are flexible** enough to create and deploy our own solution (in comparison to other providers) and scale it up
5. It leveraged a lot of our work in the last years, supported by additional grants (ORCRE, C-SCALE)



Sentinel-2 Coverage of Austria (Summer 2021), at least every 5 days a new image with 10 meter resolution



Sen2Cube.at



- Every Sentinel-2 image **has a semantic skin/layer:**
  - Reflectance values are associated to **spectral categories**
  - **Transferrable generic:**
    - Time-series of categories allow specification of classes downstream
  - complex, **graphical analyses** are possible
- **Multidimensional** data organization
- Rule-based: No black box

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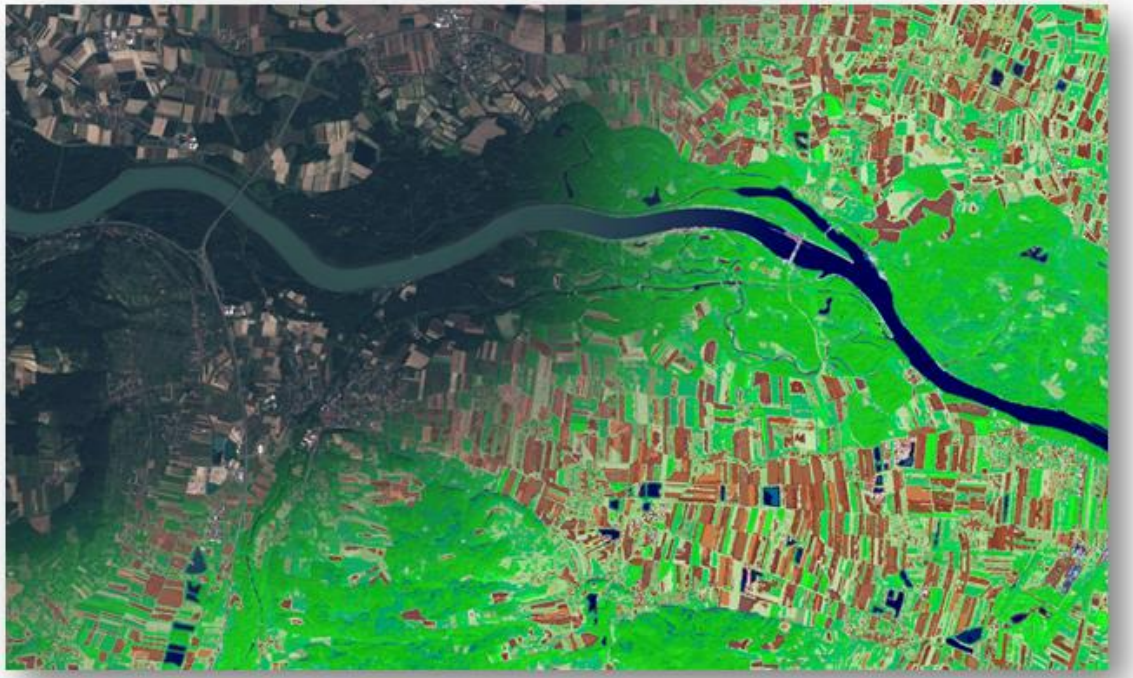
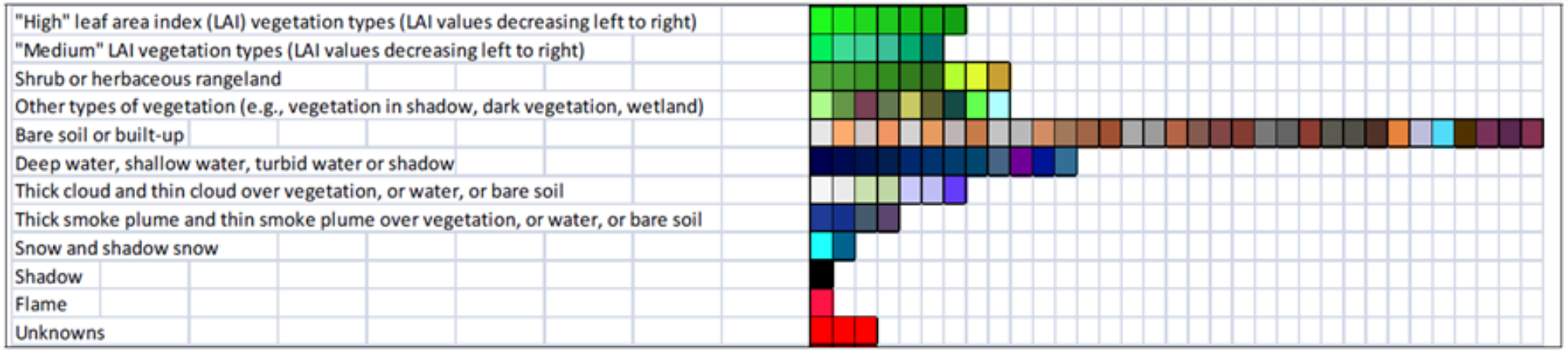
Semantic Enrichment

SIAM (Satellite Image Automatic Mapper) "multi-spectral colour naming"

- Fully automated, based on a physical model
- **No parameter, no training-samples**
- near real-time (approx. 5 min. for a Sentinel-2 granule)
- Scalable, parallelisable
- multi-sensor support (at least TOA calibration)



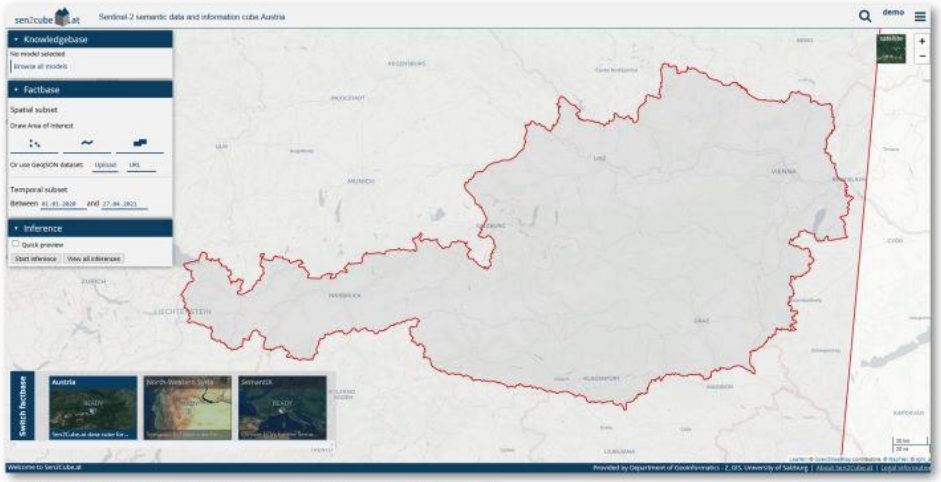


96 spectral categories

Baraldi, A., Humber, M.L., Tiede, D., Lang, S., 2018. GEO-CEOS stage 4 validation of the Satellite Image Automatic Mapper lightweight computer program for ESA Earth observation level 2 product generation – Part 2: Validation. Cogent Geosci. 4, 1–52. https://doi.org/10.1080/23312041.2018.1467254

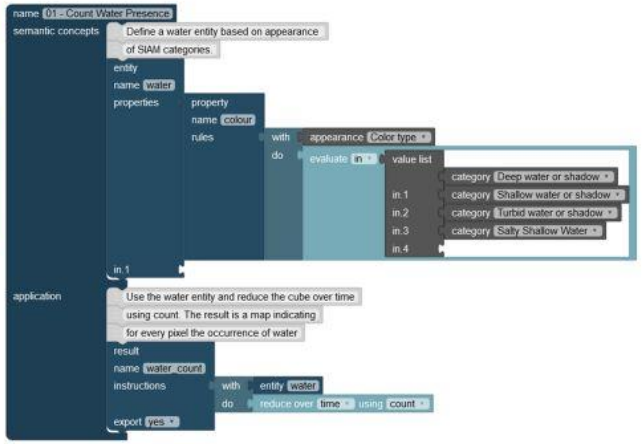
The Sen2Cube.at national semantic Earth observation data cube for Austria

sen2cube.at



SCBIR | Cloud-free composite | Phenology through time | ...

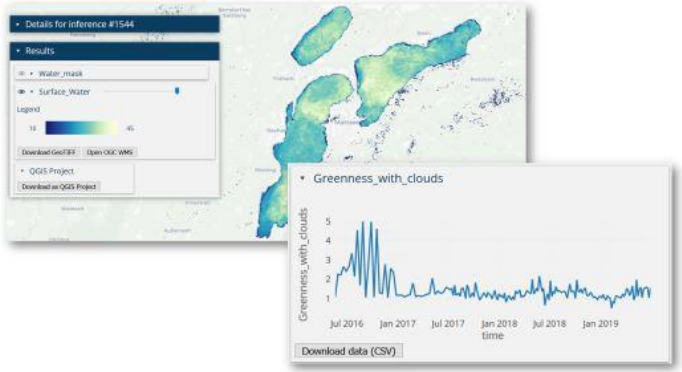
4 **Semantic querying language** with application-specific **visual models** and custom outputs:



3 Web-based **graphical inference engine** translates semantic models from the **knowledgebase** into data cube queries against the **factbase**

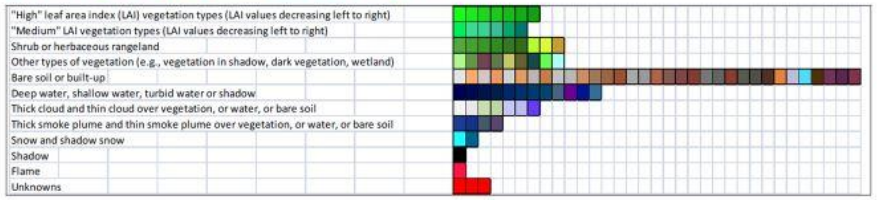
Shared knowledgebase

Generic factbase (data & information)



1 Worldwide applicable **automatic semantic enrichment** in different granularities with SIAM™

2 EO data cube in a **scalable Docker infrastructure** as application-agnostic, generic factbase



2015 - today

20 TB data

13.000 images

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FFG Promoting Innovation.

Sen2Cube.at is a project funded under the Austrian Space Applications Programme (ASAP 14)
Poster created: April 2021

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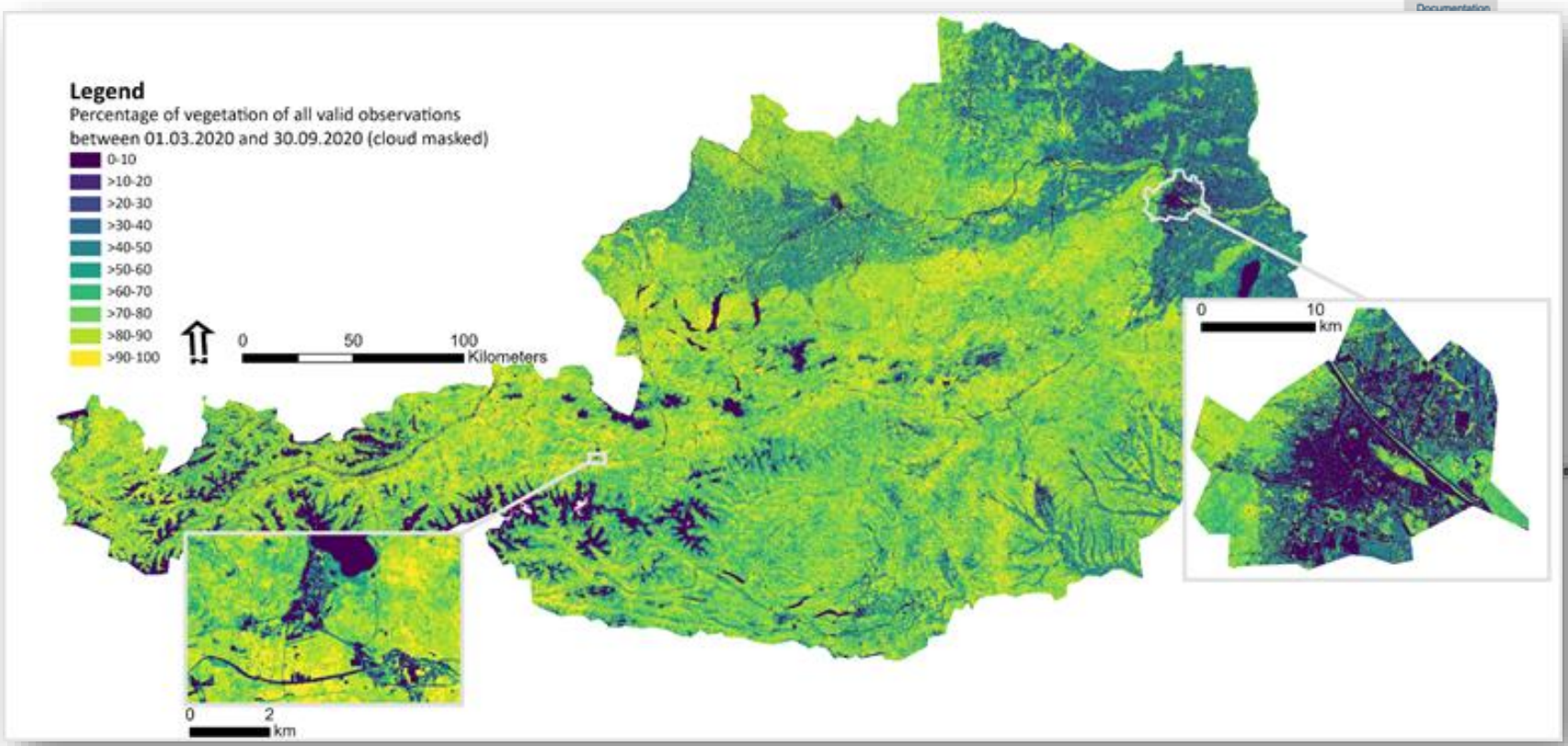
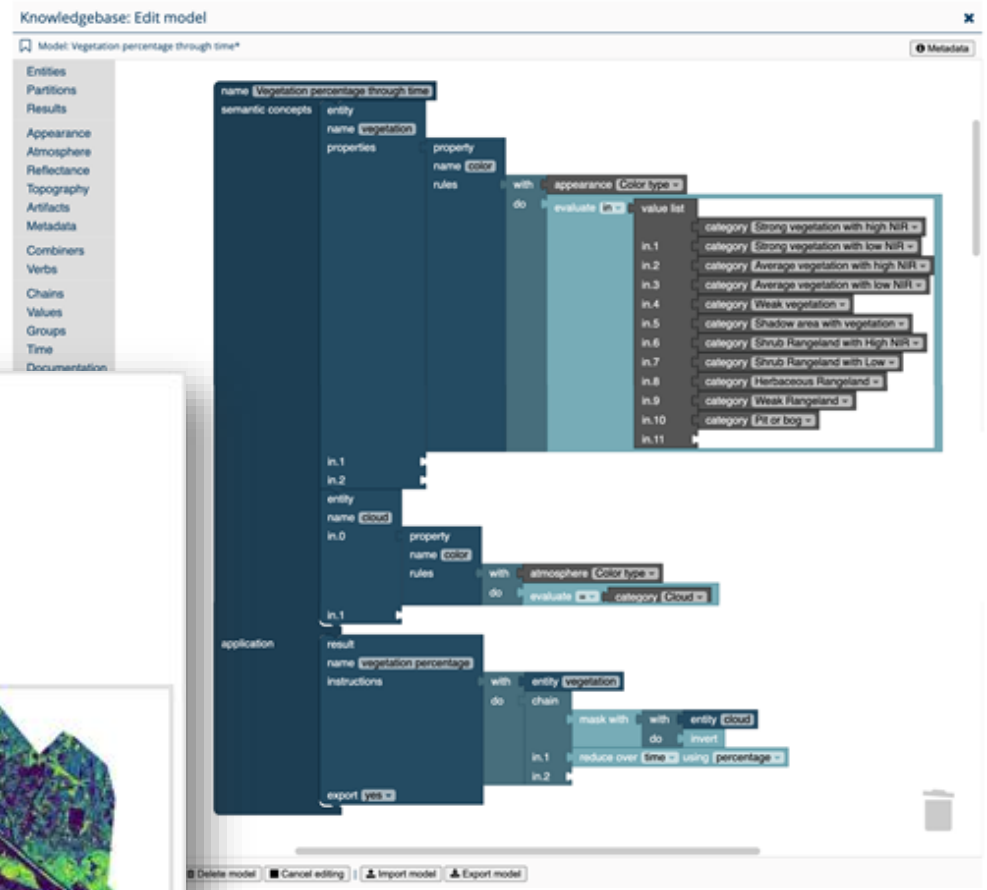
Example: How green is Austria?

Percent of vegetation observations between March and September 2020 (without clouds) for entire Austria





Sudmanns M, Augustin H, van der Meer L, Baraldi A, Tiede D. The Austrian Semantic EO Data Cube Infrastructure. *Remote Sensing*. 2021; 13(23):4807. https://doi.org/10.3390/rs13234807

Detecting soil sealing

Example

- **Inter- and intra-annual analyses** to identify changes of the Earth's surface (i.e., clouds need to be masked out)
- Time series of **spectral categories** allow formulating several assumptions, e.g.
  - A pixel time series that had consistently a category associated to vegetation is stable
  - A pixel time series that had never a category associated to vegetation is stable
  - If a pixel time series shows a change from categories indicating vegetation to categories indicating built-up or barren land, it shows potentially soil sealing
  - The reverse could be de-sealing
  - A potential soil sealing that becomes vegetated again can still have significant influence on soil parameters (greened roof, compaction, …)
  - …

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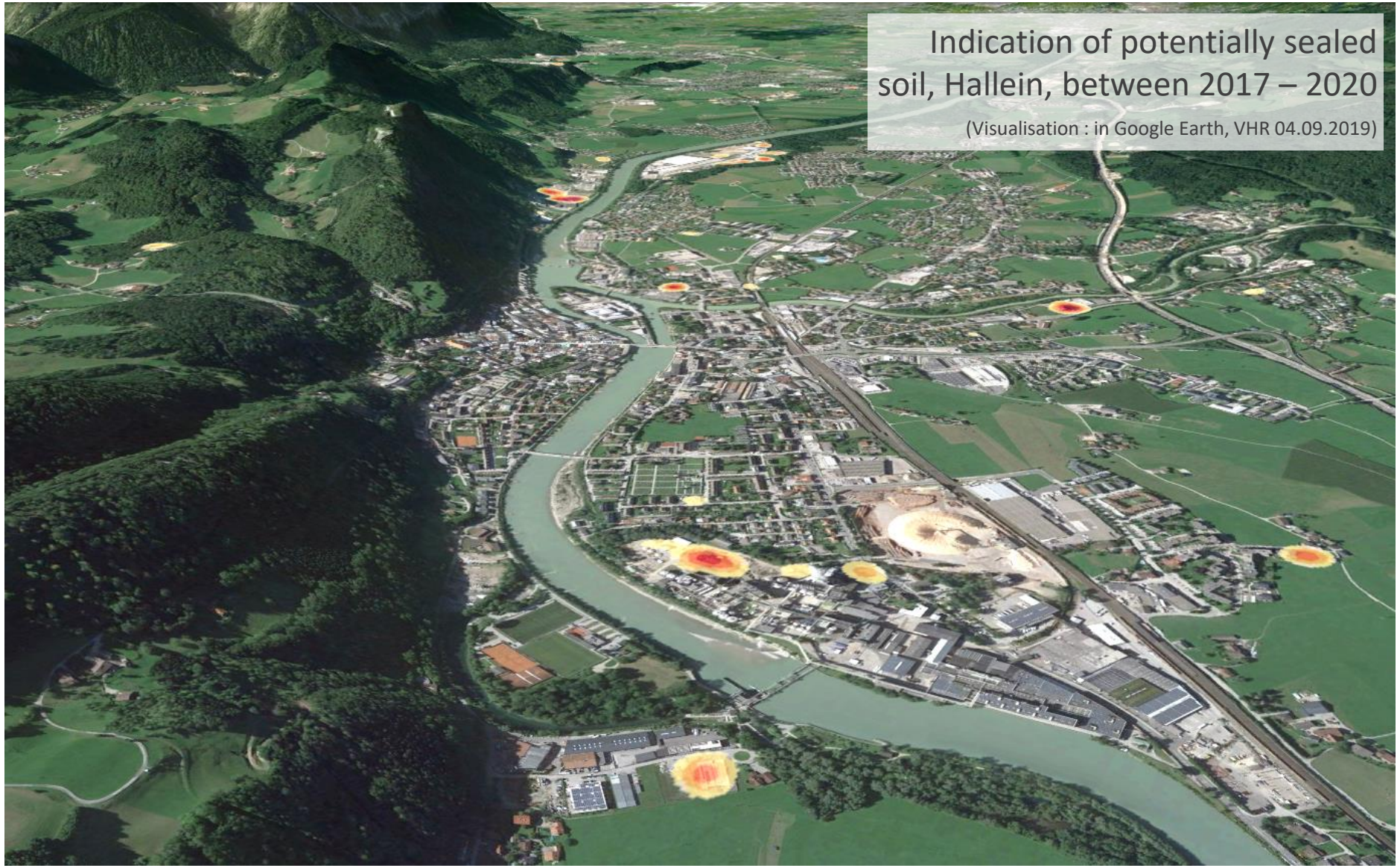
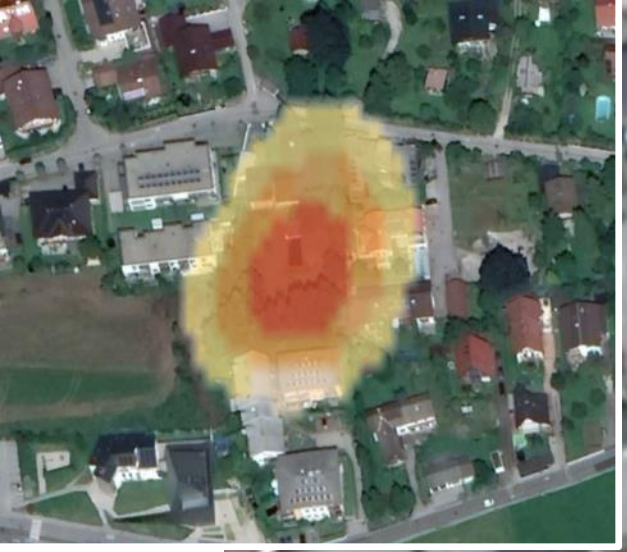
Example: Soil sealing indicators in Hallein

Example





2019


Pléiades
2020


Sentinel-2
2019
2020


Pléiades
2019
2020

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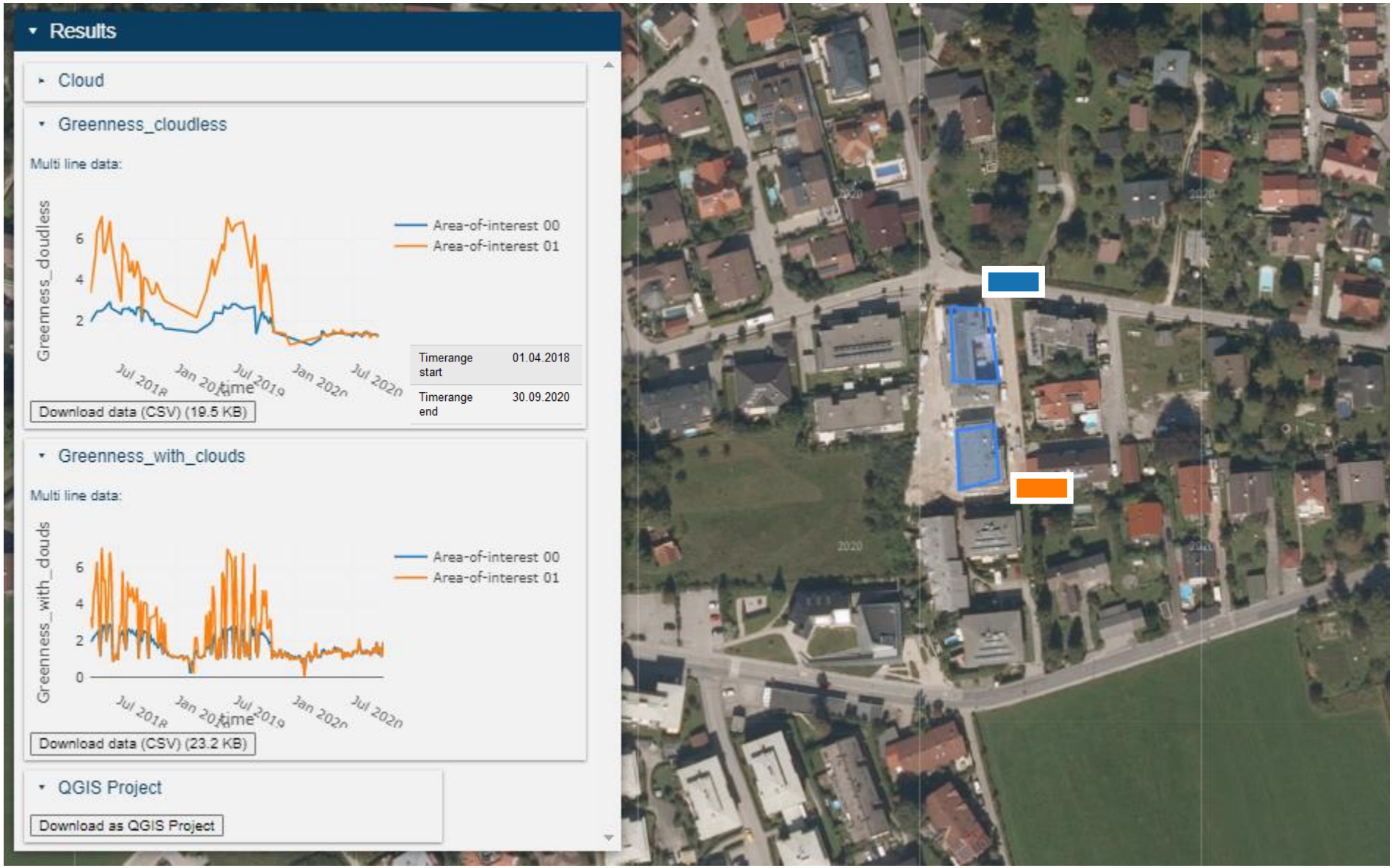

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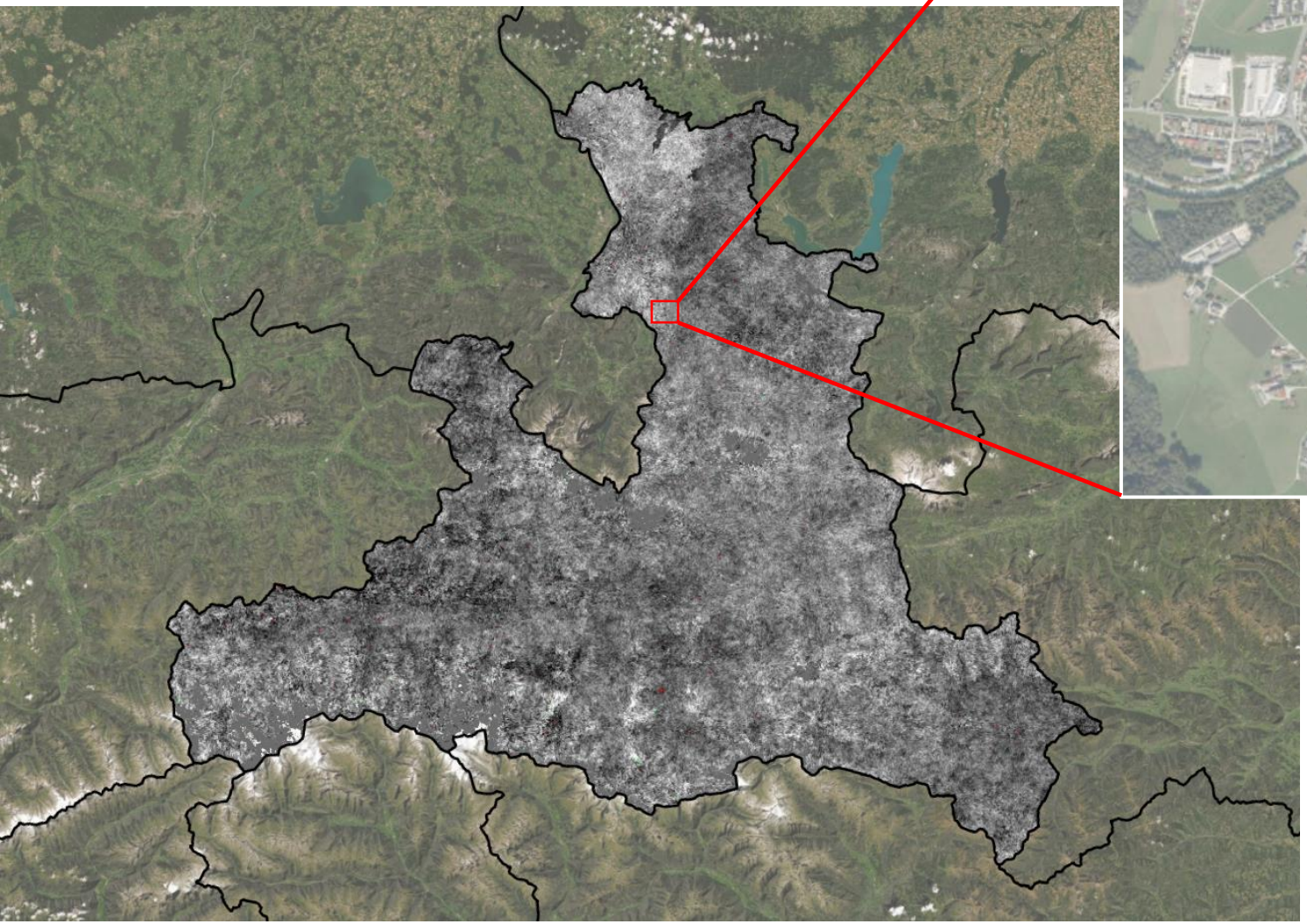
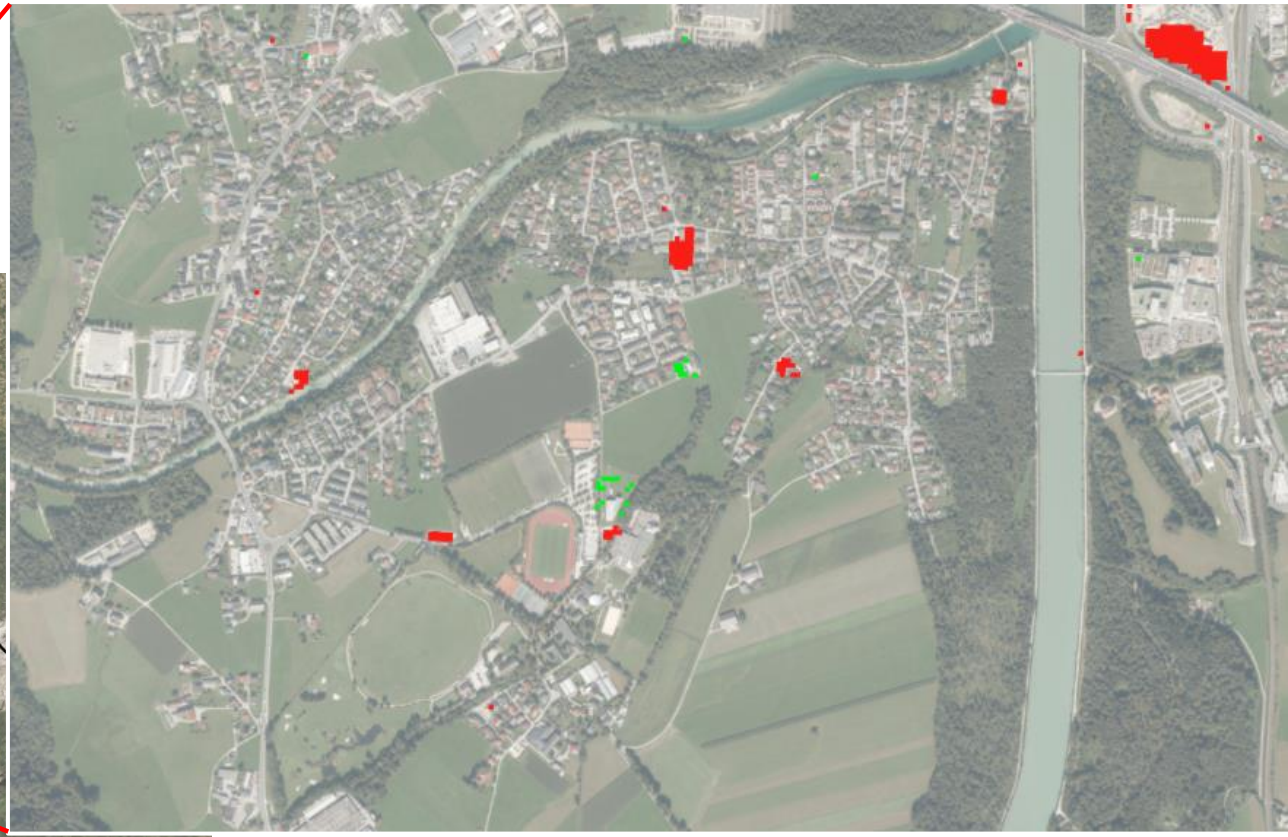
Upscaling



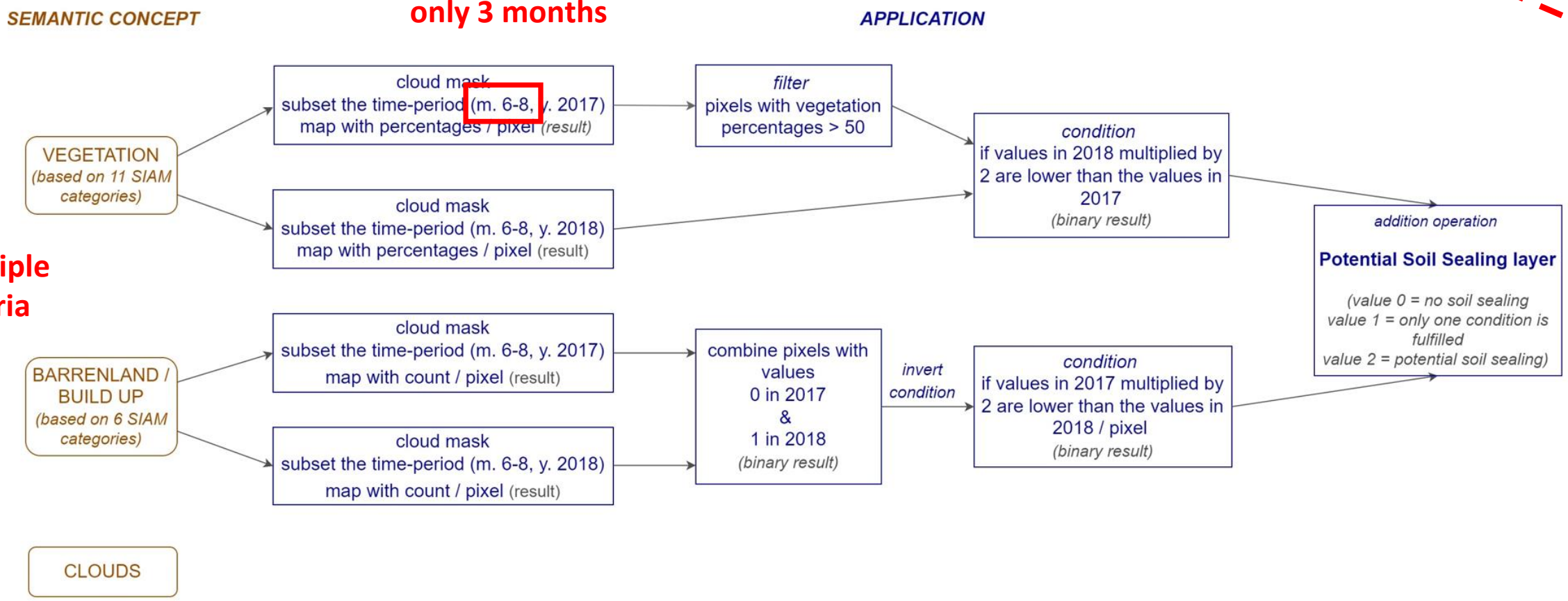


2019 vs. 2020: Change in Vegetation

Example workflow: No black box

Example

Time series of only 3 months



Multiple criteria

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SIMS: Outlook

- **Additional research**: Semantic Models (in Development)
  - What can be detected with Sentinel-2 time series?
  - Identify (additional) limitations
- **Scaling**: regular analyses on provincial or country level
- **Evaluation:** robustness and applicability of semantic models
- **Providing** semantic models (on-demand analysis) and results (pre-calculated)
  - Different platforms will be supported, e.g., Web-browser, ArcGIS, QGIS...

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