Sentinel-2 Semantic Data Cube Austria

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Project partners

AMA AgrarMarkt Austria

spatialservices

ZAMG

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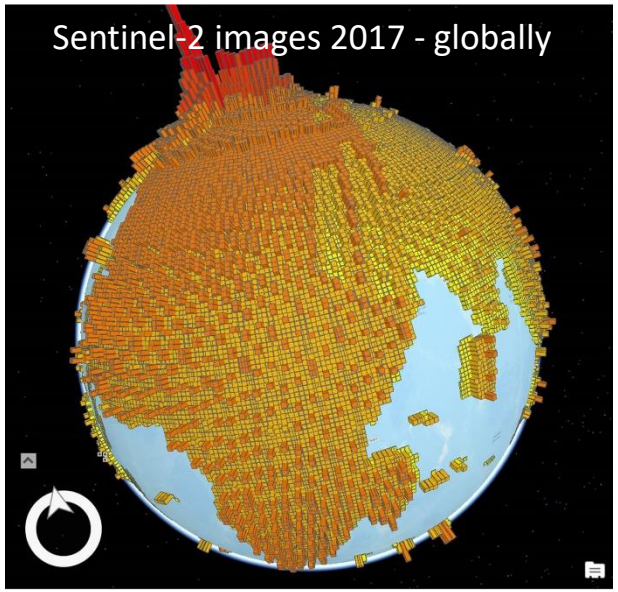
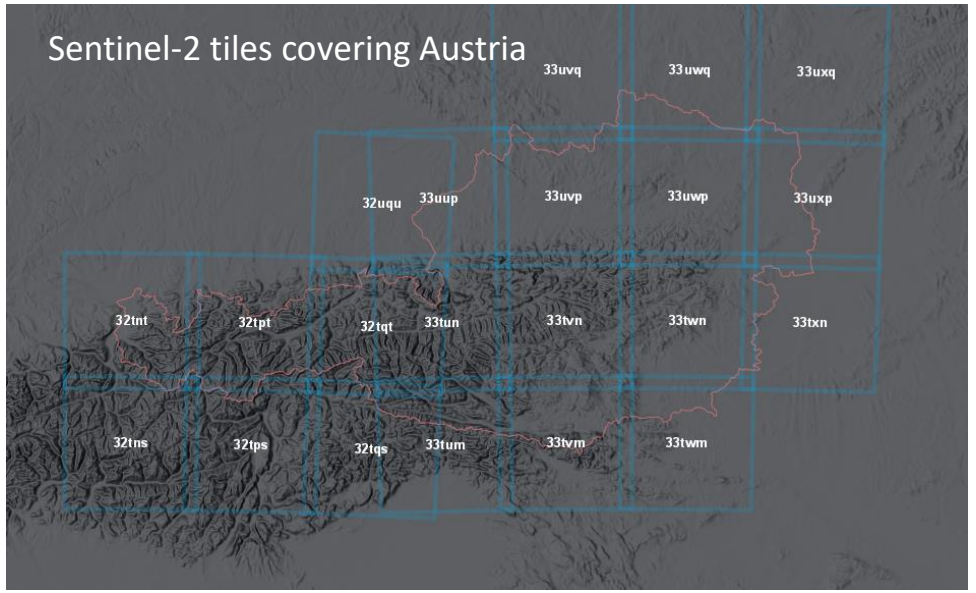
Sentinel-2 Semantic Data Cube Austria

- overarching goal ::: build an **Austrian data & information cube**
- exemplarily show that it is possible to:
  - conduct **semantic content-based image and information retrieval** (SCBIR) through time in big EO databases
  - **allow human users to query and analyse EO data on a higher semantic level** (i.e. based on at least basic land cover units and encoded ontologies)





"Conventional" queries of EO image archives

Conventional non-semantic queries of EO image archives (e.g., USGS Landsat, ESA Sentinel Data Hub). Search by:

- Metadata information.
  - ✓ Geographic geographic area (AOI)
  - ✓ acquisition time
  - ✓ sensor
  - ✓ summary quality indexes (e.g., image-wide cloud cover)
- "thumbnail" image preview (RGB image QuickLook)

- no semantic querying
- no analysis capability
- no extraction of higher-level information products through time

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Semantic Content Based Image Retrieval and Analysis

Sen2Cube.at: a Semantic Content Based Image and Information Retrieval System through time

- expected to cope with spatiotemporal semantic queries, such as:

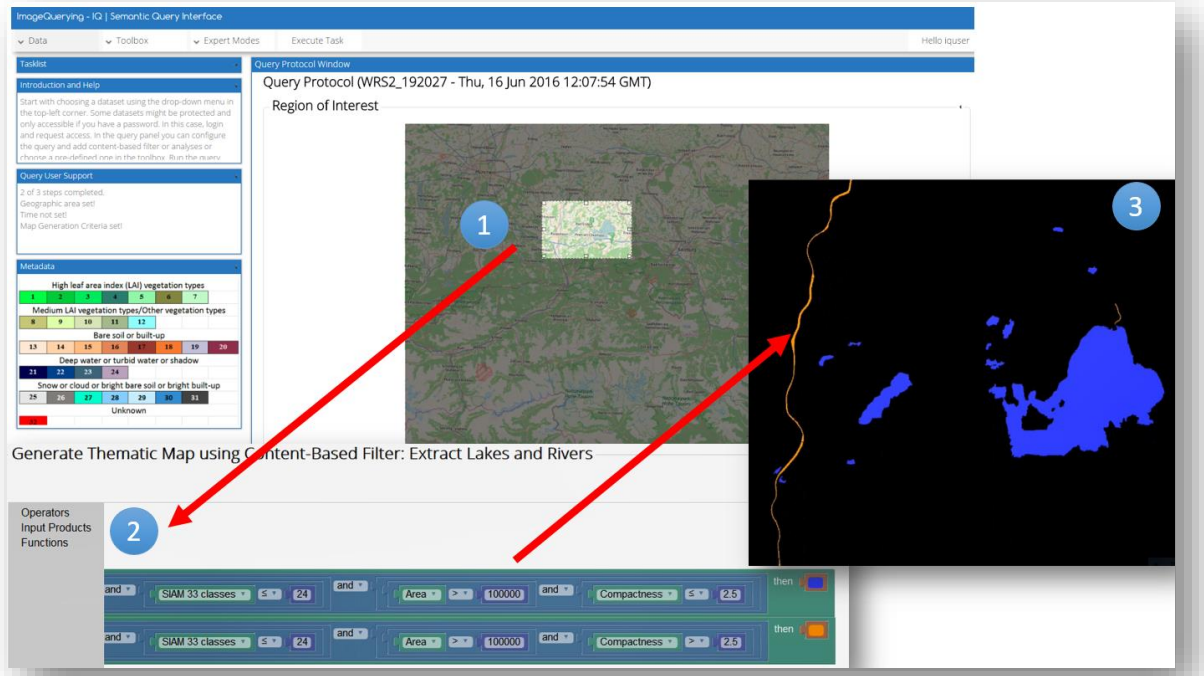
  “retrieve all images where a lake is not covered by clouds and larger than a certain area”

- **information retrieval (semantic analysis)** within the system is also possible, such as:

  "retrieve all pixels in the AOI flooded as least once in the selected time span"

Such an **SCBIR system must rely on image understanding as a pre-condition**. This makes the SCBIR problem at least as difficult (or ill-posed) as vision.

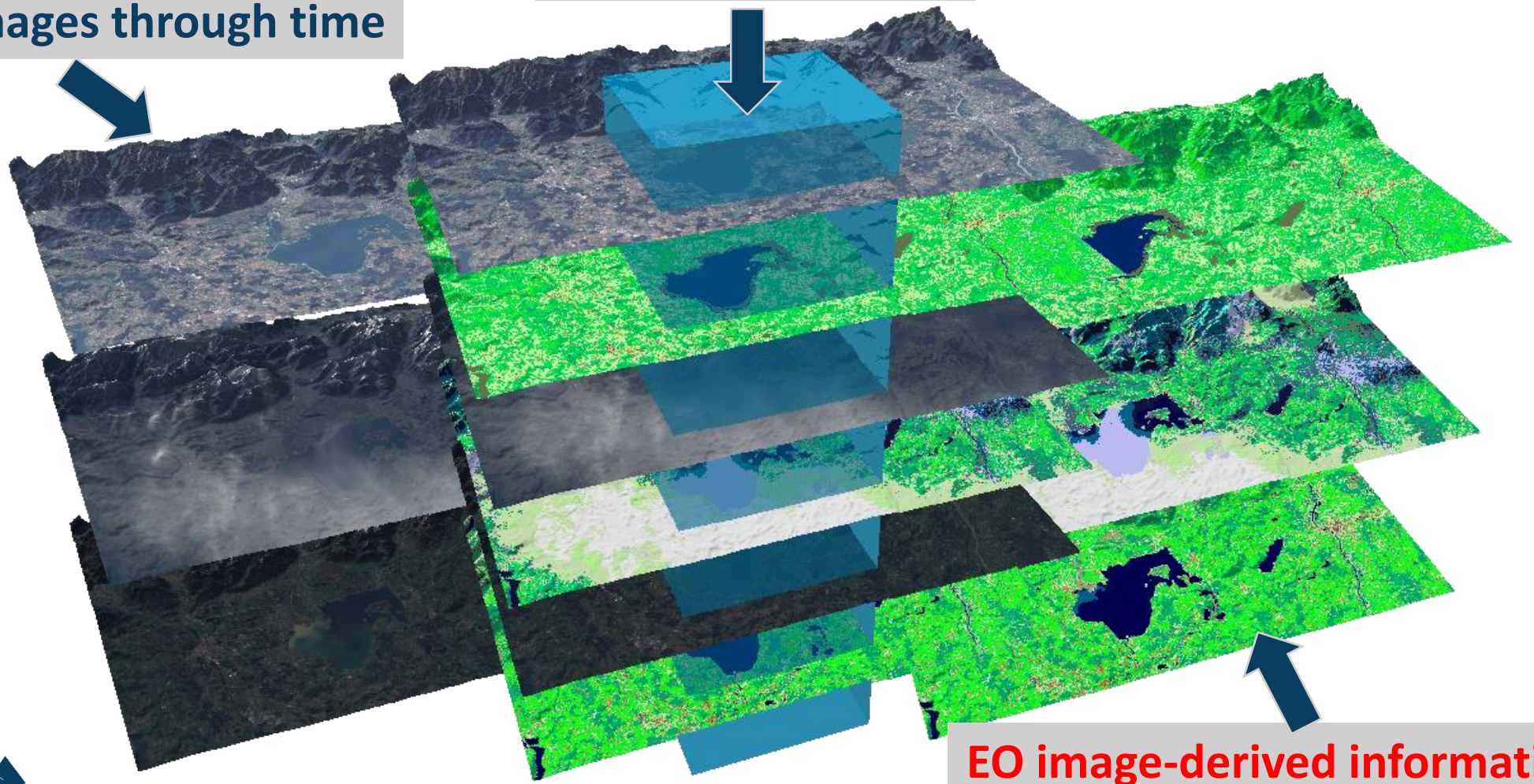
➔ **No SCBIR (Semantic Content Based Image Retrieval) system in operating mode is available to date.**



Key concept of Sen2Cube.at for spatiotemporal analytics of multi-source EO big data

Area-of-interest (AOI) in a target-time (TT) window

EO images through time

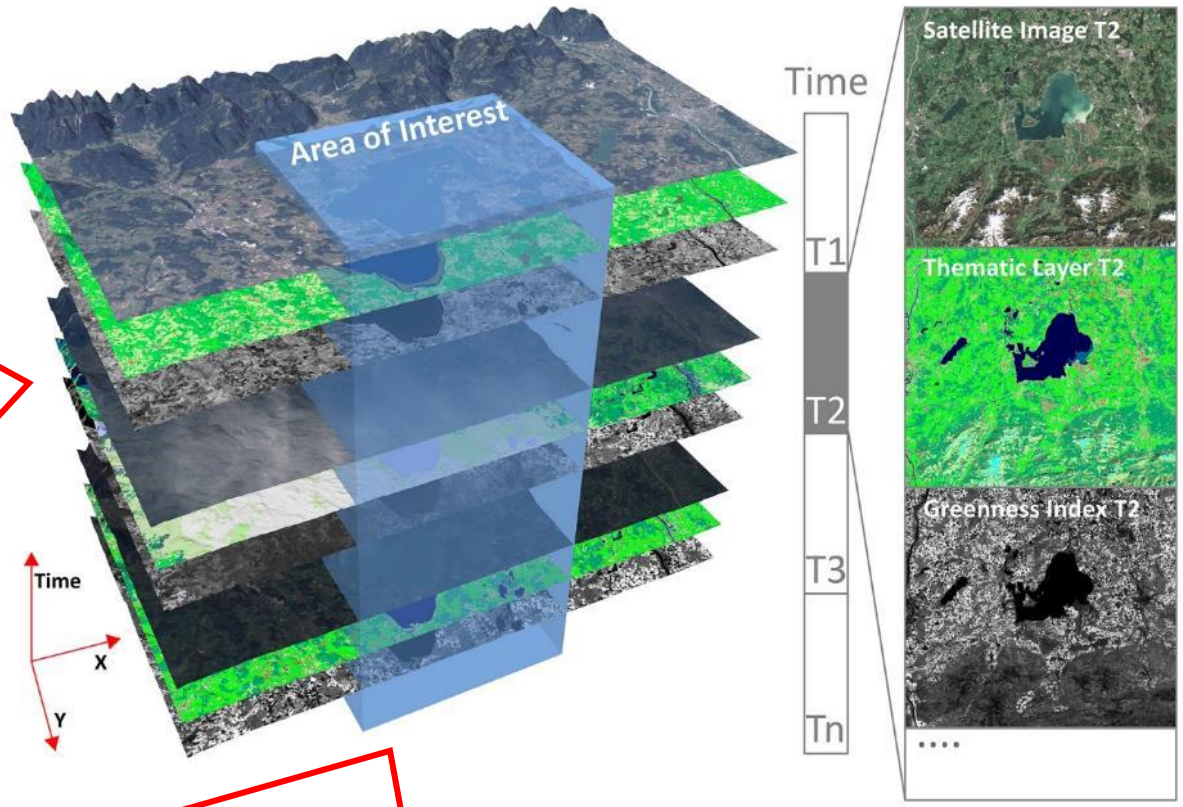


EO image-derived information layers

Key concept of Sen2Cube.at for spatiotemporal analytics of multi-source EO big data

2

Data cube system storing images and image derived products for fast querying



1

Optical satellite image and associated *fully automatic data*-derived information layers

- The semantic enrichment used in Sen2Cube.at is based on a physical-model-based, spectral categorisation (SIAM) and additionally derived information.
- These processes will be fully automated and free of any user parametrisation.

3

Semantic content-based queries through time and space in user defined AOIs by a graphical inference engine

from Tiede, D., Baraldi, A., Sudmanns, M., Belgiu, M., Lang, S., 2017. Architecture and Prototypical Implementation of a Semantic Querying System for Big Earth Observation Image Bases. Eur. J. Remote Sens. 50, 452–463. doi:10.1080/22797254.2017.1357432

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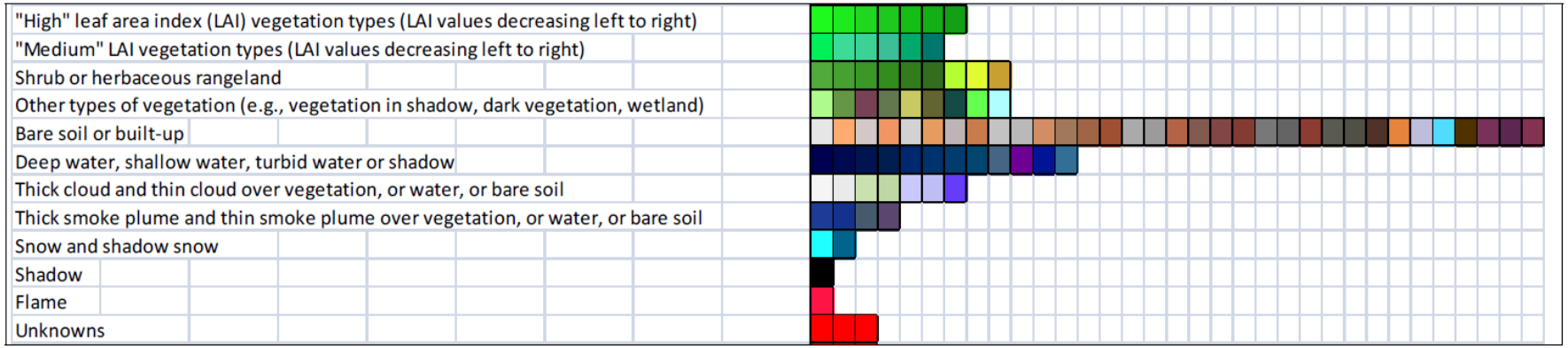
SIAM spectral categorization

SIAM spectral categorization

- fully automated
- parameter-free
- near real-time (ca. 5 min. per Sentinel-2 granule)
- scalable and parallelisable
- multi-sensor support

Automatically generated information layers:

- **pre-classification/spectral categorization**: 18, 33, 48 and 96 classes
- multi-spectral **greenness index**
- binary **vegetation mask**
- 5 category **haze mask**



96 spectral classes (pre-classes) represented by pseudo-colours and associated semantics.
See slides 4-7 for example images and results.

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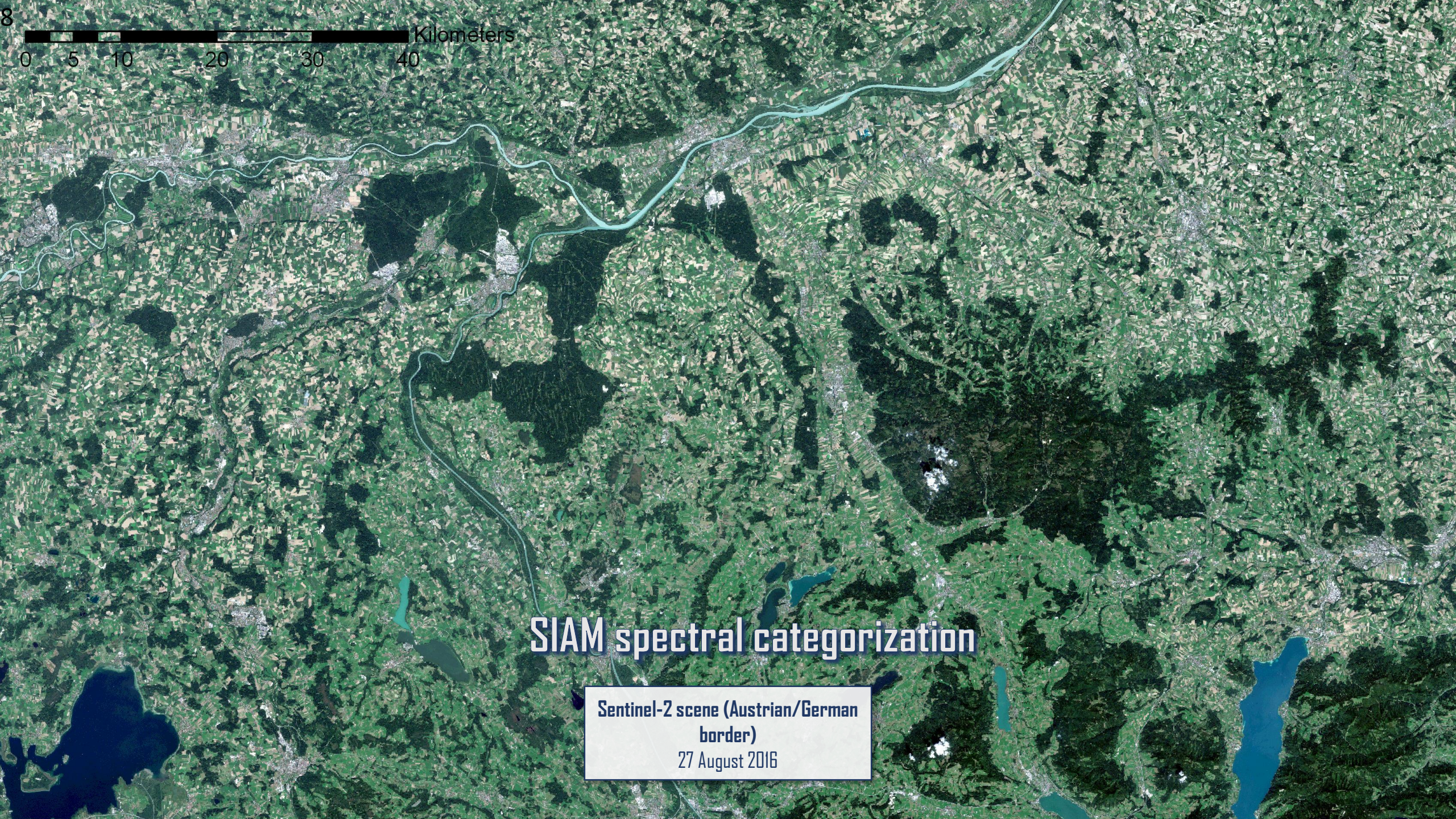

8
Kilometers
0 5 10 20 30 40
SIAM spectral categorization
Sentinel-2 scene (Austrian/German border)
27 August 2016

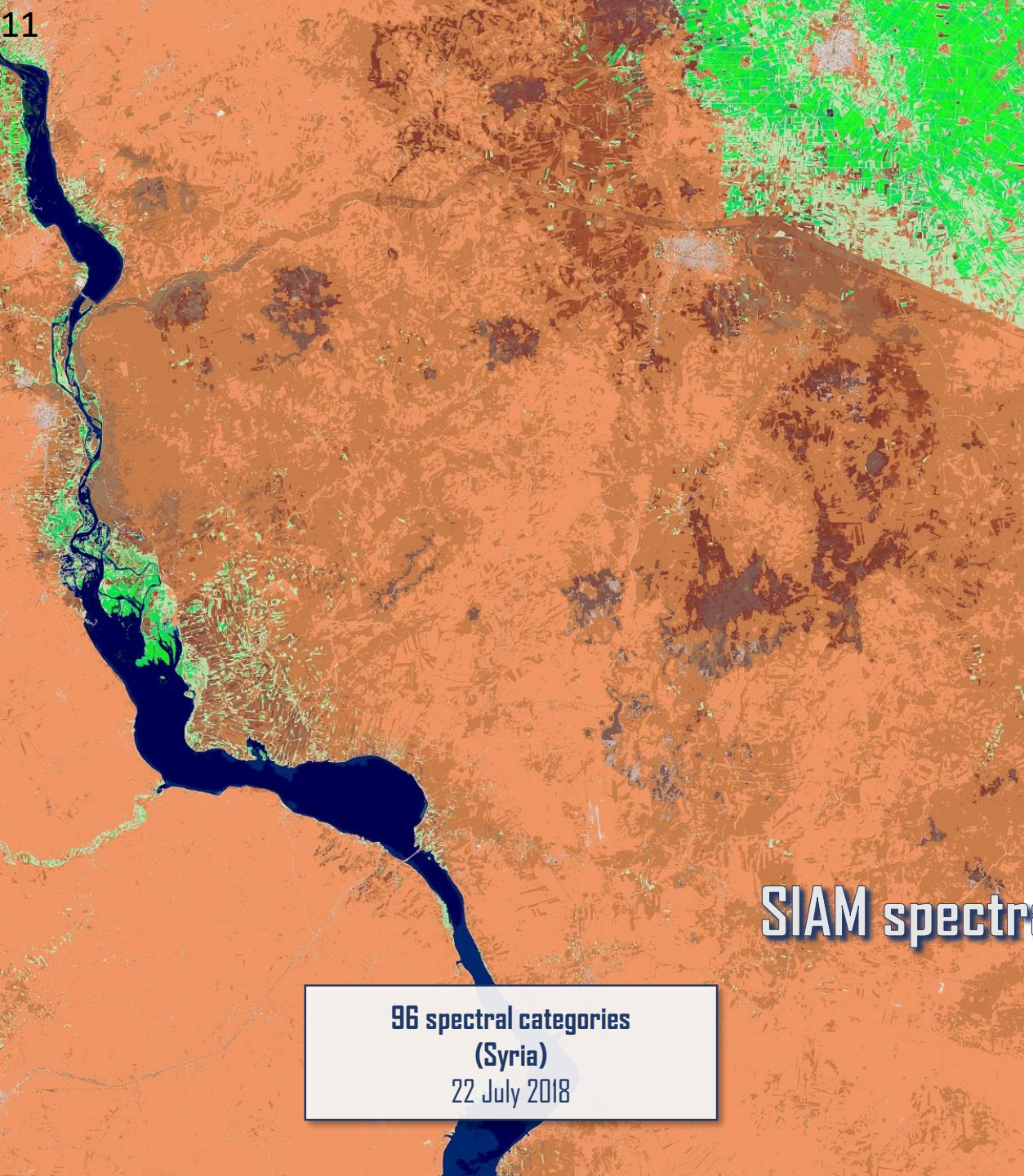

9
Kilometers
0 5 10 20 30 40
SIAM spectral categorization
96 spectral categories
(Austrian/German border)
27 August 2016

SIAM spectral categorization

Sentinel-2 scene
(Syria)
22 July 2018

Sentinel-2 scene
(Cambodia)
21 April 2017

SIAM spectral categorization

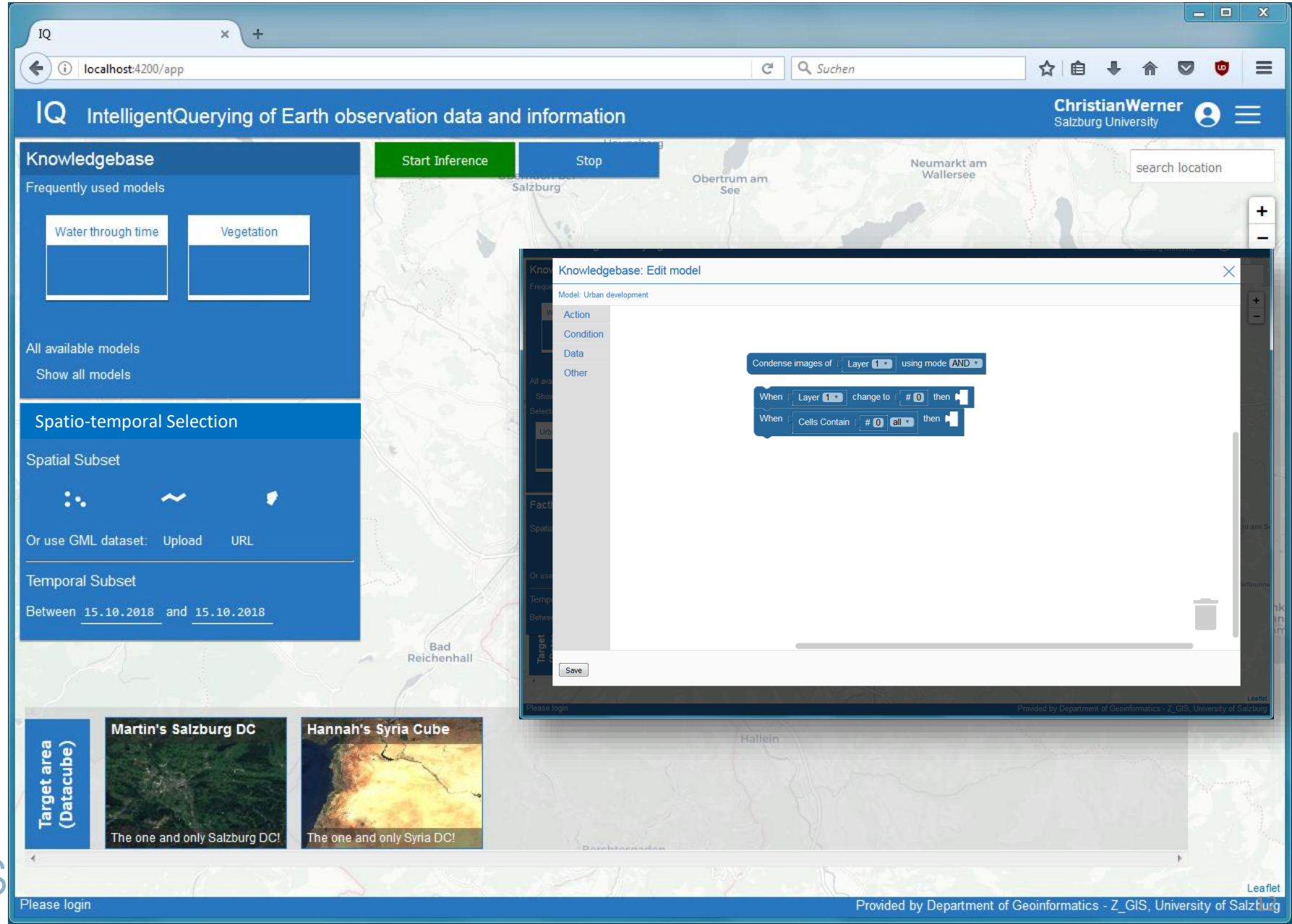


96 spectral categories (Syria)
22 July 2018

96 spectral categories (Cambodia)
21 April 2017

Web-interface Development

Generic Web-Interface (Access of different data cube models)



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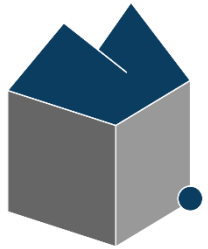

Semantic Data Cube – Syrian example

First, connect to the datacube

In [6]:
```
dc = datacube.Datacube(app='siam_syria_10km')
api = datacube.api.API(datacube=dc)
```

Get extent information about a specific product in the datacube.

In [7]:
```
product = 'siam_utm37n_10km'
products = dc.list_products()
platform = products.platform[products.name == product].values[0]

#
# Get the pixel resolution of the selected product
#
resolution = products.resolution[products.name == product]
lat_dist = resolution.values[0][0]
lon_dist = resolution.values[0][1]

#
# Get the extents of the cube
#
descriptor = api.get_descriptor({'platform': platform})[product]

min_date = descriptor['result_min'][0]
min_lat = descriptor['result_min'][1]
min_lon = descriptor['result_min'][2]

min_date_str = str(min_date.year) + '-' + str(min_date.month) + '-' + str(min_date.day)

max_date = descriptor['result_max'][0]
max_lat = descriptor['result_max'][1]
max_lon = descriptor['result_max'][2]

max_date_str = str(max_date.year) + '-' + str(max_date.month) + '-' + str(max_date.day)

#
# Display metadata
#
generate_metadata_report(min_date_str, max_date_str,
                         min_lon, max_lon, lon_dist,
                         min_lat, max_lat, lat_dist)
crs = products.crs[products.name == product]
epsg_code = crs.values[0]
```

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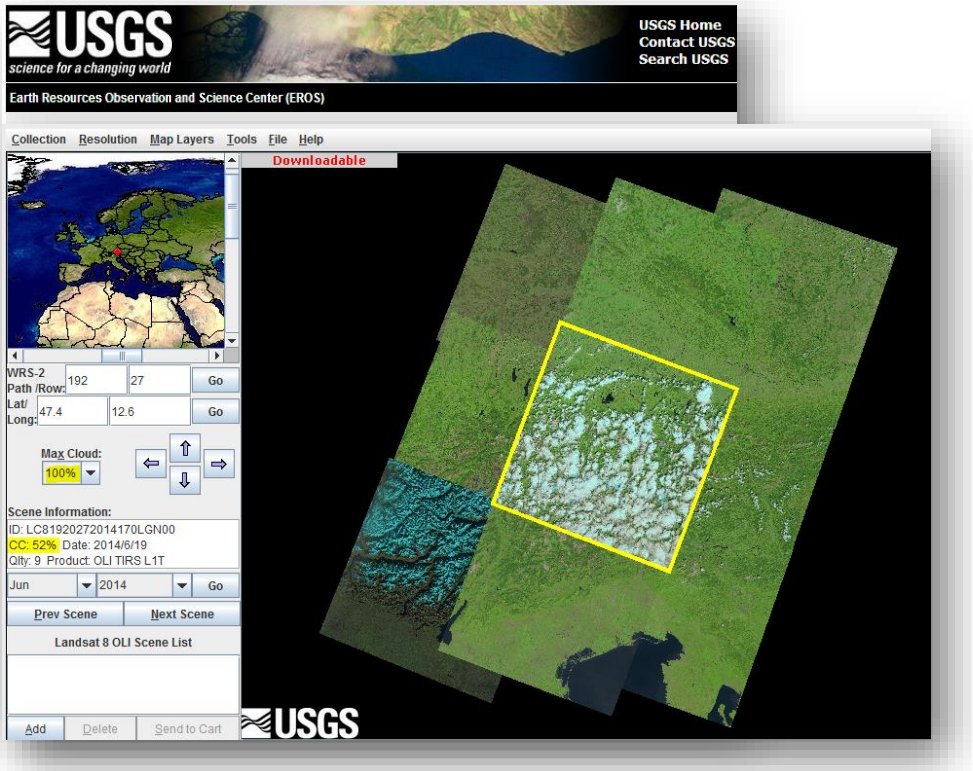
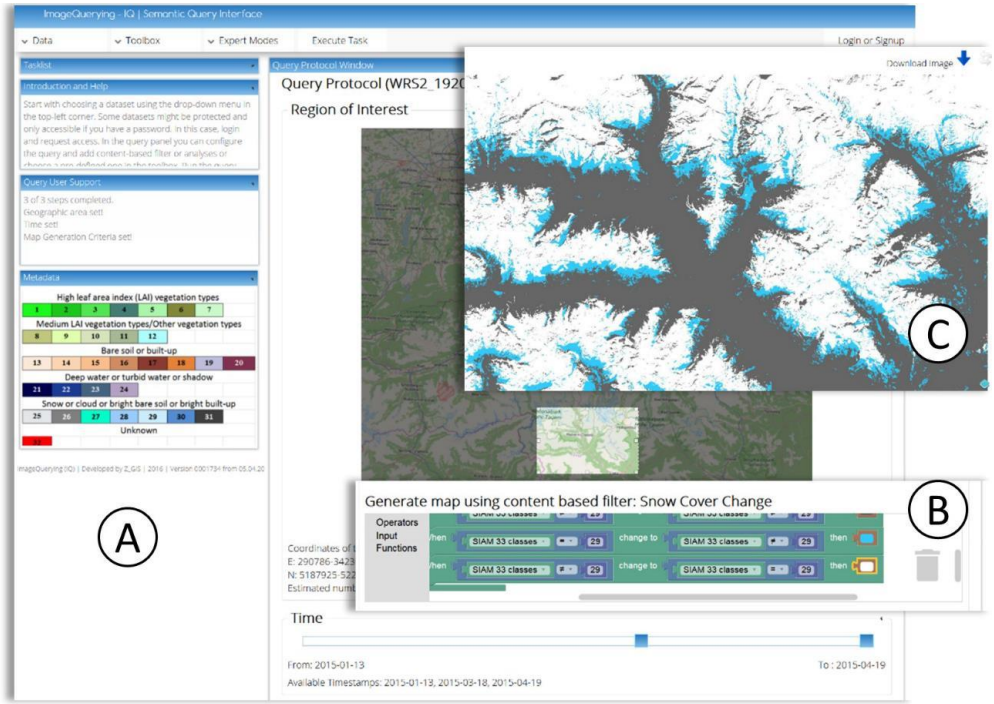
Demo 1: semantic queries for content-based image retrieval

- develop knowledge-based semantic queries
- search and select Sentinel-2 scenes based on their content



An inference engine for enhanced querying will be programmed as a Web interface in a client-server solution.



Demo 2: user-defined cloud-free mosaics and composites

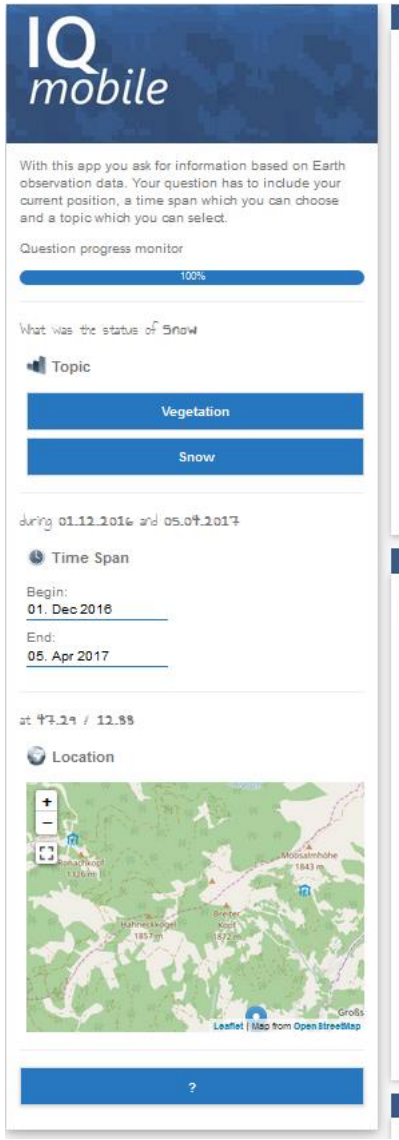
- apply pre-defined semantic queries through time
- user-defined areas-of-interest and timeframes
- better selection of best-suited pixels on the fly using semantics

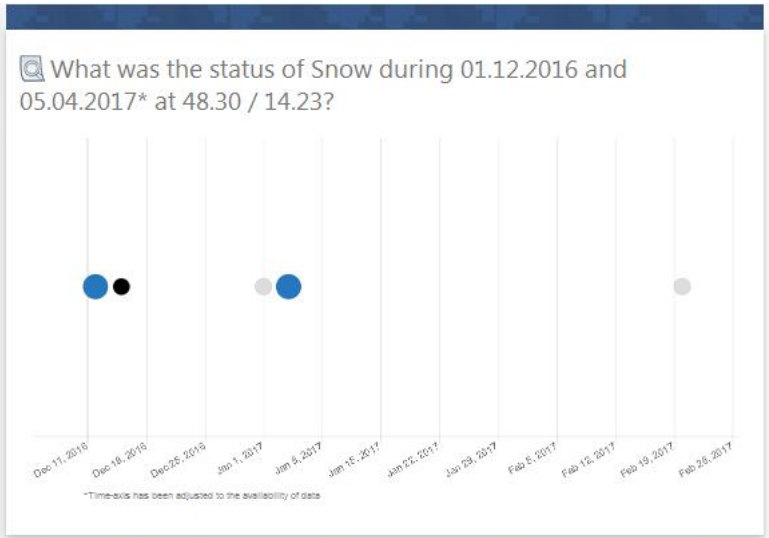
Source: Sentinel-2

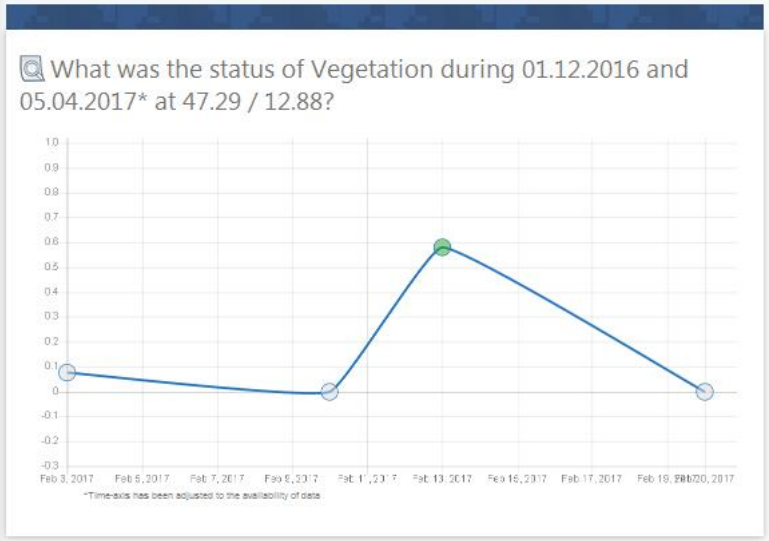
Demo 3: location-based access

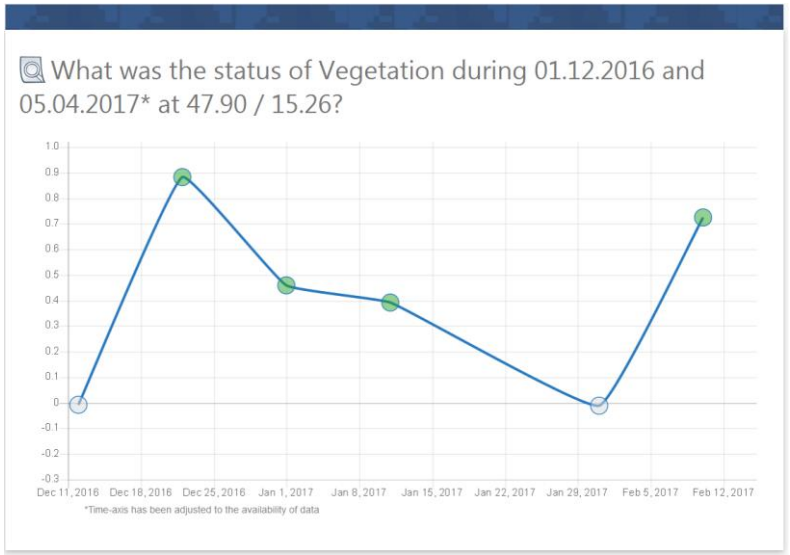
- historical data-derived trends where you are (or elsewhere)
  - location-based access
- example prototype developed in IQ4Sen
  - ZAMG project
  - implemented by SpaSe

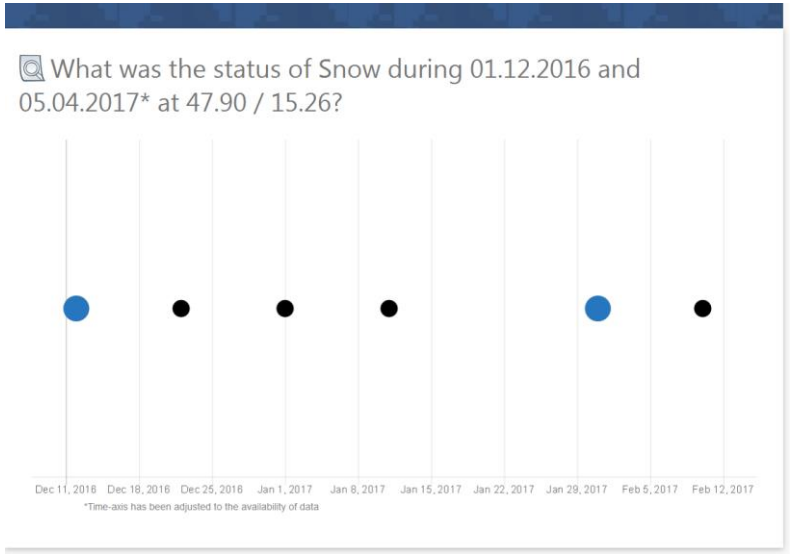
Demo 3: location-based access







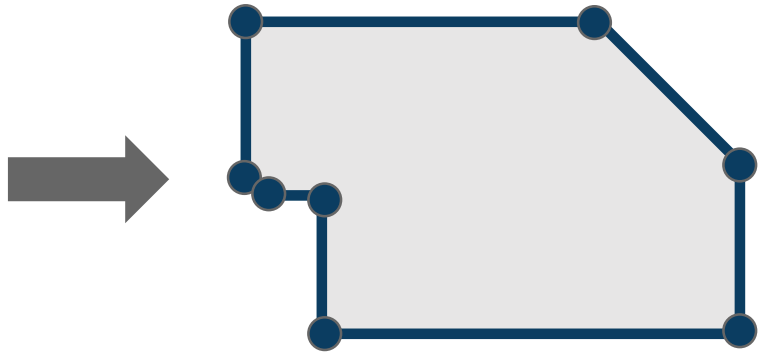




Demo 4: per-parcel statistics

- allow user-defined parcel calculations for spectral and semantic profiles through time
- particularly relevant for forestry and agricultural domains

Source: Sentinel-2



- vegetation trends
- event detection
- when snow was last detected
- ...

Thank you for your attention!

http://sen2cube.at/

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