

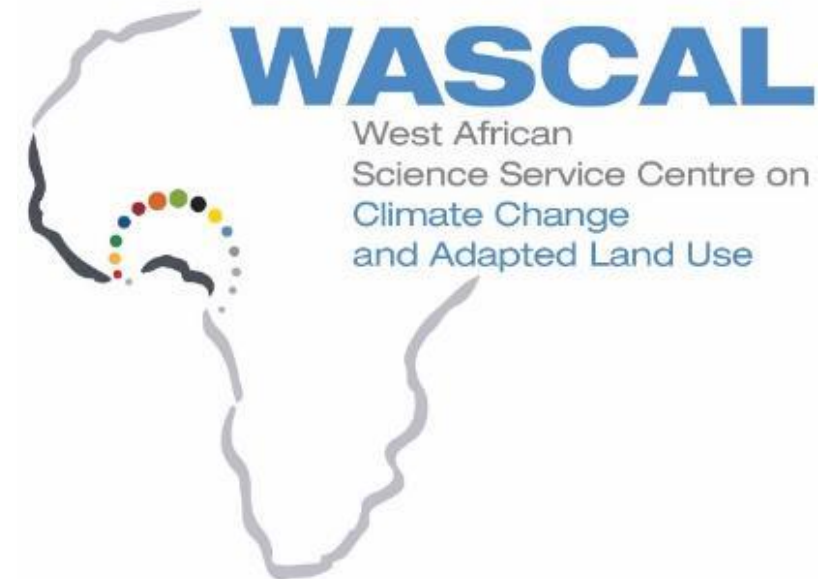
WASCAL Data Cube

Big data remote sensing to monitor the environment

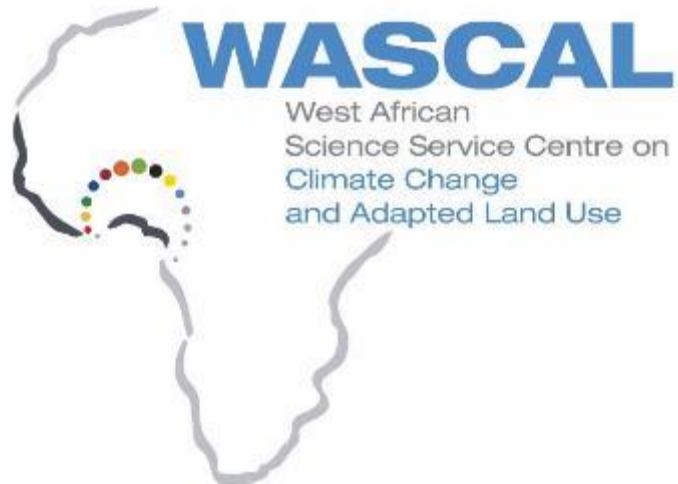
Steven Hill

Department of Remote Sensing, Institute of Geography and Geology, University of Würzburg

- West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL)
- Large scale climate service center, build to help tackle the challenges of climate change and climate variability in the region
- By strengthening the research infrastructure and capacities related to climate change
- Funded by the Federal German Ministry of Education and Research (BMBF).
Implemented in a cooperation between german and west African partners lead by the Center for Development Research (ZEF Bonn).
- Since 2014 recognized as international Institution



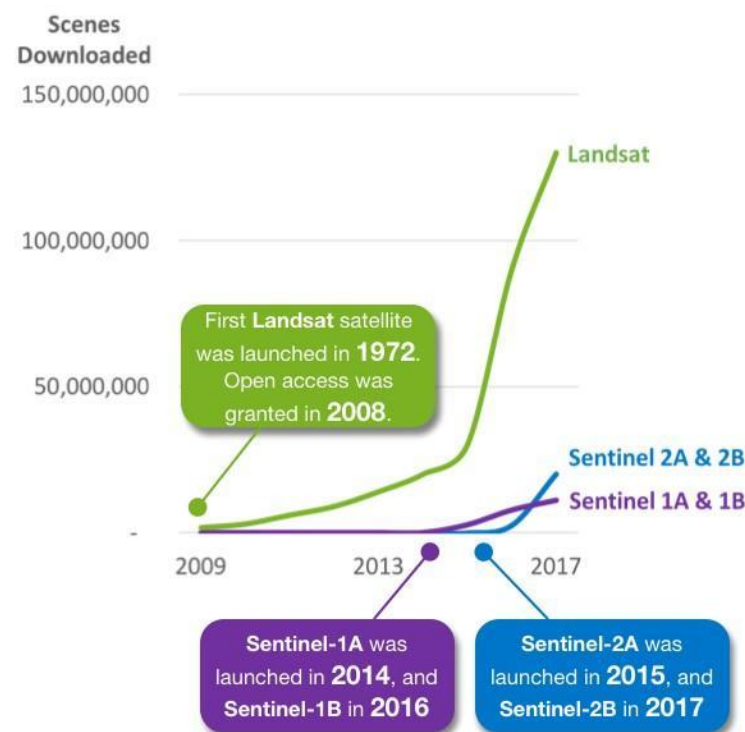
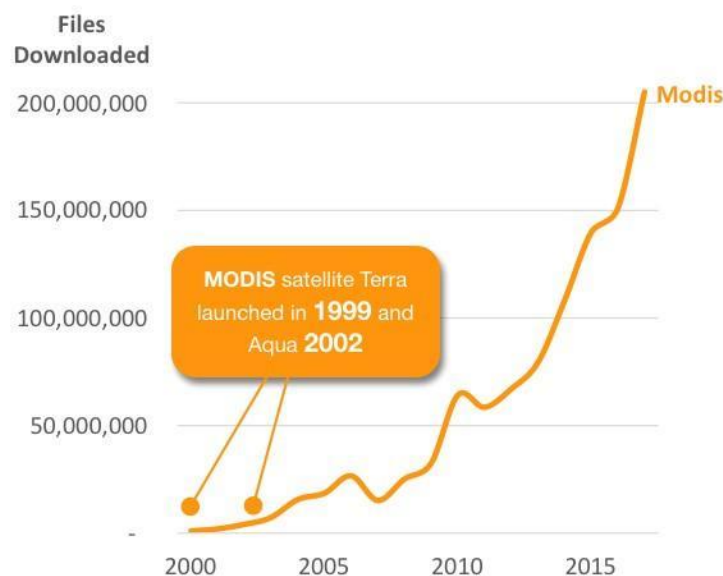
- 11 countries in West Africa
- Headquarter in Accra
- Competence Center in Ouagadougou
- Beyond language borders



Why do we use Earth Observation Data Cubes ?

Open Satellite Data Downloads

The number of downloads every year from the open data portals has increased exponentially!

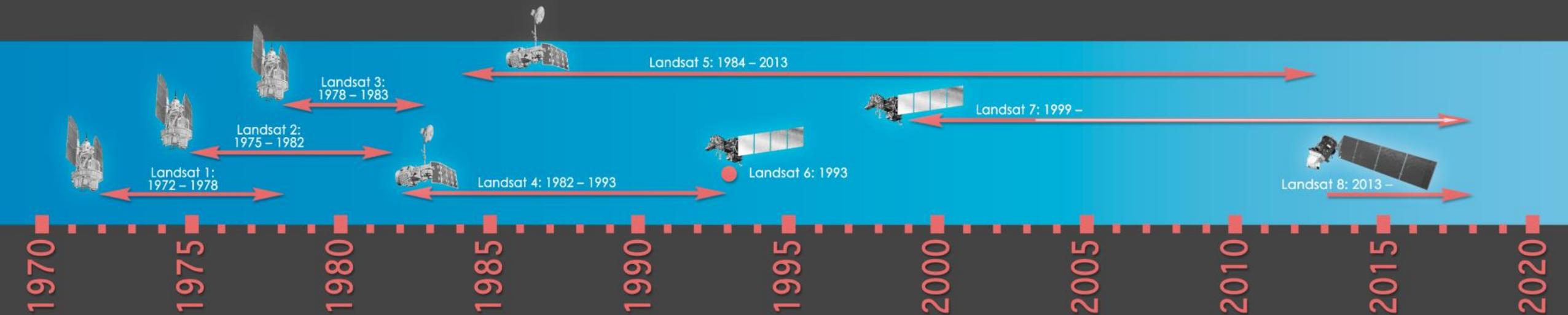


SOURCES: MODIS and Landsat data was provided by NASA
Sentinel data was obtained via their annual reports, 2015-2017

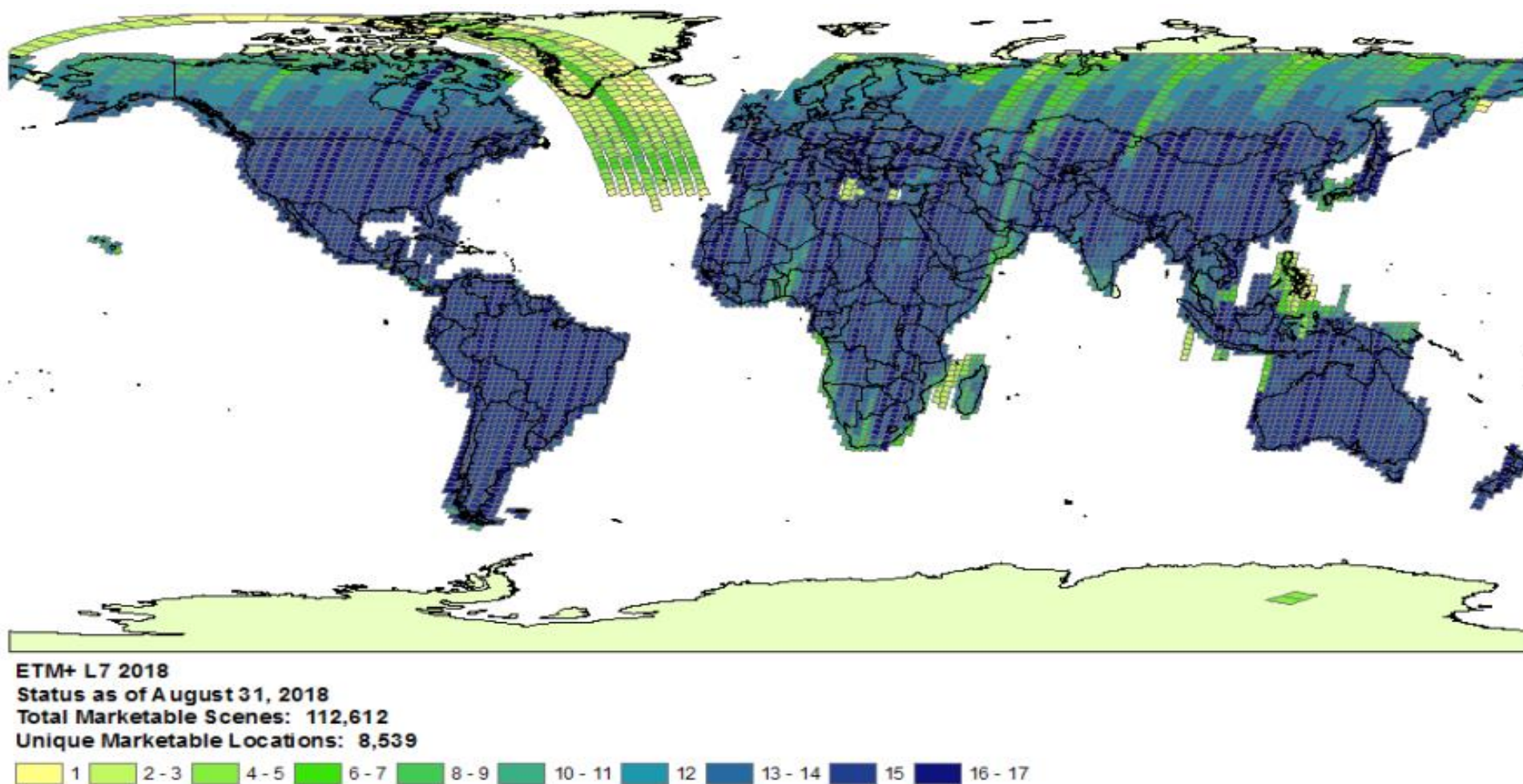
*Files downloaded from the MODIS portal often contain multiple scenes

Landsat has already taken more than 7.5 million images of the Earth's surface

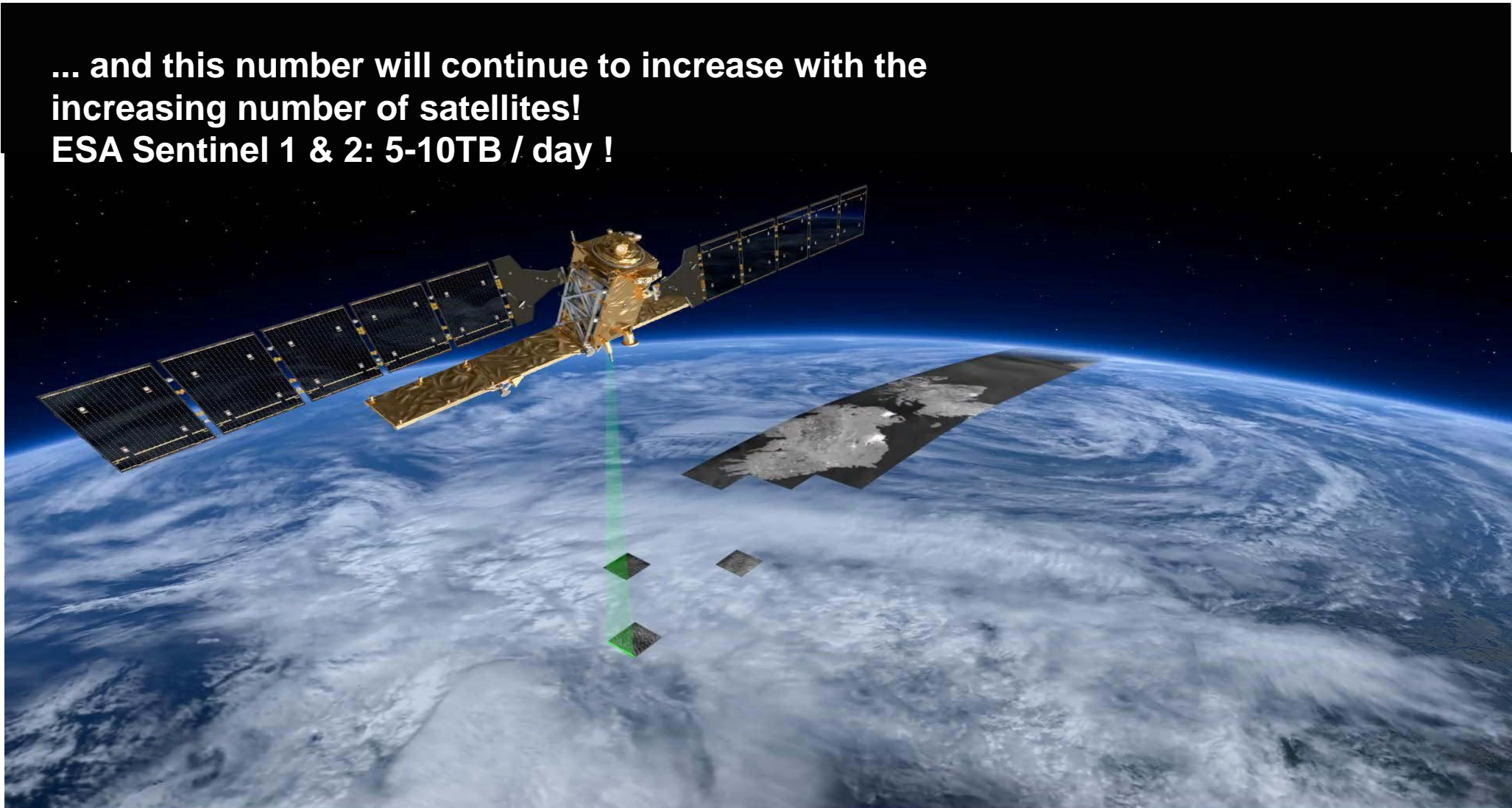
40 Years of Global Observations



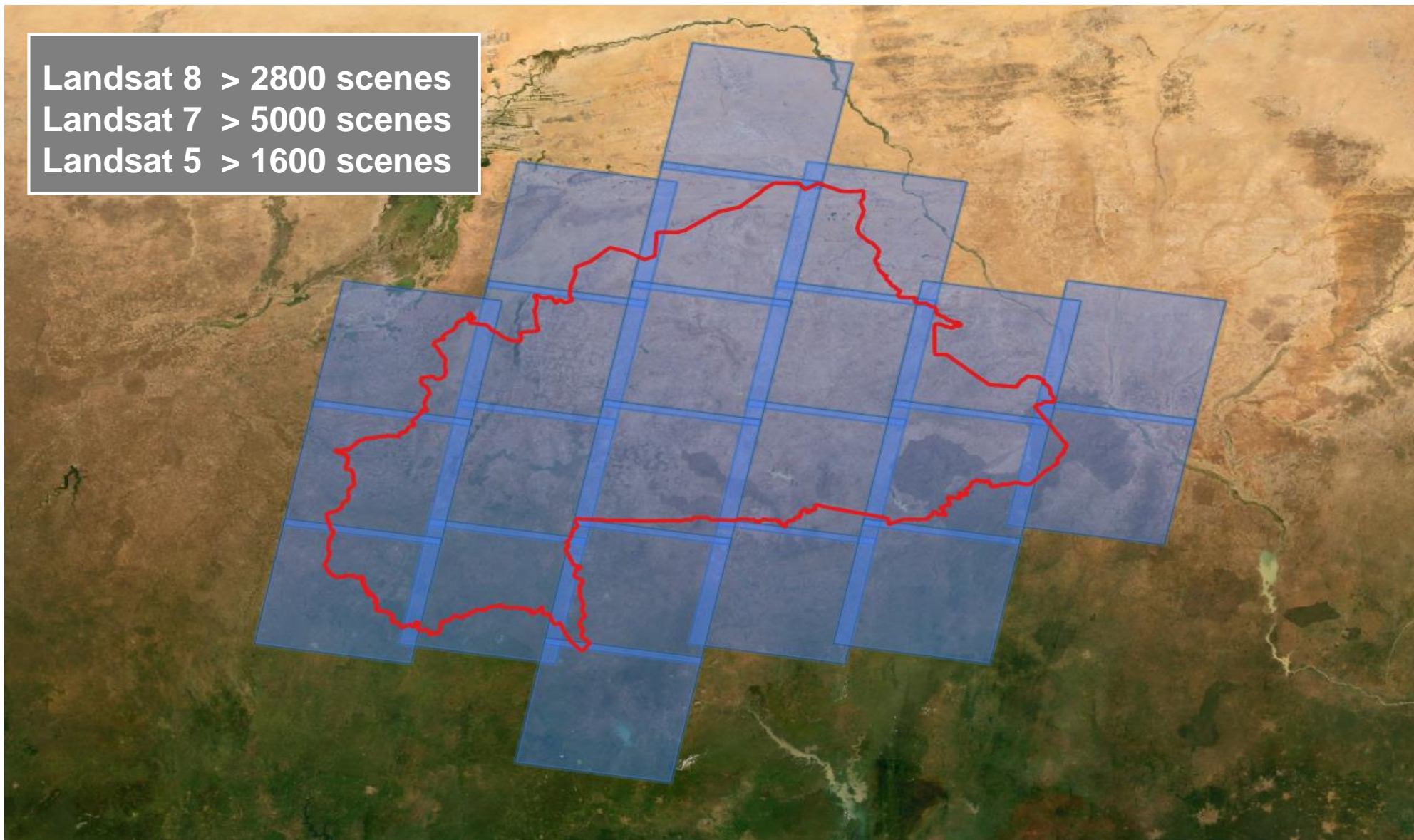
This corresponds to a data volume of > 7.5 petabytes...



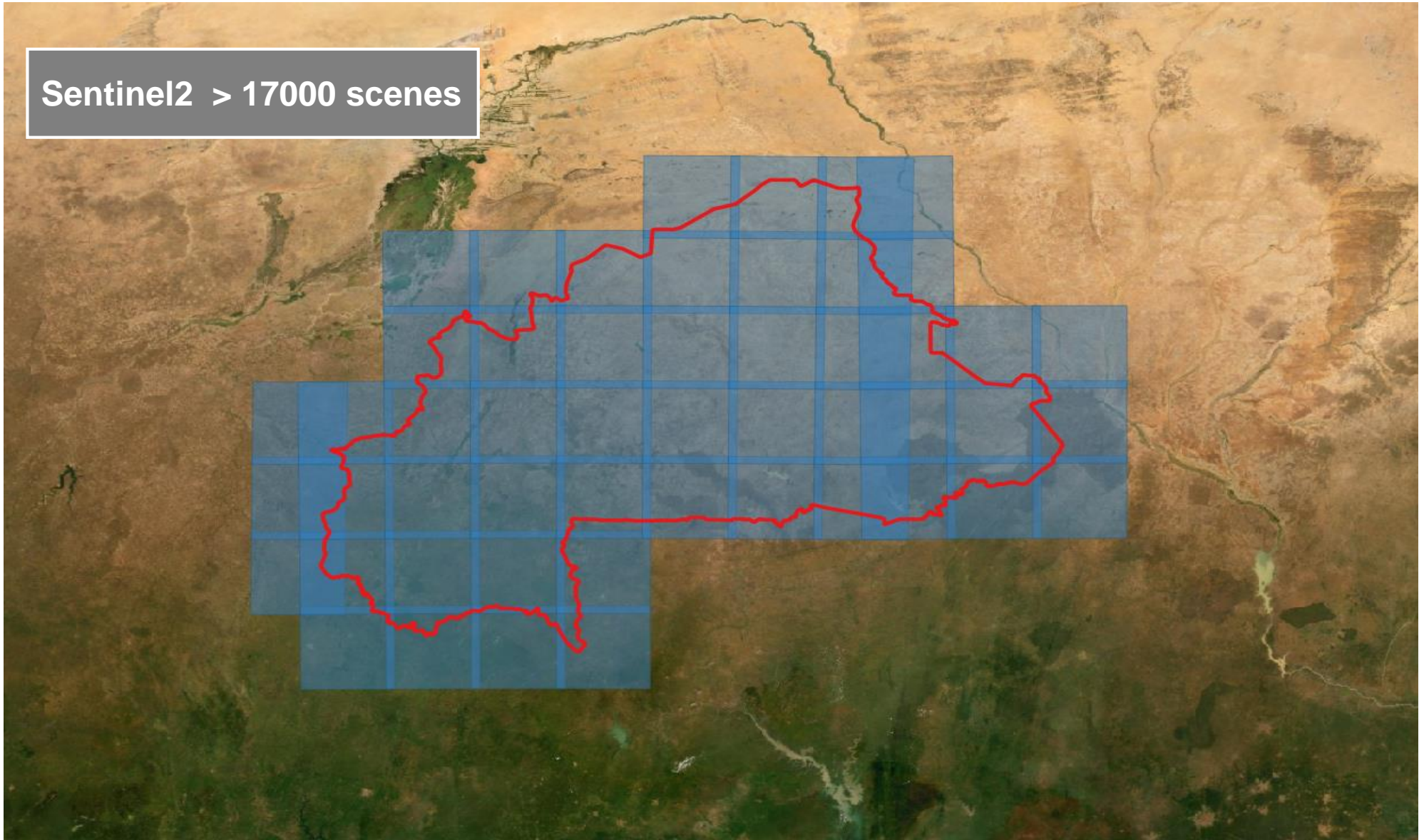
**... and this number will continue to increase with the
increasing number of satellites!
ESA Sentinel 1 & 2: 5-10TB / day !**



Landsat 8 > 2800 scenes
Landsat 7 > 5000 scenes
Landsat 5 > 1600 scenes



Sentinel2 > 17000 scenes

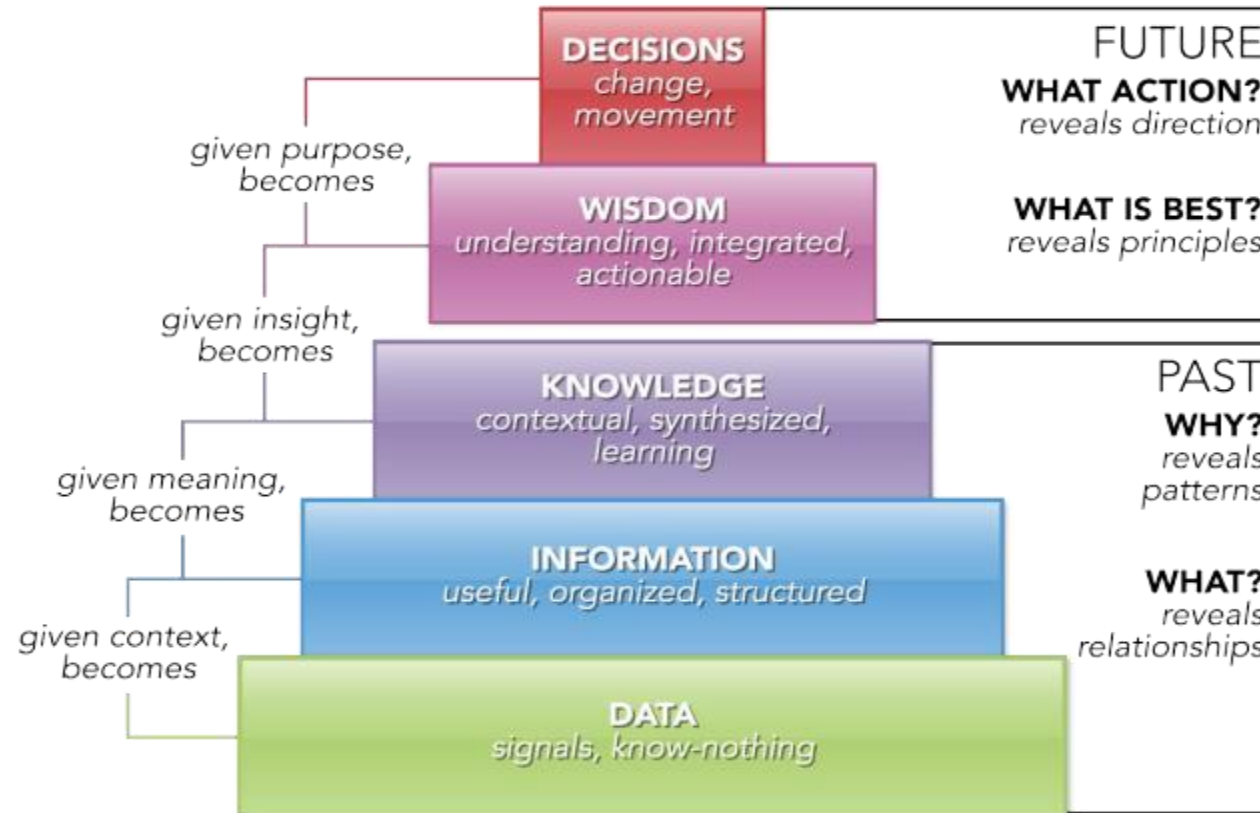


The data deluge



*“Data is not information,
information is not knowledge,
knowledge is not understanding,
understanding is not wisdom”
(Clifford Stoll)*

How to transform this large amount of data into useful information and support evidence-based decisions



Why do so few people use satellite data?

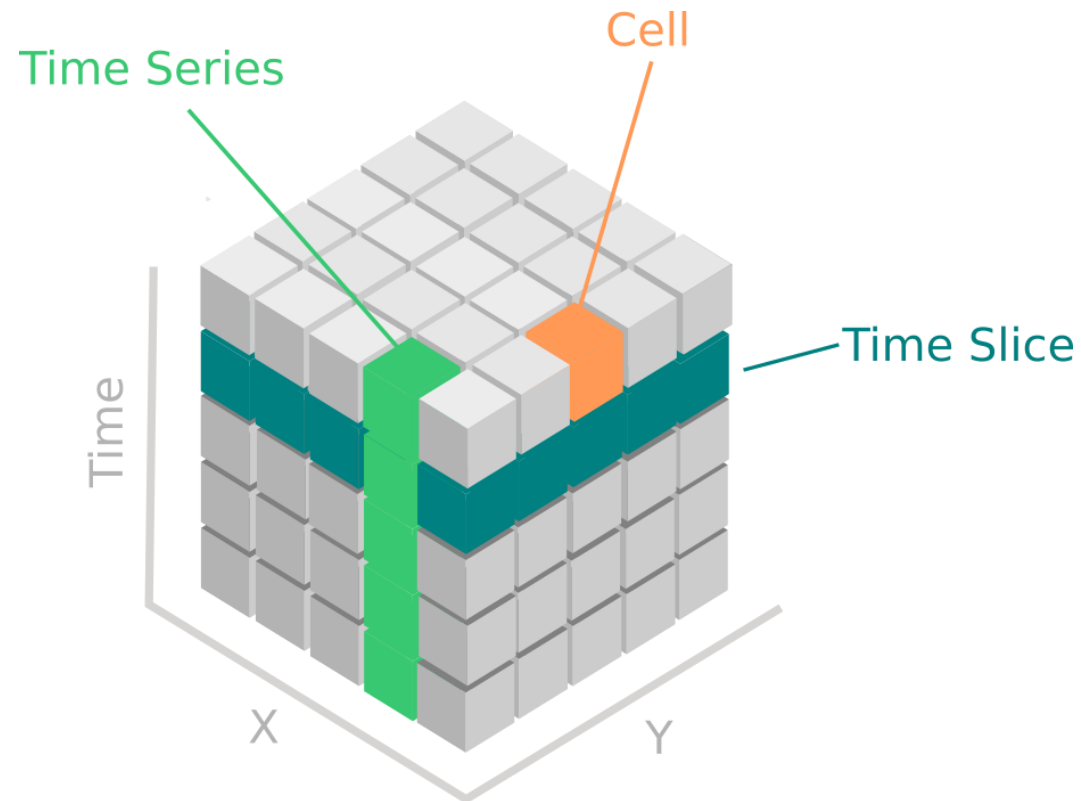
- Scientific knowledge is required to understand... (what kind of data? / resolution? / what type?)
- Difficult to access and download
- Difficult to prepare... atmospheric corrections, geometry, alignment, formats
- Need for training and capacity building

A new solution.... **DATA CUBES ?**



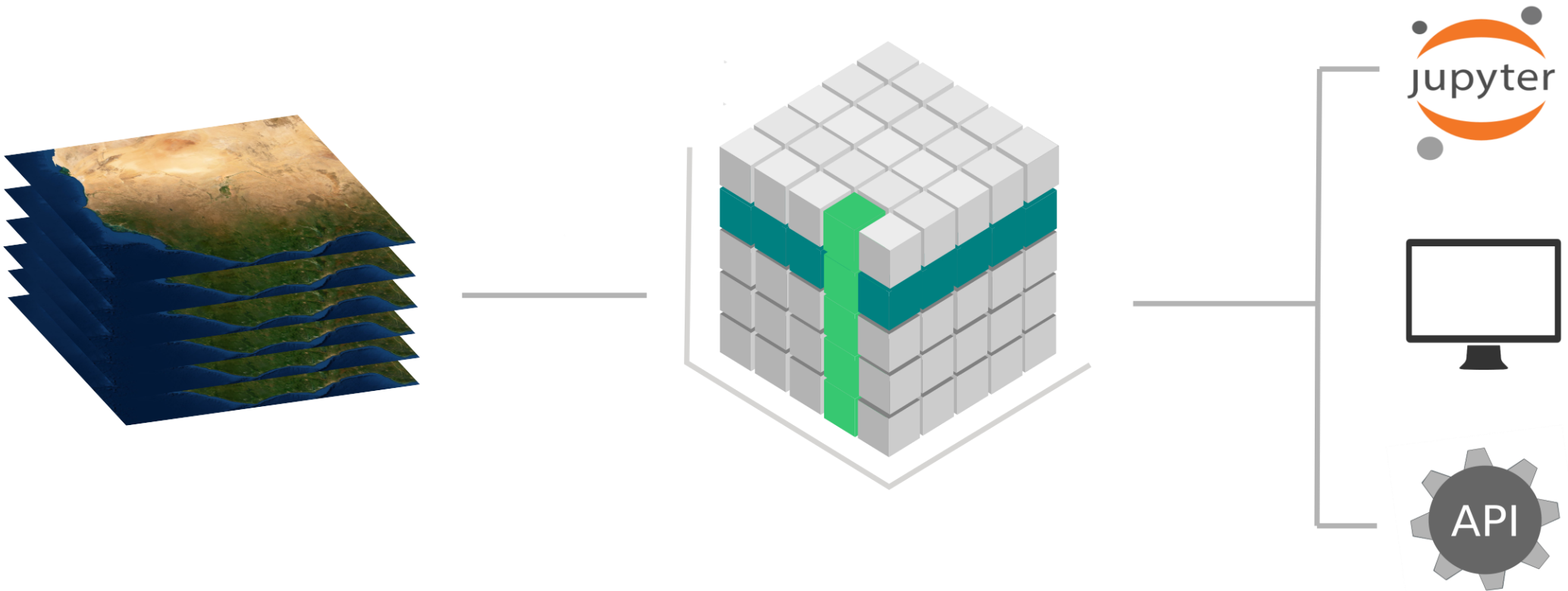
What are data cubes?

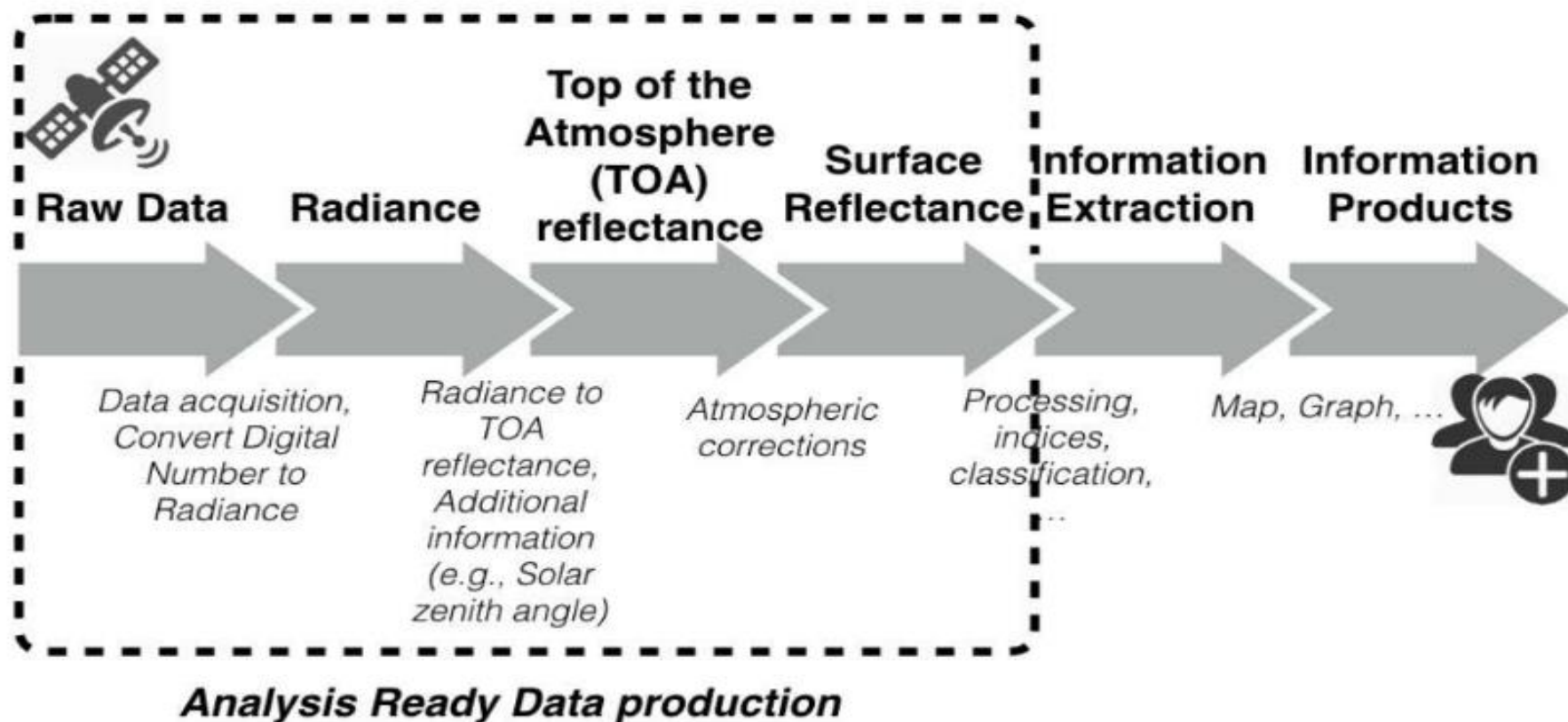
Multi-dimensional stack (space, time, data type) of spatially aligned pixels & used for efficient access and analysis.



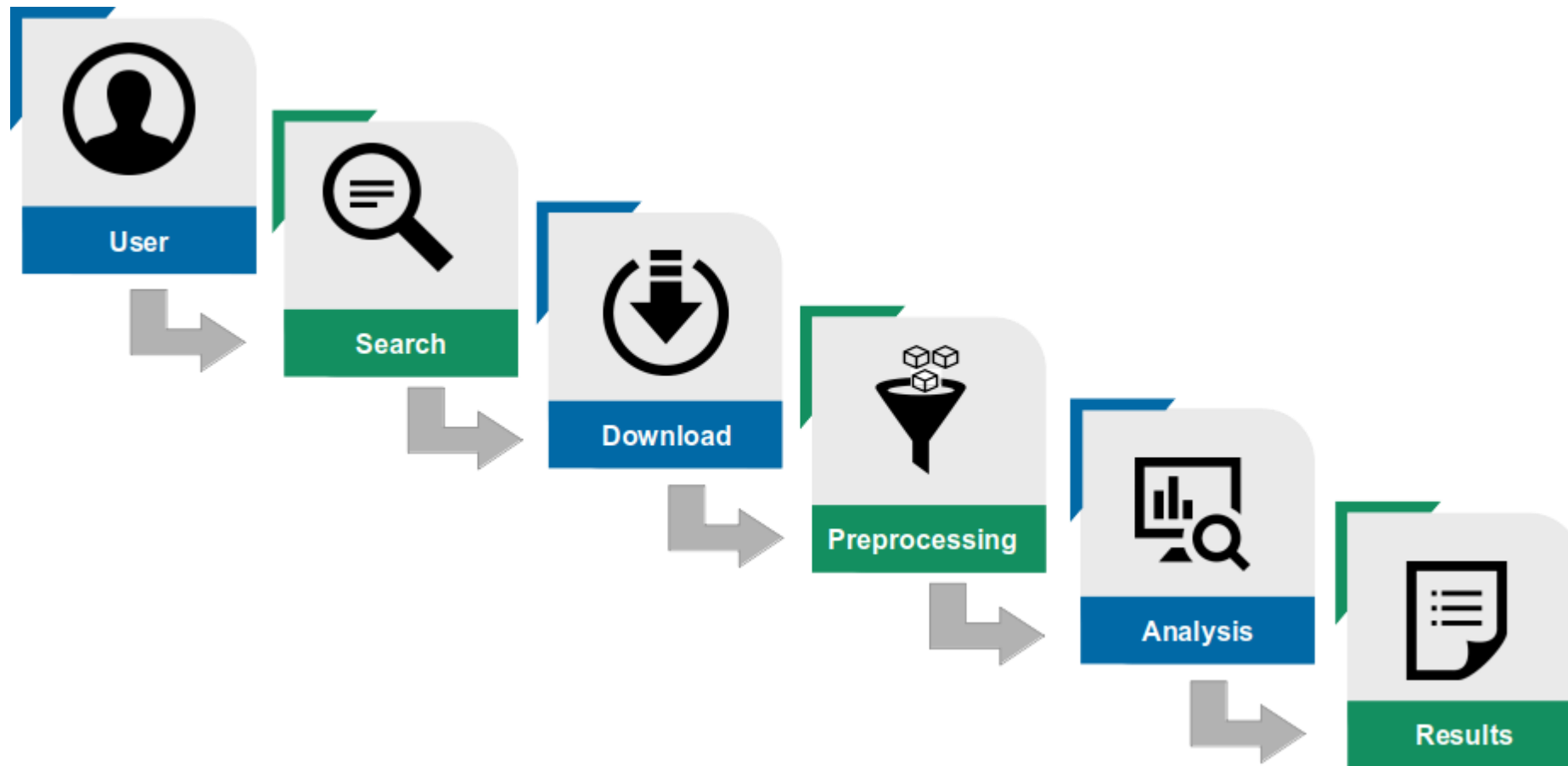
The idea of the WASCAL Data Cube is ...

to **increase the value and impact of global Earth observation satellite data for west africa** by providing an accessible exploitation architecture for an **efficient and user-oriented analysis based** on multi-temporal earth observation data.

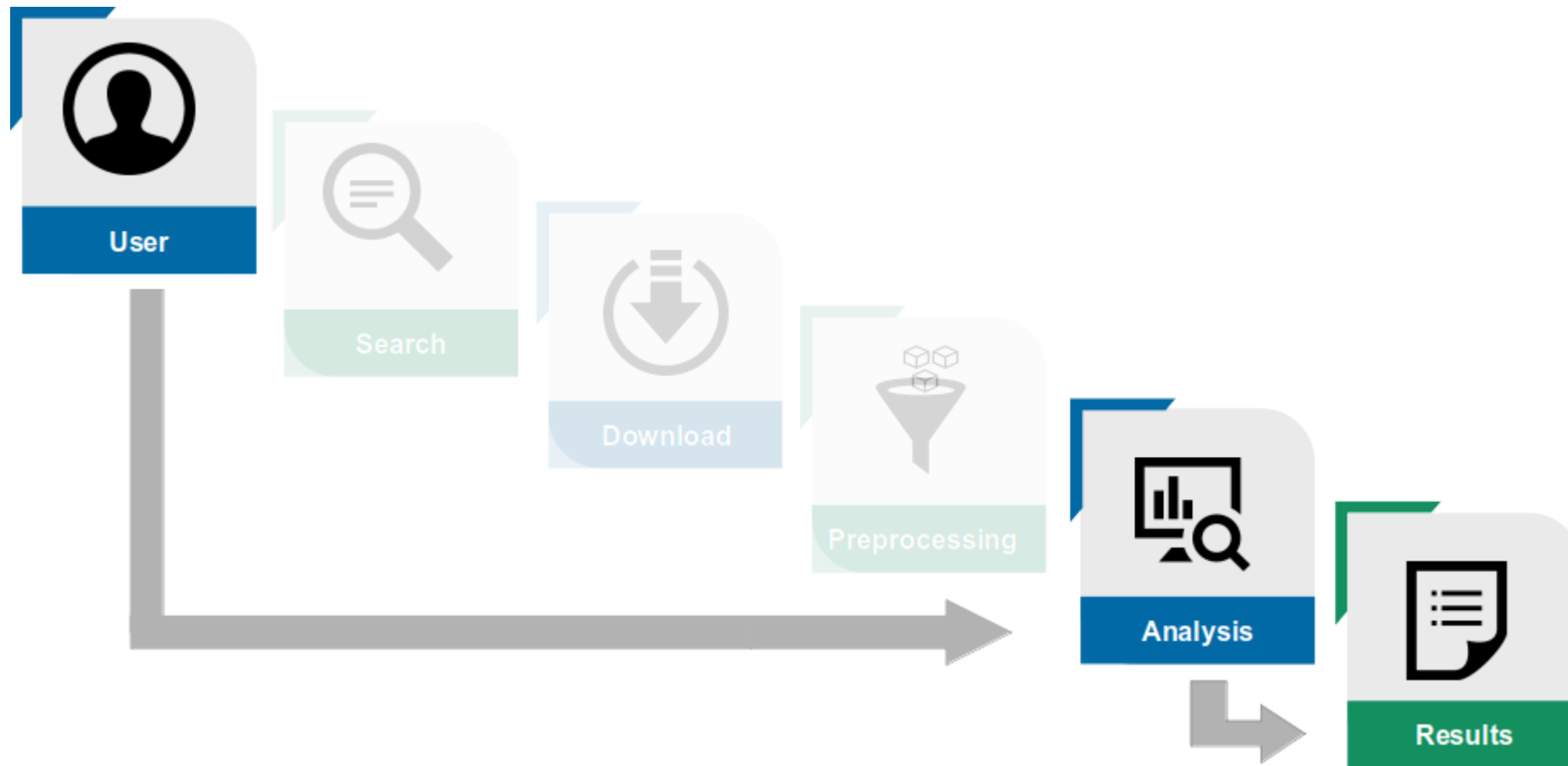




Traditional approach



Datacube approach

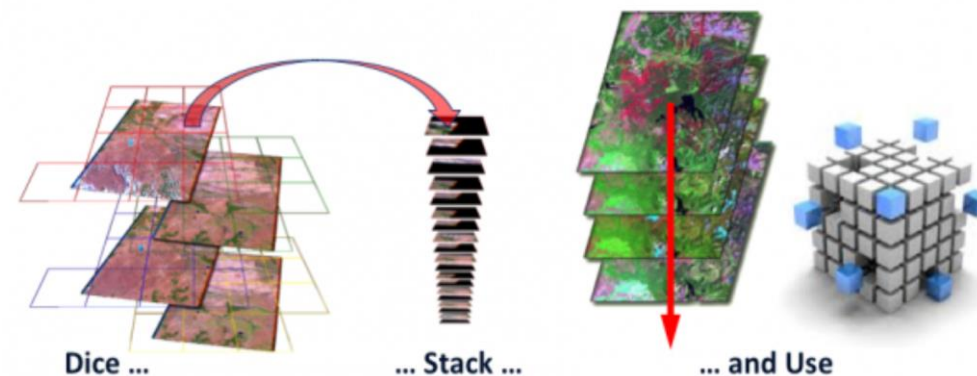


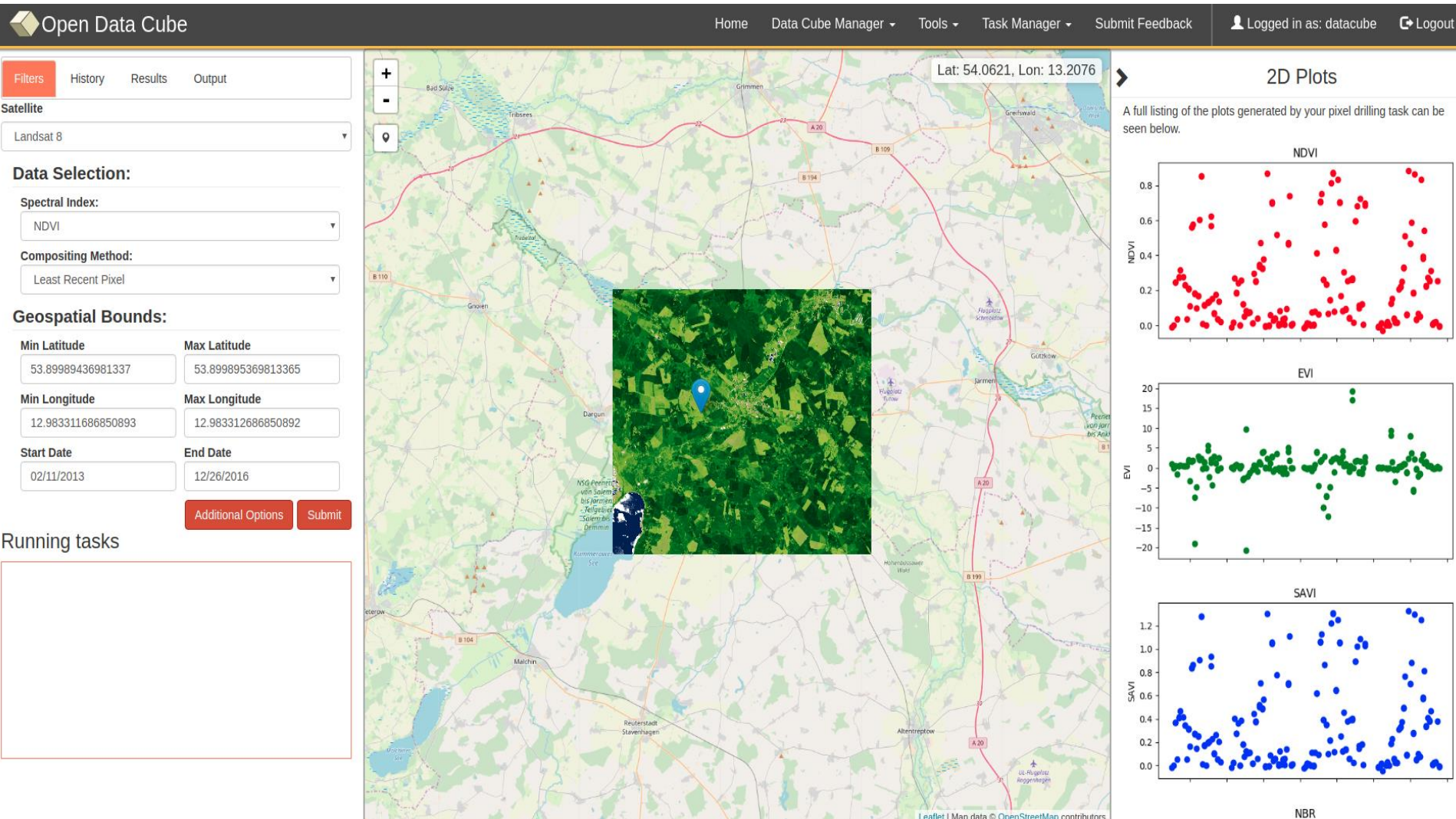
What is Open Data Cube ?

The Open Data Cube Infrastructure provides an integrated gridded **data analysis environment** providing **long-term analysis** ready earth observation data from **multiple satellites and other acquisition systems**.

Why using this approach?

The Data Cube framework allows multi-sensor environmental monitoring on a **cloud-based platform** for an **efficient and user-oriented analysis** of land surface phenomena based on **multi-temporal earth observation data**.





jupyter BurkinaFasoCube (Lake Bam) (unsaved changes)

Logout

File Edit View Insert Cell Kernel Widgets Help

Trusted Python 3 C

Run Stop Restart Clear Cell Output

Visualize DataCube extent

```
In [4]: from utils.data_cube_utilities.dc_display_map import display_map
platform = "LANDSAT_8"
product = "ls8_lasrc_burkinafaso"
longitude_extents = (-1.57, -1.485)
latitude_extents = (13.303, 13.55)
display_map(latitude = latitude_extents, longitude = longitude_extents)
```



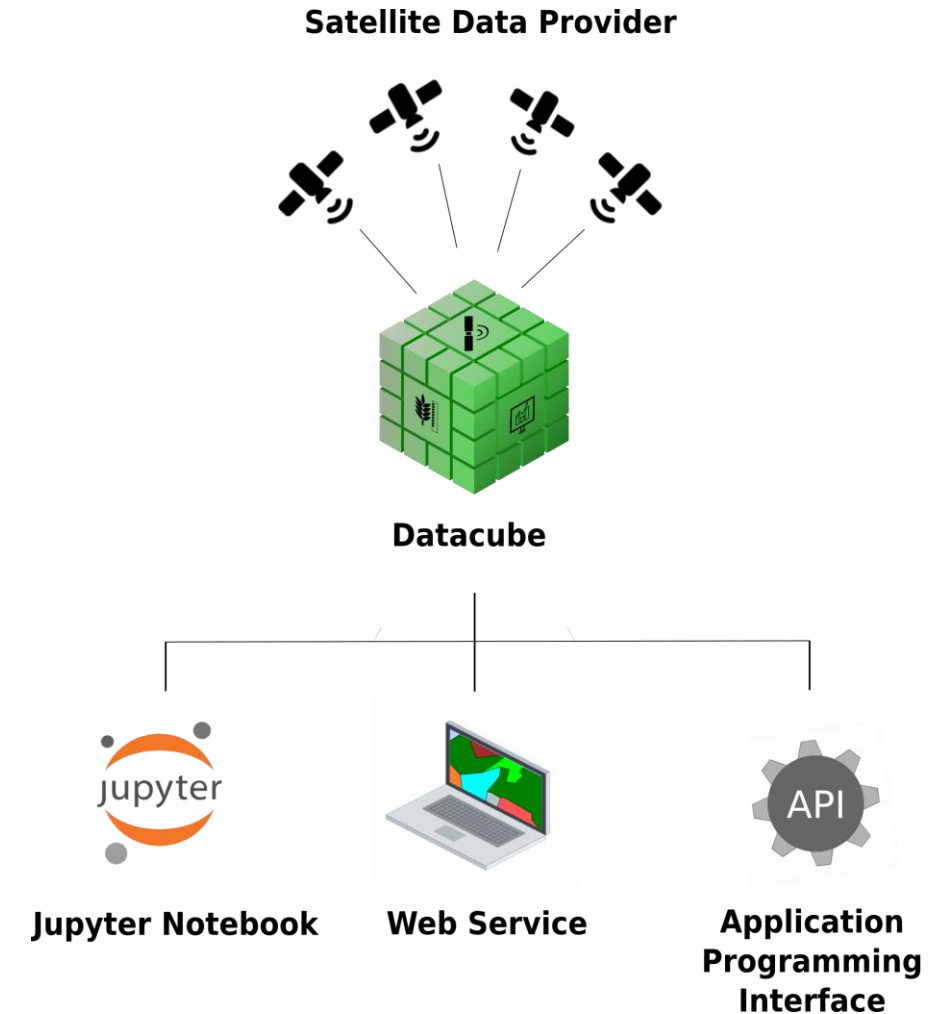
Load the dataset and the required spectral bands

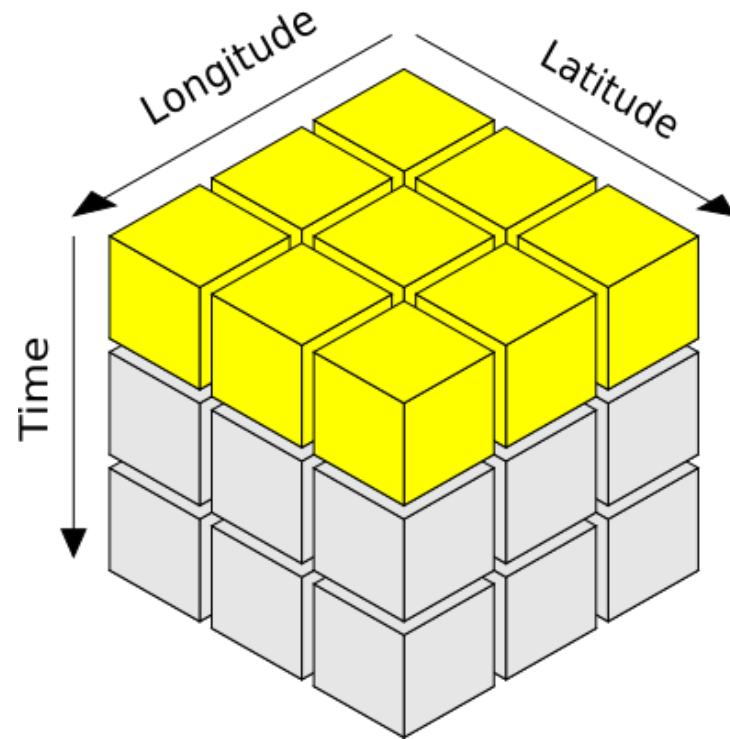
```
In [5]: from odc.ui import with_ui_cbk

landsat_dataset = dc.load(latitude = latitude_extents,
                           longitude = longitude_extents,
                           platform = platform,
                           time = time_extents,
                           product = product,
                           measurements = ['red', 'green', 'blue', 'nir', 'swirl1', 'swirl2', 'pixel_qa'],
                           progress_cbk=with_ui_cbk())
```

The Data Cube is a system designed to:

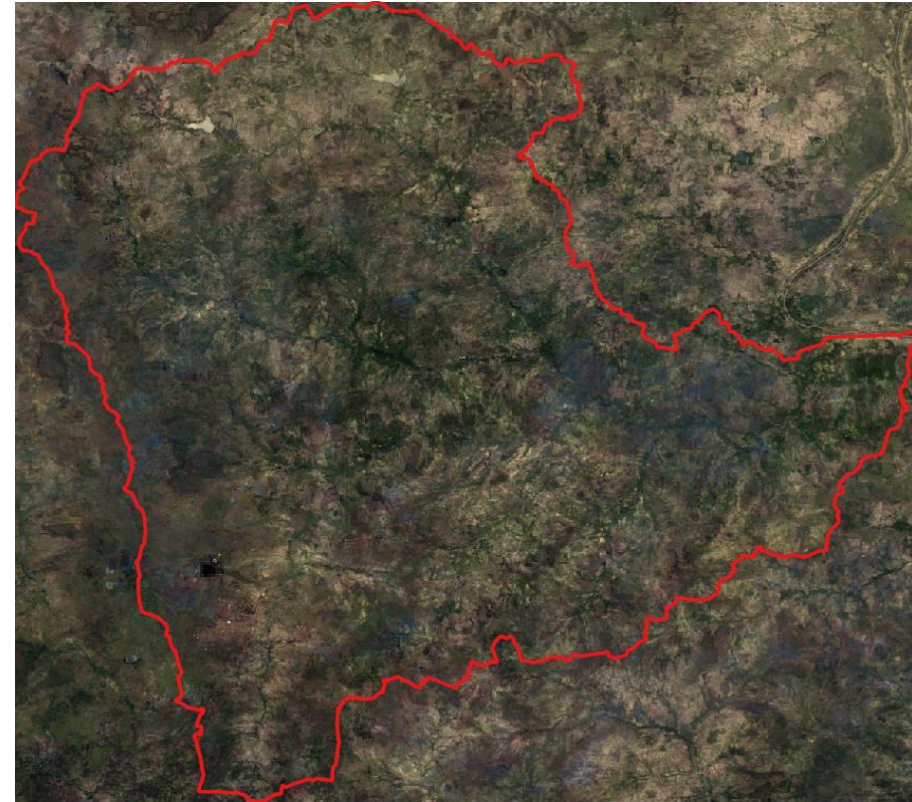
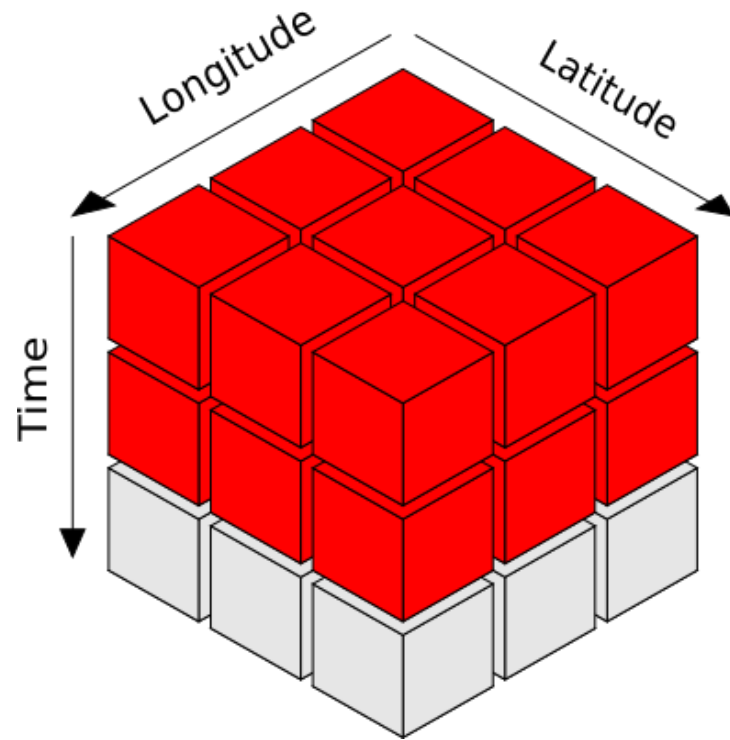
- Catalog large amounts of EO-data
- Provide a Python based API for high performance querying and data access
- Give scientists and other users easy ability to perform Exploratory Data Analysis
- Allow processing of the stored data on a continental scale
- Track the provenance of all the contained data to allow for quality control and updates





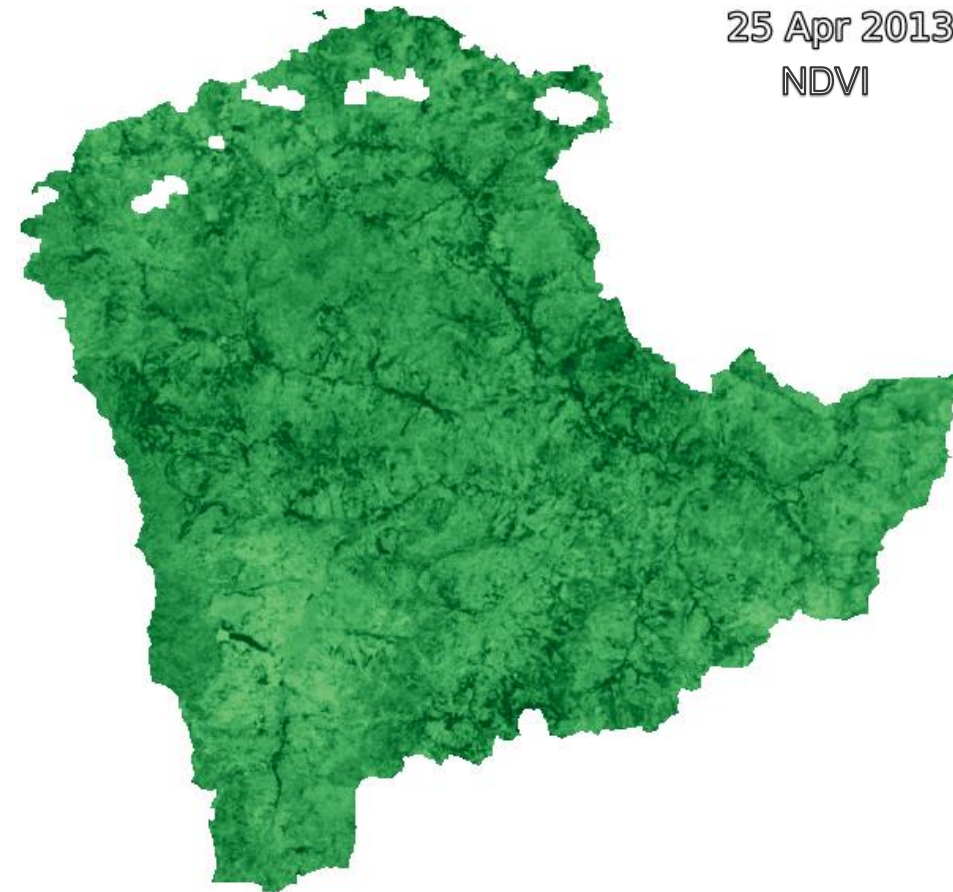
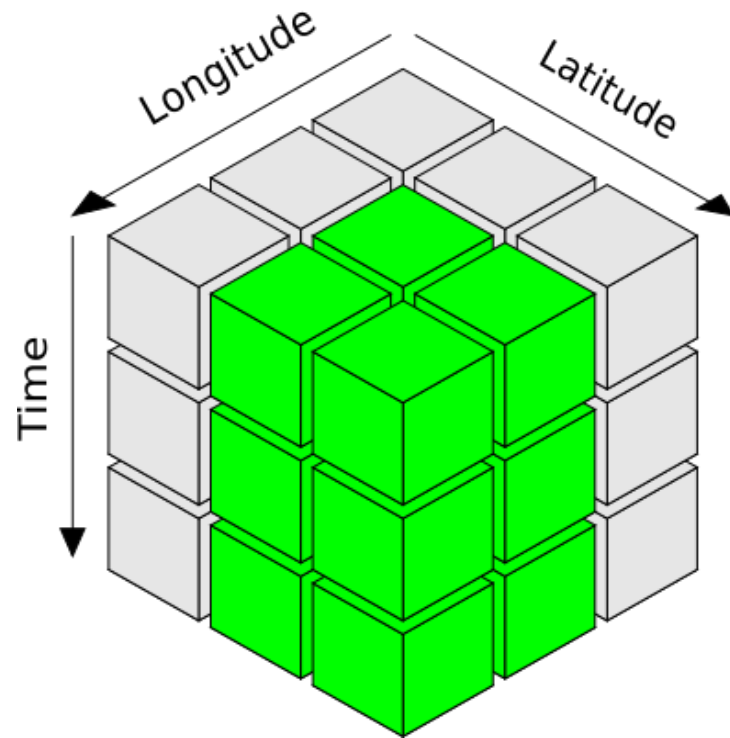
All available data at one point as time

Large scale mosaic



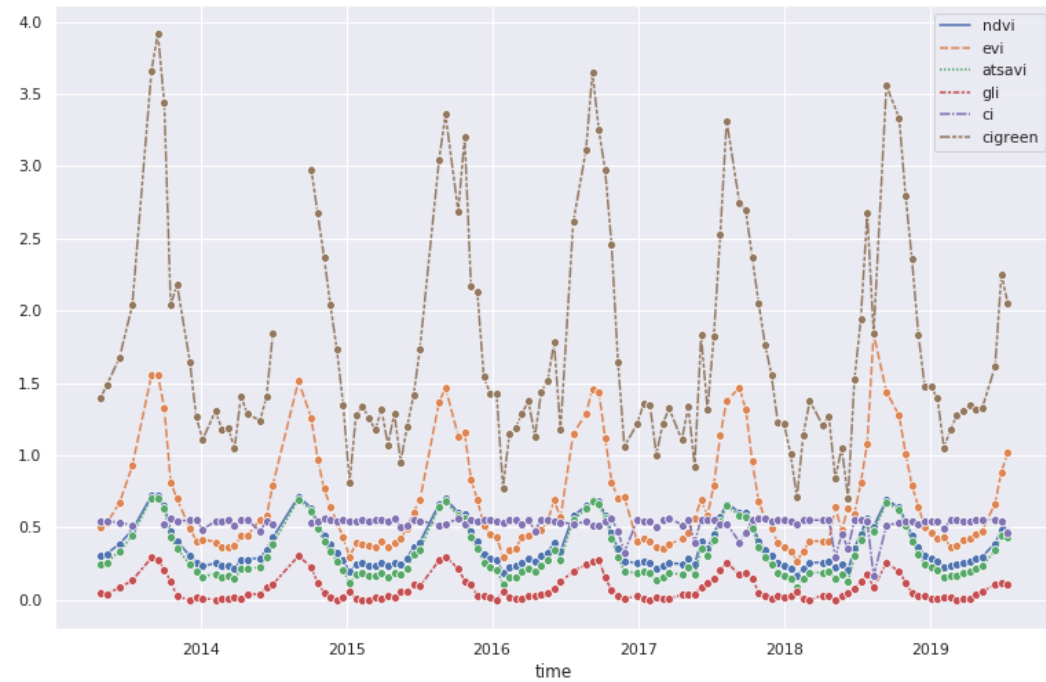
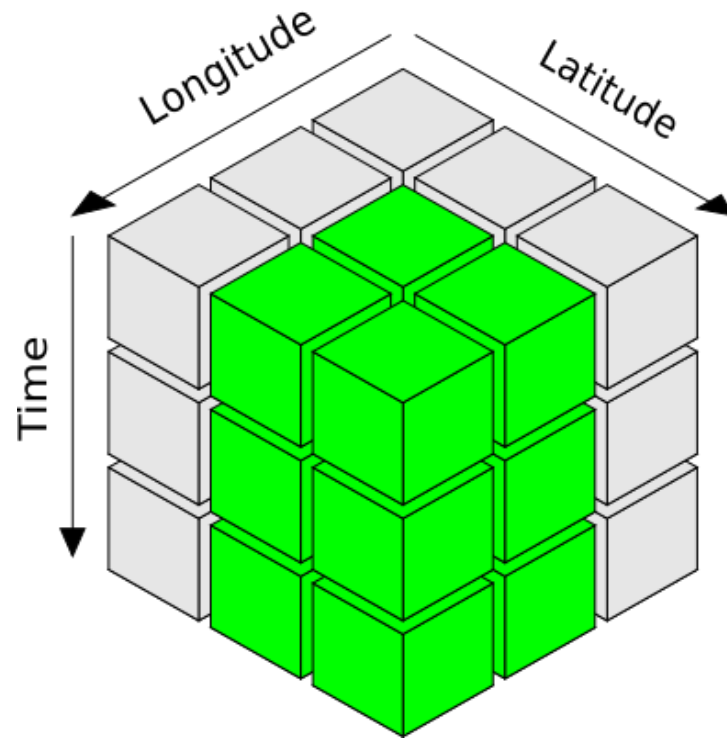
Combine several time slices

Cloud removal



All slices for a specific region

Time series analysis



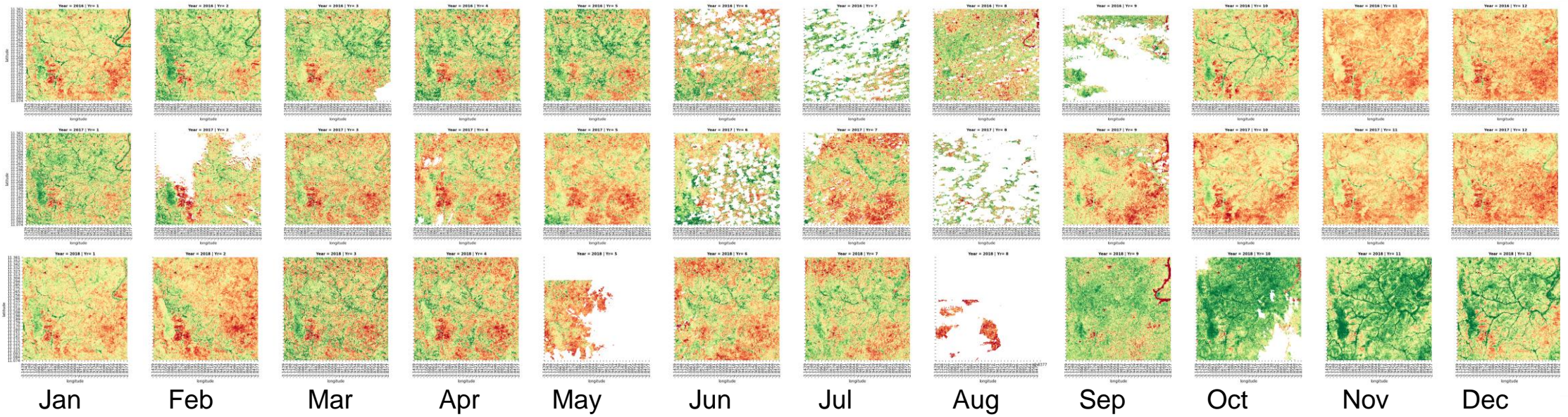
All slices for a specific region

Time series analysis

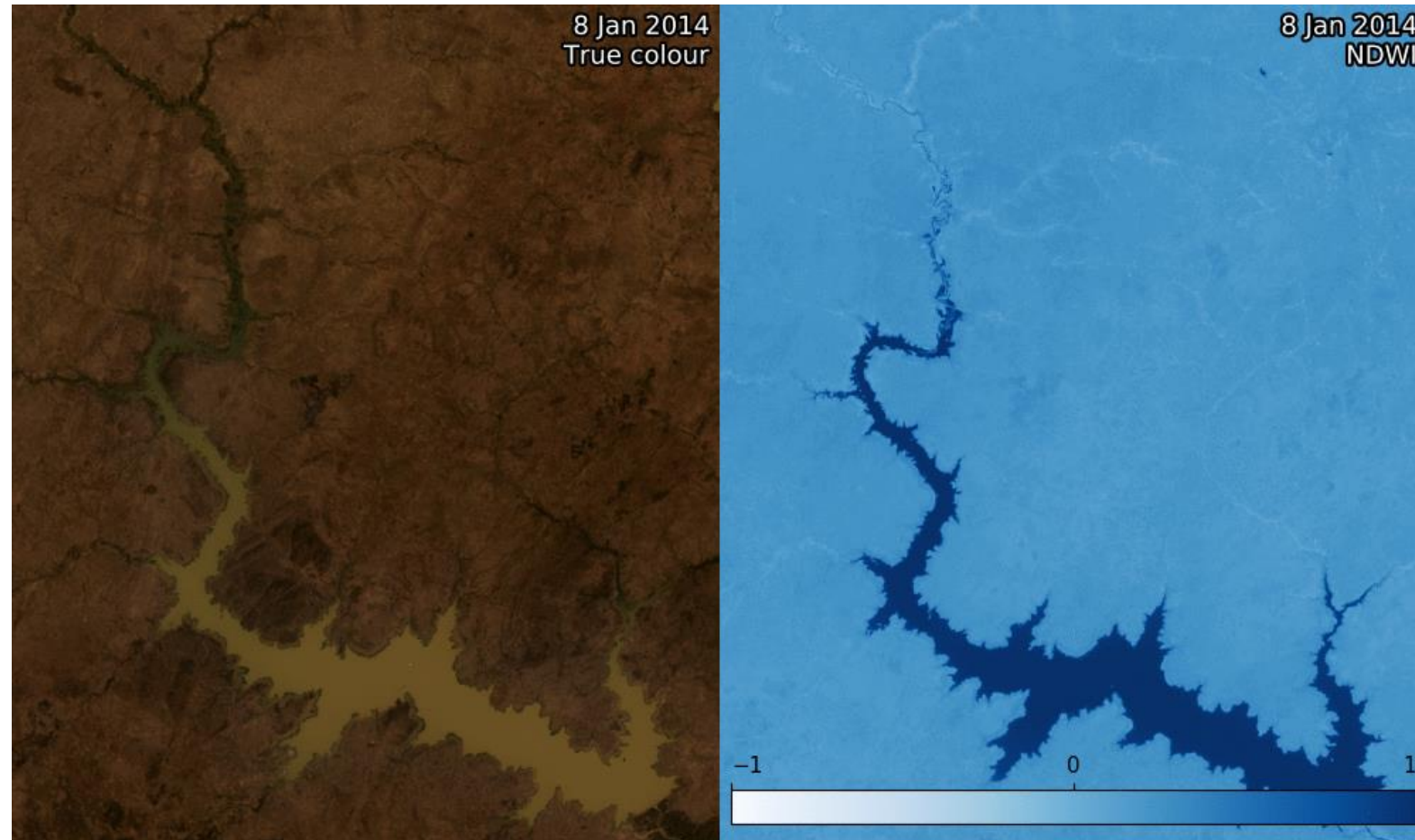
2016

2017

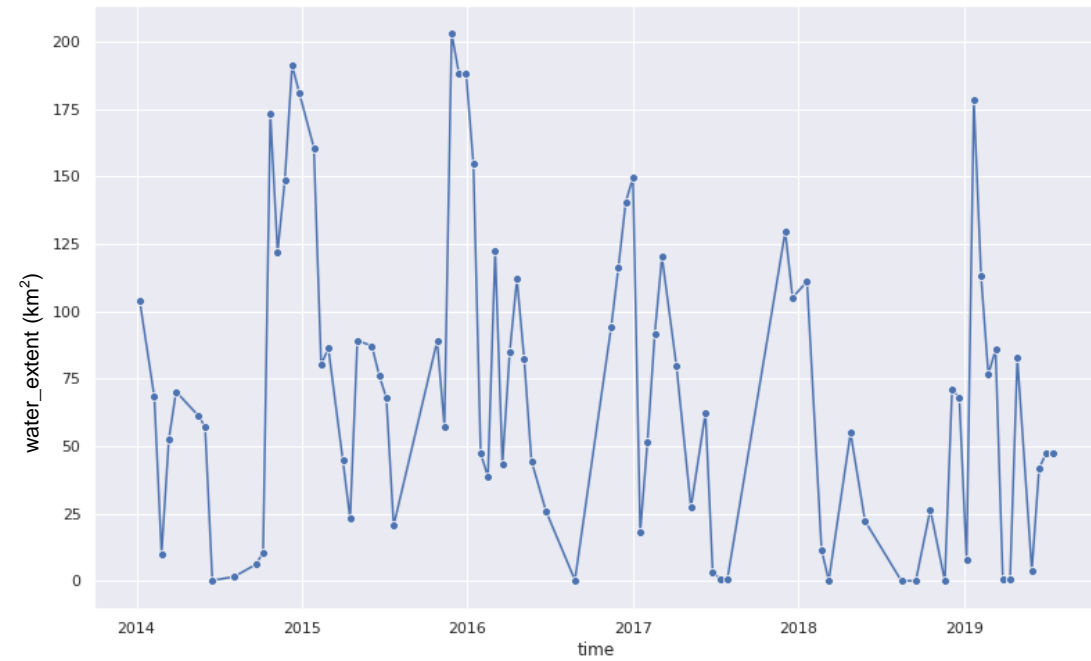
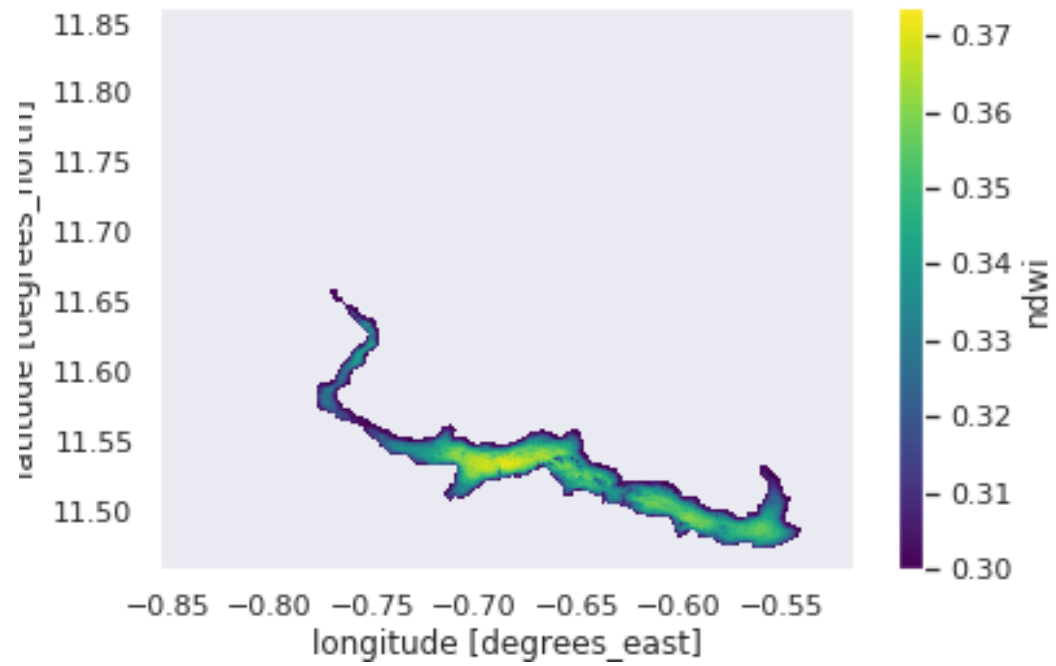
2018



NDVI Z-Score



time = 2014-02-09T10:21:13

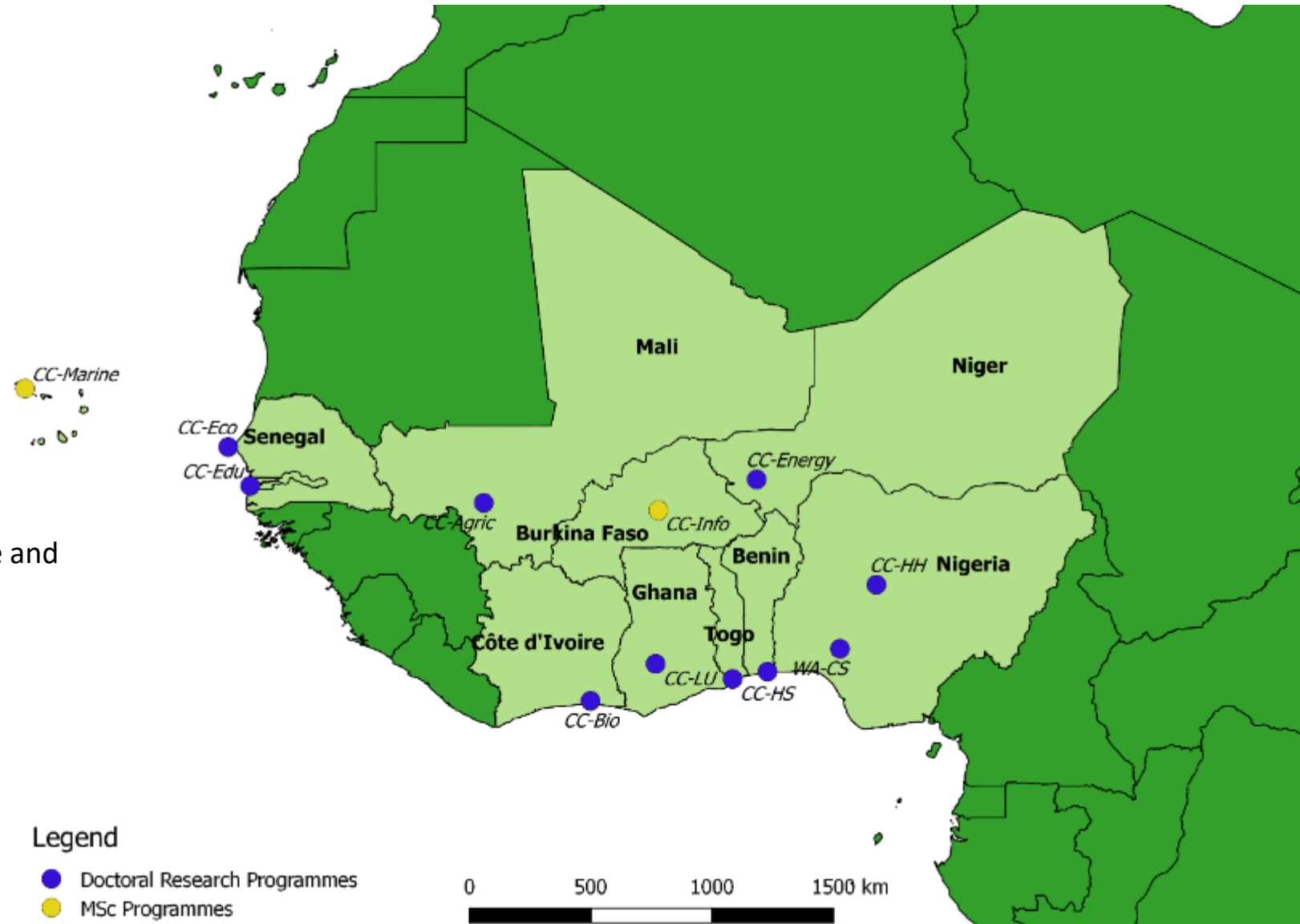


Why using the Data Cube approach?

- Makes it easier to use satellite data by **reducing preparation** time
- Enables **efficient time series analyses** and data interoperability
- Provides free and open source software and **algorithms for the cloud** or a local computer
- Allows **community development**, shared capacity building and organized algorithms
- Because it works ... just ask Australia and Switzerland!

Thank you for listening
Questions?

- **Benin:** Climate Change and Water Resources
- **Burkina Faso:** Climate Change Informatics
- **Cap Verde:** Climate Change and Marine Science
- **Côte d'Ivoire:** Climate Change and Biodiversity
- **Ghana:** Climate Change and Land Use
- **Mali:** Climate Change and Agriculture
- **Niger:** Climate Change and Energy
- **Nigeria:** West African Climate System; Climate Change and Human Habitats
- **Senegal:** Climate Change Economics
- **The Gambia:** Climate Change and Education
- **Togo:** Climate Change and Human Security



www.phenocube.org



Welcome to the Open Data Cube

CEOS is using the power of the Open Data Cube to help address the needs of satellite data users, giving them a better picture of their land resources and land change.

- Ease of use and access to satellite-based data
- Multiple dataset interoperability and spatial consistency
- Use of "Analysis Ready" Data Products
- A Shift in Paradigm from Scenes to Pixels

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