Flood Monitoring using ACube - An Austrian Data Cube Solution

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Users View

Flooding along the Gurk River in Austria, November 2019. Photo: Feuerwehr Gurk

Extreme weather events (e.g., storms, intense and enduring precipitation, heavy snow fall, strong snow melt with significant run-off, ...) can result in natural disasters, which threaten citizens, their properties and economy. It is therefore essential to assess the behaviour of the event (e.g., propagation of flooding, trail of a mudslide, terrain instability, ...) and the damages caused by it to be prepared for such a disaster in the future.

Here, we show a specific use case concerning a flooding event in Carynthia in mid-November 2019, which was classified as a thirty year flood. Heavy rainfall and snow melt led to severe flooding of rivers and lakes demanding the commitment of the Austrian army and fire brigades.

User - Data Interaction

EO Data Users (e.g., universities, ministries, companies, farmers)

Demands:
Use Cases
Data Sets
Spatial Resolution
Temporal Resolution
Metadata

Data Access

ACube offers different possibilities for data visualisation through QGIS (WMTS/WMS or WCS) or JupyterHub. The latter interface also supports simple processing and data analysis features through the Python API of **Open Data Cube**.

Jupyter Hub/Notebook

Web Map Service in QGIS

Data Access

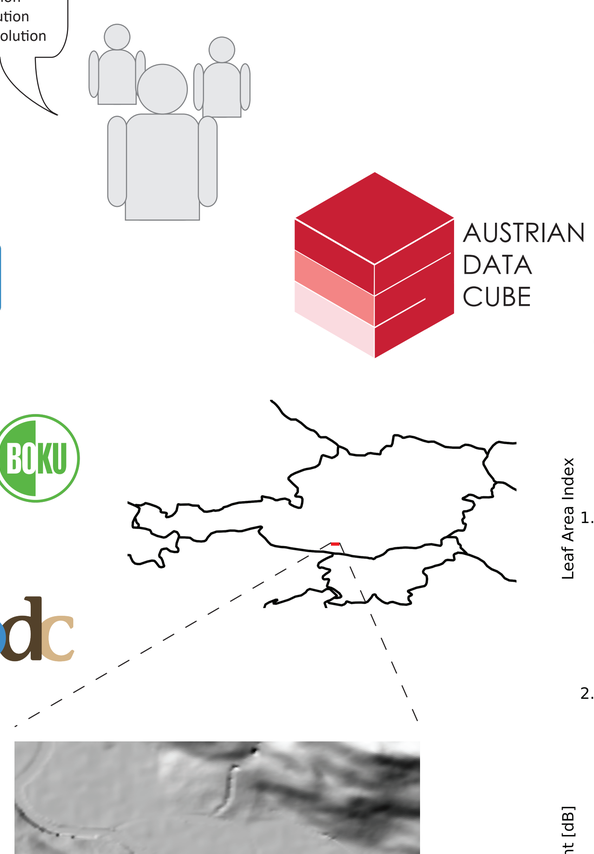
Flood Data Users (e.g., ministries, fire brigade, army, citizens, ...)

Data Analysis

Damage Detection
Damage Assessment
Flood Analysis
Flood Prevention

Possibilities:
Data Sets
Interfaces
Data Exploration
Spatial Resolution
Temporal Resolution

Scientists and Remote Sensing Experts (TU Wien, BOKU and EODC)



Hillshade of EUDEM

Currently, **ACube** hosts manifold data sets in the order of 35 TB derived from the basic Copernicus Level-1 data. This includes C-band radar backscatter (sigma nought (SIG0) and radiometric terrain flattened gamma nought (GMR)), Surface Soil Moisture (SSM), various optical bands, True Colour Images (TCI), Normalized Difference Vegetation Index (NDVI), Leaf Area Index (LAI), Fraction of Absorbed Photosynthetically Active Radiation (fAPAR), and monthly composites derived from these products. In addition, the EUDEM was ingested as a static data set. Pixel spacings vary between 10 and 500 m and the temporal resolution is platform dependent (max. 1-3 days at **Austrian** latitudes).

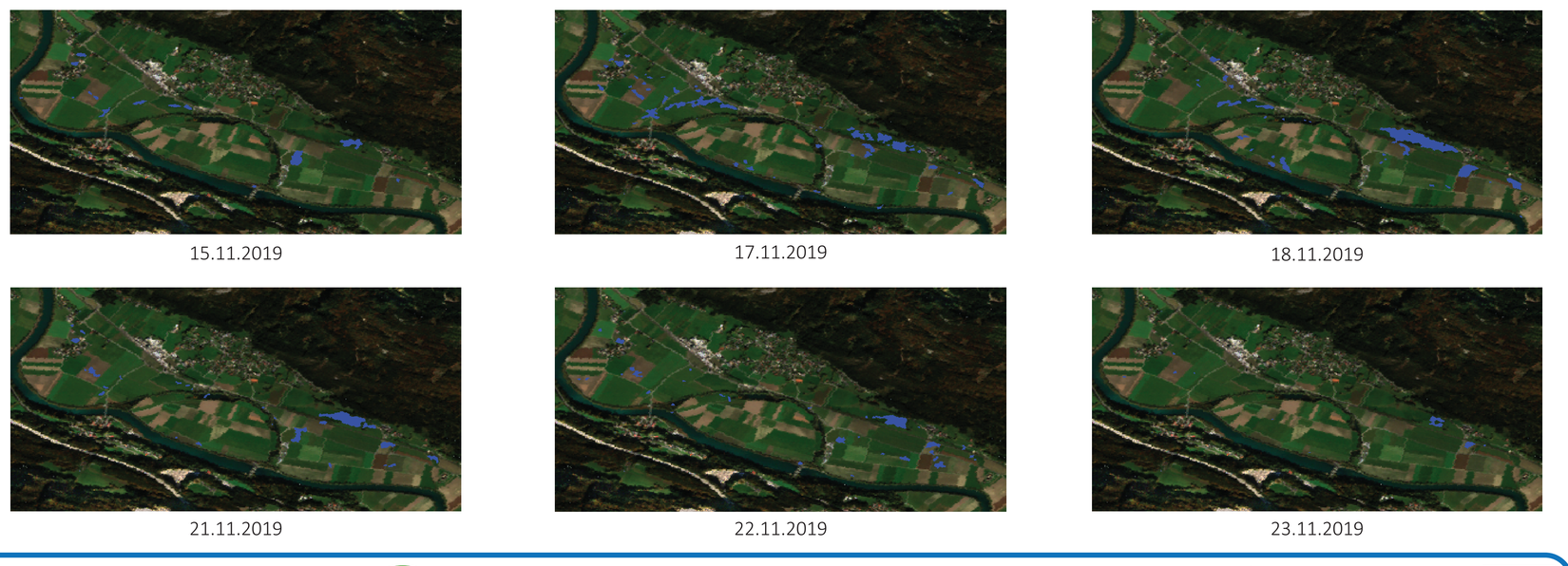
ACube prepares ground for many applications, e.g., land cover classification, snow melt monitoring, grassland yield estimation, land slide and **flood detection**. With a focus on the latter use case, first analyses based on Sentinel-1 radar backscatter data have already shown promising results (see below). Therein, a difference between a backscatter image at time *t* and a statistical backscatter parameter (monthly or seasonal mean), which is derived from data before *t*, is computed. A gaussian filter was used to smooth the intermediate output and to reduce the influence of speckle. After applying a threshold and a morphological operator for classifying watered areas, false positives in steep or forested areas were manually excluded with the aid of optical imagery and a digital elevation model.

The six figures below clearly show the progress and decline of the **flooding** for a smaller region of interest near Weißenstein, Carynthia in November 2019. Flooded areas are coloured as blue and are overlayed on a Sentinel-2 TCI image, sensed on 23.10.2019.

A near real-time fusion of radar, optical and ancillary data (DEM, land cover, etc.) through machine learning techniques could further improve an indication of **flood events**. Building a dedicated web service is foreseen as an upcoming action. Such an emergency service would provide much potential for authorities and users to assess damages, and also to determine vulnerability to progressing flooding.

ACube Data

Flood Maps



Data Cube and Flood Monitoring

Geospatial data come in **various formats** and originate from **different sensors** and **data providers**. This poses a **challenge** to users when aiming to **combine** or simultaneously access them. To overcome these obstacles, an easy-to-use **data cube** solution was designed for the **Austrian user community** and gathers various relevant and near real-time Earth Observation (EO) data sets. Here we show how such a system can be used for **flood monitoring**.

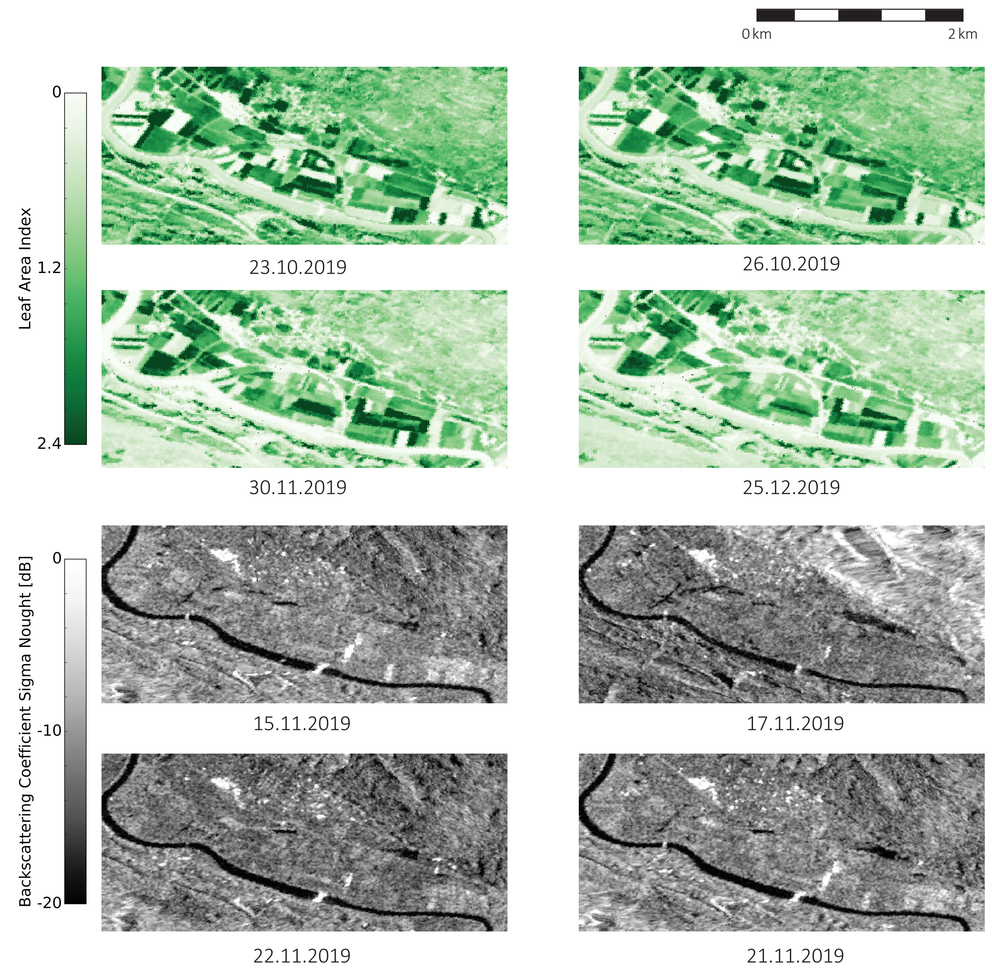
In 2018, a joint project between the Earth Observation Data Centre for Water Resource Monitoring (**EODC**), Vienna University of Technology (**TU Wien**) and Vienna University of Natural Resources and Life Sciences (**BOKU**) has led to the emergence of the Austrian Data Cube (**ACube**). **ACube** implements the generic Python software from **Open Data Cube**, but further tailors it to national needs of Austrian ministries, universities or smaller companies. With user-driven input coming from all these partners, data sets and metadata attributes have been defined to facilitate query operations and data analysis. A focus was put on high-resolution remote sensing data from the **Copernicus programme** including data from the Sentinel satellites, i.e. radar data from Sentinel-1 and optical data from Sentinel-2, and higher-level data sets, e.g. the EUDEM.

An essential part for tailoring **ACube** to the needs of the **Austrian user community** were the lively discussions between representative users (e.g., ministries, companies), and scientists and remote sensing experts (e.g., universities, data centres). Through several queries and use case examples, an appropriate setup of offered data sets, spatial resolution, temporal resolution, metadata and user interfaces could be settled.

Within **ACube**, tasks are split according to the expertise of the partners. Data processing and ingestion is done by **TU Wien** (Sentinel-1 data) and **BOKU** (Sentinel-2 data), whereas the **data cube** and its interfaces were implemented and are maintained by the **EODC**. This ensures a seamless user support, where a user can directly contact experts in each discipline. In case of data inquiries the involved universities can assist the user, whereas **EODC** is responsible to answer data cube, processing, or interface questions. Other **data cube** like infrastructures (e.g., Google Earth Engine) lack in advising users with scientific expertise and cannot fulfill demands on a national level.

ACube was developed based upon the Python software **Open Data Cube**, which expects a more or less strict definition of data sets, e.g., a product name, a list of measurements (i.e., bands or polarisations), and additional metadata attributes. The latter defined attributes allow to query the data not only by time and space, but also by arbitrarily defined data properties, e.g., cloud coverage or relative orbit. In the background, **Open Data Cube** uses a PostgreSQL database to perform spatial queries and to store relevant data pointers. In addition, a metadata database is used by **ACube** to manage ingested data and its attributes.

Moreover, **ACube** enables access to a High Performance Computing (HPC) environment connected to a Petabyte-scale storage, which is exploited for generating all offered products, but could be also used for example for **flood mapping**.



Partners

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