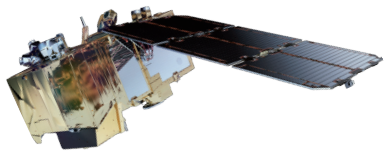Exploitation of Sentinel-2 observations for operational

CROP MONITORING

*"In Europe we should know nowadays the normal land cover of every land parcel, but what is really raising **our interest in the CropMon products** is the potential **to learn more about the actual state and condition of ecosystems and crop types** and their variation over time."*

Gebhard Banko, DI, Deputy Head of Unit Biodiversity & Nature Conservation, Umweltbundesamt

Raster Database

Phenological parameter retrieval

Object- based Image Analysis
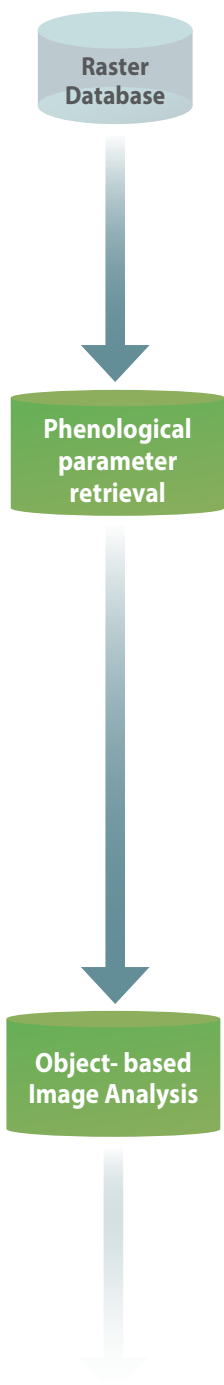
Introduction

Satellite Earth Observation (EO) contributes to crop monitoring as a proven source to be timely and consistent information on agricultural productivity at various scales. With the successful launch of the Sentinel-2 satellites, a new chapter for European and global land monitoring will be opened: The two satellites will provide high spatial and temporal resolution optical imagery of the Earth's land surface allowing to identify, monitor and govern changes in agricultural areas. Here the CropMon project comes into play, with its aim to pave the way for a full exploitation of the potential of Sentinel-2 observations to provide operational crop monitoring information solutions by the preparation of **supercomputer ready processing chains** for the identification of crop types and condition monitoring as well as an **online, interactive service order and delivery platform** for the "Earth Observation Data Centre" (EODC).

Sentinel-2 Simulated Database

The operational crop monitoring builds on a simulated database of S-2-like imagery, which is based on time series of cloud-free, "bottom-of-the-atmosphere" (BOA) multi-spectral Landsat images. Such time series of satellite observations are suitable to identify crop types and their status as well as to monitor crop and grass conditions. The following three regions of interest (ROI) were chosen for the simulations:

- **Lower Austria (Marchfeld),**
- **Castilla-la-Mancha, Spain (Barrax), and**
- **Brazil (Sao Paulo State)**

The sites were selected for the availability of in-situ crop type data and other ancillary information. To get a good representation of the full vegetation cycle, each year is covered by 24 images (two images per month). Depending on the availability of in-situ data, several years were selected for each ROI. To create a "Sentinel-2-like database", Landsat observations were used together with an algorithm originally developed in the LandMon project (ASAP 10). From the filtered reflectance in the six reflective spectral channels of Landsat, the NDVI (Normalized Difference Vegetation Index), NDWI (Normalized Difference Water Index), fAPAR (fraction of absorbed photosynthetically active radiation) and Tasseled Cap Brightness (TCB) were calculated.
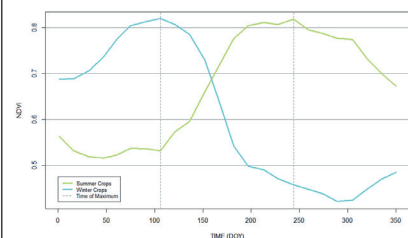
Crop Phenology

The VIs and in-situ crop field data are used to derive the most meaningful phenological parameters do describe the characteristics of the crops (Atzberger, Klisch, Mattiuzzi & Vuolo, 2014). These following parameters appear to have a high informative value for the condition of crops and are crucial for the identification of the crop types in the subsequent processing steps:

- **Start of season (SoS)**
- **Baseline**
- **Maximum and minimum value**
- **Time of maximum value**
- **Integral of the cyclic fraction (until maximum)**
- **Integral of the cyclic fraction (whole vegetation period)**
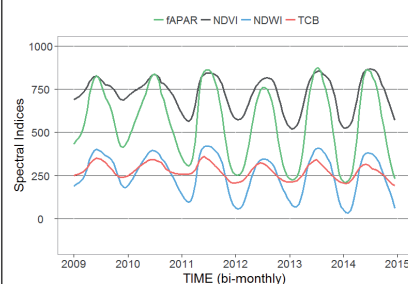
Example of a time series (15-day resolution) (from Marchfeld) for four vegetation indices calculated from the smoothed/gap-filled reflectance data set. The four vegetation indices are NDVI, NDWI, fAPAR and TCB.

Comparison of a typical NDVI curve of a winter and summer crop for one growing season (from Marchfeld) and the derived Time of Maximum for each crop type.
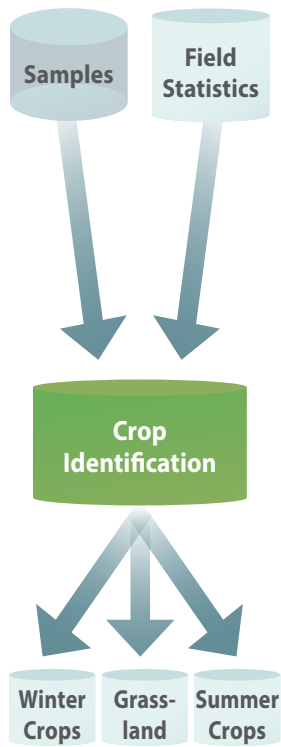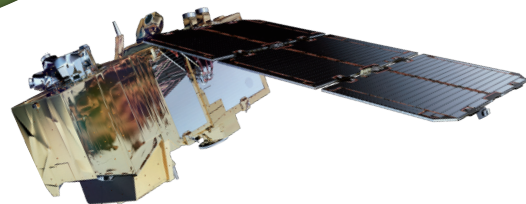
References:

Atzberger, C.; Klisch, A.; Mattiuzzi, M.; Vuolo, F. Phenological Metrics Derived over the European Continent from NDVI3g Data and MODIS Time Series. *Remote Sens.* 2014, 6, 257-284.

T. Blaschke, Object based image analysis for remote sensing, ISPRS Journal of Photogrammetry and Remote Sensing, Volume 65, Issue 1, January 2010, Pages 2-16, ISSN 0924-2716

Schultz, B.; Immitzer, M.; Formaggio, A.R.; Sanches, I.D.A.; Luiz, A.J.B.; Atzberger, C. Self-Guided Segmentation and Classification of Multi-Temporal Landsat 8 Images for Crop Type Mapping in Southeastern Brazil. *Remote Sens.* 2015, 7, 14482-14508.

J. Michel, D. Youssefi and M. Grizonnet, "Stable Mean-Shift Algorithm and Its Application to the Segmentation of Arbitrarily Large Remote Sensing Images," in *IEEE Transactions on Geoscience and Remote Sensing,* vol. 53, no. 2, pp. 952-964, Feb. 2015.

Exploitation of Sentinel-2 observations for operational
CROP MONITORING

Samples

Field Statistics

Crop Identification

Winter Crops

Grass-land

Summer Crops

Image Segmentation

Based on the phenological layers meaningful segments corresponding to field boundaries are extracted, using the open-source Large-Scale Mean Shift Region Merging algorithm from the OTB Orfeo Toolbox (Michel, Youssefi & Grizonnet, 2015). This approach shows better classification results compared to the traditional pixel-based technique by reducing noise visible at pixel level (Blaschke, 2010). Furthermore, it overcomes some of the problems of pixel-based analysis of high spatial resolution data, such as from S-2 and allows the calculation of field level statistics that enhance the performance of the crop identification:

- **Size**
- **Phenology**
- **Average vegetation density**
- **Intra-Segment Variability**

Crop classification

In a last step the crop identification was performed, using the popular supervised classification model Random Forest, which has become very common for remote sensing data classification in the last few years (Schultz et al., 2015). The inputs for this ensemble learning classification tree algorithm are the field segments that contain the calculated field level statistics and an in-situ database of sample points for the three test sites (Marchfeld, Barrax and Sao Paulo). These samples consist of parcels, point-based field measurements and extracted crop type information. The result is a detailed land cover map on field level for the examined growing season that distinguished between summer-, winter crops and grassland.
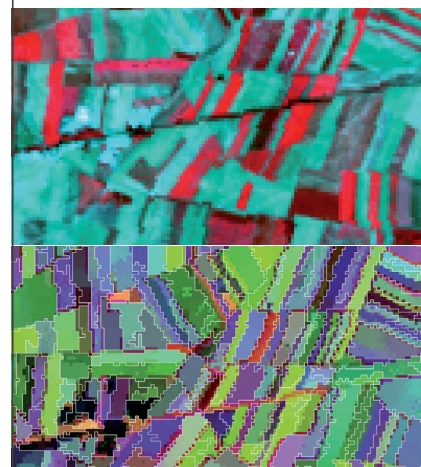
The upper image depicts the field structure (L8 false color composite RGB 432) in the Marchfeld region. The lower image shows the derived segments from the Large-Scale Mean Shift algorithm based on the radiometric filtered phenological layers.

Crop Monitoring
dev-0.5.1

Account
eodc@sidp.eodc.eu

Area of Interest
Bounding Box | Shape | Map

Time Range
2015-01-01 - 2015-12-31

Marchfeld Landcover Classification
Generated on 2016-03-21, dev-5.3.1, eodc@sidp.eodc.eu

Product Preview

- Water
- Build up
- Bare soil
- Forest
- Summer Crops
- Winter Crops

Product Download

Cropmon Products can be analyzed directly online.

Or download them for local usage.

> Products are available in standard product formats (ESRI Shapefiles, GeoJSON, KML, GeoTIFF, etc.)

Order Cropmon Products for your Region of Interest (*)

> Just specify Location, Timeframe, and Classification Parameters.

> (*) may be limited depending on observation data availability

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