Indicator version: v1.0

Crop masks

The Crop Masks used in the European Drought Observatory (EDO) and Global Drought Observatory (GDO) consist of 36 binary spatial layers (one for each 10-day period of the year) used to depict the location and extent of crop in its growing season ("active crop", hereafter).

The crop masks have global coverage. Figure 1 illustrates an example of these masks for Spain for each 10-day period at 1/100 decimal degrees (nominal 1 km by 1 km) resolution. These maps distinguish "active" and "non-active" crop pixels, with white areas depicting no-crop pixels.

Variable	Temporal scale	Spatial scale	Coverage
Crop Masks	10 days	1/100 decimal degrees 1/24 decimal degrees 1/12 decimal degrees	Global

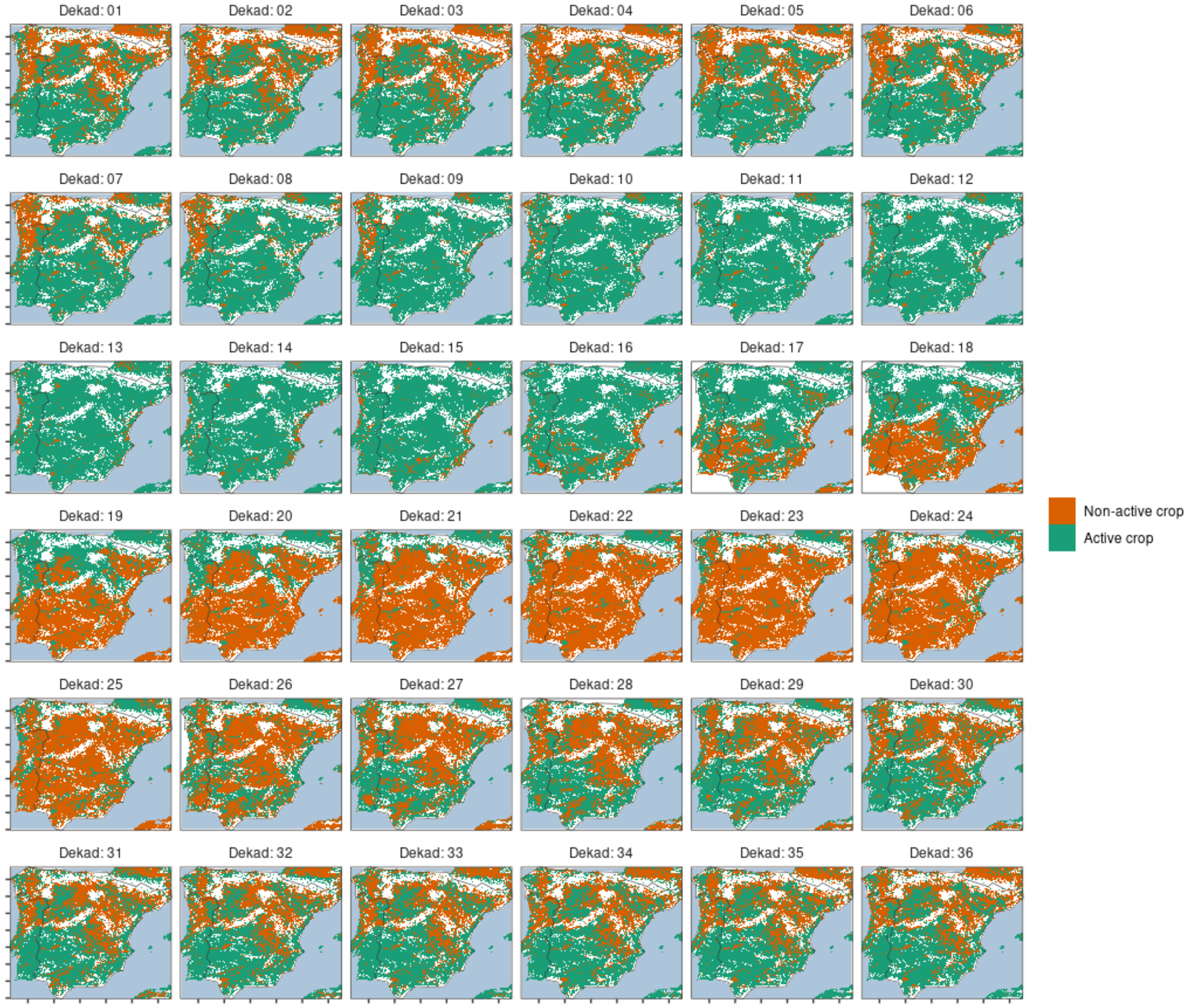

Figure 1An illustrative examples of the EDO & GDO Crop Masks in Spain. White areas correspond to "no-crop" pixels.

1. Motivation for the use of Crop Masks in EDO and GDO

FAPAR is a remote sensing indicator used in EDO and GDO for detecting and monitoring the impacts of drought on vegetation growth and productivity. Negative anomalies of FAPAR are often adopted as a proxy variable for the adverse effects of drought on vegetation (Cammalleri et al., 2022).

The analysis of vegetation indices like FAPAR benefits from the use of crop masks, as they allow to filter out non-vegetated surfaces after crop harvest ("non-active" crop areas), especially in regions where agricultural production has strong seasonal patterns related to the biological lifecycle of crops (Valero et al., 2016). Indeed, the reflectivity characteristics of soil background and crops differ completely in the Red and Near-Infrared bands (Ding et al., 2014), and anomalous signals of FAPAR from exposed bare soil in crop fields must not be confounded with drought stress on vegetation.

2. Generation of the Crop Masks

In agriculture monitoring, crop masks are fundamental for identifying crop areas in remote sensing images (Zhang et al., 2019). The EDO & GDO global crop masks are based on the cropland and rangeland mask available through ASAP (Anomaly hot Spots of Agricultural Production, https://mars.jrc.ec.europa.eu/asap/index.php), an early warning system that provides timely information about possible crop production anomalies (Meroni et al., 2018; Rembold et al., 2019). The ASAP global cropland and rangeland is a raster file, which furnishes the percentage of each pixel with crop/rangeland (area fraction) and has a spatial resolution of about 1 km². For the implementation of the crop masks in EDO & GDO, first the ASAP cropland and rangeland mask has been converted from area fraction (percentage values in the range 0 – 100%) to binary ("crop/no-crop" pixel) values and the rangeland pixels filtered out. In the binary masks, a crop pixel is one with at least 1% of crop. Secondly, isolated crop pixels (clumps smaller than 5 pixels) have been removed ("sieved") in order to reduce noise and improve the representation of crop areas. Finally, the binary mask has been integrated with the information retrieved by the ASAP phenology maps reporting, for each crop cell, the Start Of the growing Season (SOS) and the End Of the growing Season (EOS). The SOS and EOS maps have been derived as long-term average of 10-day MODIS NDVI data.
The result is a collection of 36 binary maps covering the periods from the 1st to the 10th, from the 11th to the 20th and from the 21st to the last day of each month.

Note:

- to downsample the maps to the resolution of 1/12 and 1/24 decimal degrees, a "mode" resampling strategy has been used (i.e., the value which appears most often of all the sampled pixels has been selected);

- for the calculation of the Combined Drought Indicator (CDI) implemented in EDO, based on the Standardized Precipitation Index (SPI) and Soil Moisture Anomaly (SMA) and FAPAR anomalies, the SOS and EOS of each crop cell have been anticipated and prolonged by 10 days, respectively. This temporal buffer partially addresses dynamic annual area changes and rotations in crop fields (Zhang et al., 2019).

3. Strengths and weaknesses

Strengths:

- The standard FAPAR product has no concept of cropping seasons. However, crop calendar events such as crop harvest can significantly affect the spectral response of cropland areas. Crop masks can be used to limit the analysis of FAPAR anomalies to the growing season in crop fields and make more consistent monitoring and analysis of temporal and spatial variation of drought events. FAPAR masking is of importance for the calculation of the Combined Drought Indicator, as it prevents the assessment of ALERT status (stress for vegetation) in crop fields out of the growing season.

Weaknesses:

- The EDO & GDO crop masks are conceived as "static" masks, where the start and the end of the growing season of each crop cell are fixed in time. In other words, the actual implementation of the crop masks is not able to describe in near real-time the seasonal progression of crop (expansion, maturity, senescence).

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