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Detection of New Urban Elements in Agricultural Parcels

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Context

- In the particular context of the Common Agricultural Policy, the detection of new non-eligible areas – such as buildings and infrastructures – inside agricultural parcels is of great importance. This monitoring should be done as frequently as possible.
- More generally, this kind of monitoring helps tackling the problem of increasing pressure on biodiversity and ecosystems due to the loss of natural and semi-natural vegetated land.
- Such detections can be made using Very High Resolution images but they are usually not available at global scale and not frequently updated.

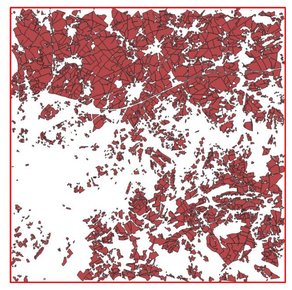
➤ With their global coverage, high temporal frequency and medium spatial resolution, could Sentinel-2 (S2) images be useful? What are the strengths and limitations of such approach in an operational context?

Example of urbanisation seen on orthophotos

Study area and data

- Study conducted in the Walloon Region (southern portion of Belgium). Area of interest of 20 x 20 km². Diverse land occupation: from densely urban to mainly agricultural.
- Time series derived from S2 images (on tile T31UFR) during the 2020 agricultural season.
- Land Parcel and Identification System: contains polygons of agricultural blocks surrounded by physical non-agricultural elements (road, forest…) and polygons of fields parcels with information about their crop type.
- Orthophotos (for validation)

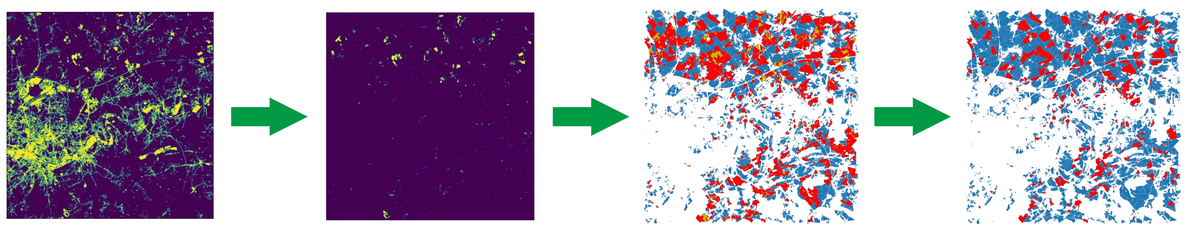

Orthophoto of the AOI


LPIS over the AOI

Algorithm workflow

1. Pixel classification as urban / non-urban (see below)
2. Application of a mask based on agricultural parcels (-10m buffer on the join of parcels to avoid unwanted border detections (roads, …))
3. Flagging of parcels containing a flagged masked pixel
4. Additional filter on the parcel crop type to lower the number of false detections (e.g.: some crops typically have low NDVI during a specific period)

⟳ The procedure can be repeated at several times of the year to allow for periodic detections (the crop filter must be adapted)

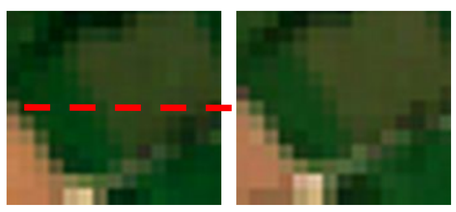

1 - Pixel classification | 2 - Masking pixels | 3 - Flagging parcels | 4 - Filter on crop type

Coping with the geometric misalignment

Imprecise alignment of S2 images from date to date tends to break time series at the pixel-level ➟ implemented mitigation techniques:

- Co-registration of images based on phase correlation with a reference image
- Pixel value replaced by the min(NDVI) over a 3x3 window around the pixel

⚠ aggregation function must be adapted to the pixel classification algorithm


Example of misalignment (shown by the red line): an urban point jumps from one pixel to an adjacent one

Validation dataset

Collection of agricultural polygons classified as containing an urban element (45) or not (2961). The dataset has been built by

- a pre-classification based on the differences between the 2020 and 2019 LPIS
- a visual verification on orthophotos of the parcels classified as “urbanised”

Examples of false detections


Potatoes field

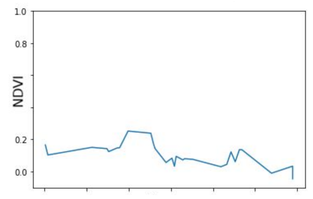

Mud in grasslands

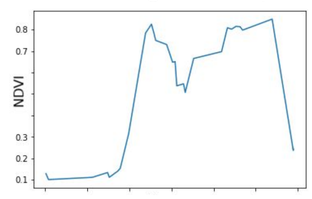

Storage

Pixel classification

- Basic idea: the dynamics of some vegetation indices (e.g. NDVI) of a urban area is very flat compared to an agricultural area
- Flagging criterion: NDVI < 0.3 during 3 months
  + additional conditions to ensure minimal number of data points
- More elaborated criteria have been tested but not retained
- Many false positive, removed by the subsequent steps of the algo

NOTE: in this test, we have only considered the period may-june-july





Results

- Parts of the algo leading to the most significant improvements:
  3x3 window + buffer + crop filtering
- 80 % urbanised parcels correctly flagged (TP)
  missed parcels = small urban elements at the parcel border
- 90 % True Negative
- 10 % False Positive. Possible improvements:
  - longer time period = lower FP <u>but</u> higher detection delay
  - stronger crop filter = lower FP <u>but</u> lower TP on given period

Examples of correctly flagged parcels

Examples of missed detections

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