

# Earth Observation Artificial Intelligence Use Cases Digitaal Vlaanderen

Earth Observation Data Science (EODaS)

Artificial Intelligence for NMCA's  
(27-28 October 2023)

**DIGITAAL  
VLAANDEREN**



**Vlaamse  
overheid**

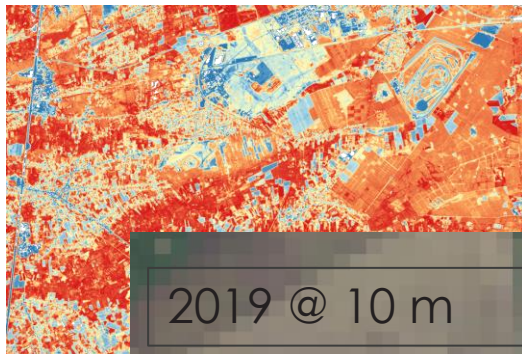
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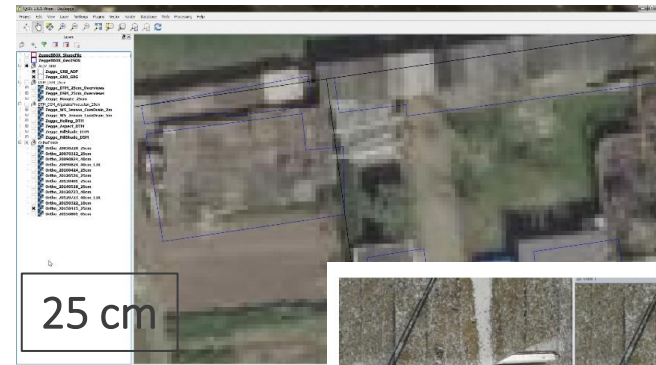
# Earth Observation : basis for mapping, monitoring, change detection, ...

or the recognition of objects and/or changes in the landscape for Mapping Agencies

- based on various sources, data and images
- use of various algorithms such as Machine learning
- Integration of sources with different spatial and temporal resolution,
- ...



Satellite images Sentinel  
Spatial resolution : circa 10m  
Temporal resolution : circa 3 days



Aerial images  
Spatial resolution : circa 5-25cm  
Temporal resolution : yearly, ...



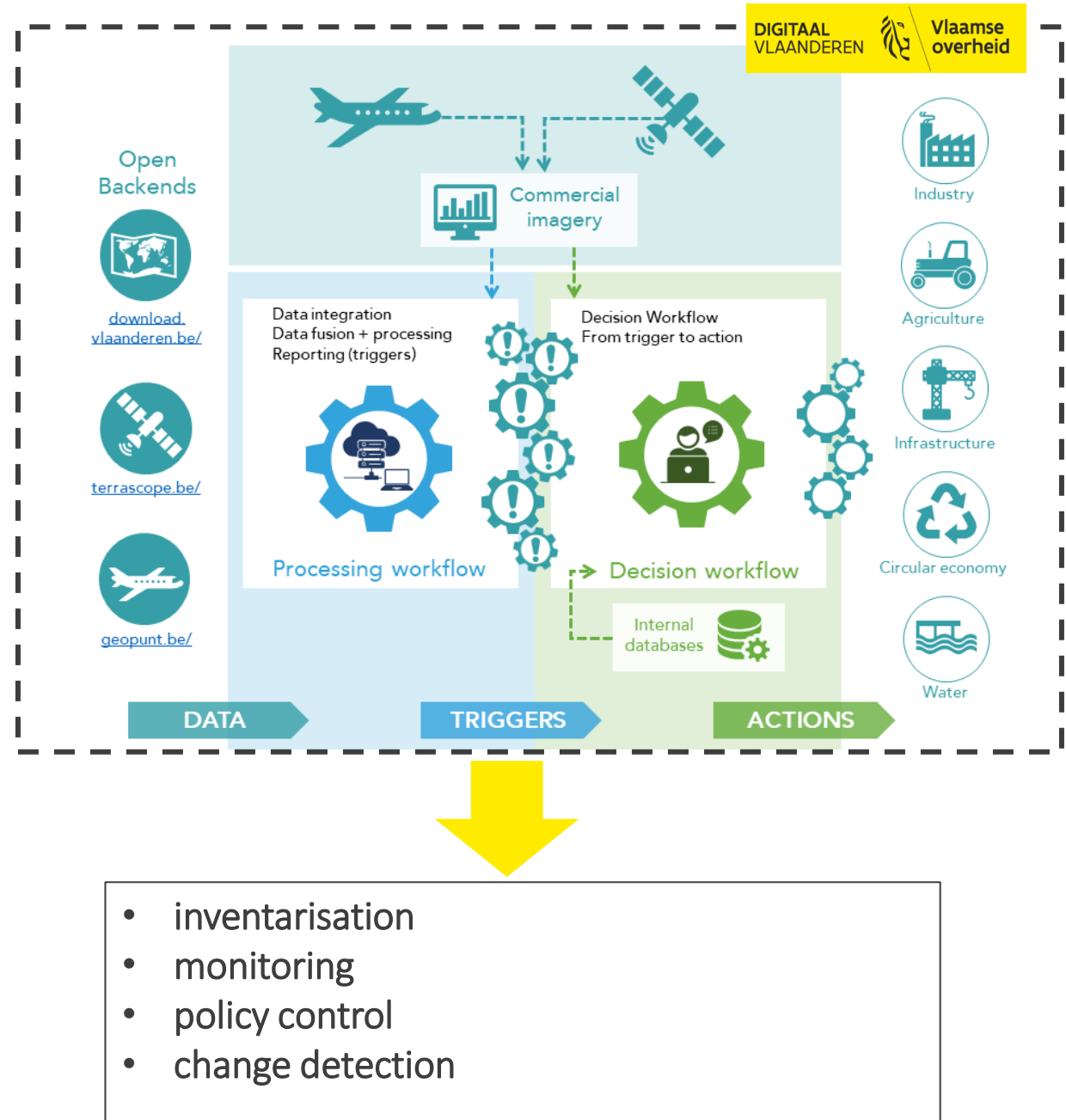
Drone/UAV  
Spatial resolution : circa 1-5  
Temporal resolution : ad hoc, ...



# Agenda

## USE CASES

- Satellite images
- Aerial images and LiDAR (DHMVII)
- LiDAR (DHMVI en DHMVII)

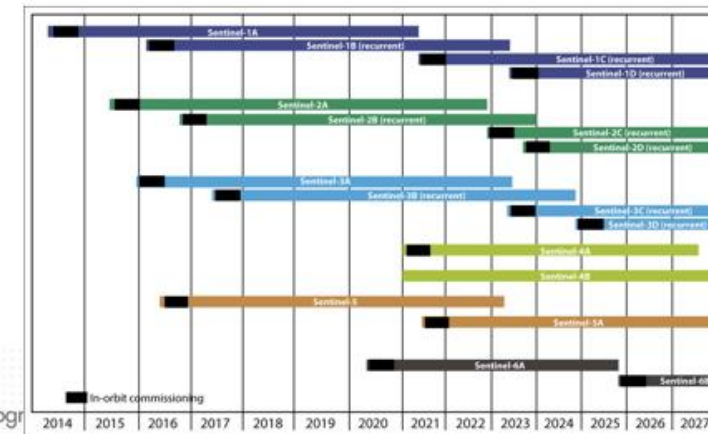


# The use of Satellite Images

## SENTINEL-1 EN SENTINEL-2 TIME SERIES ANALYSIS > PROOF OF CONCEPT PROJECTS

**EC+ESA** : long-term guaranteed global availability of raw images.

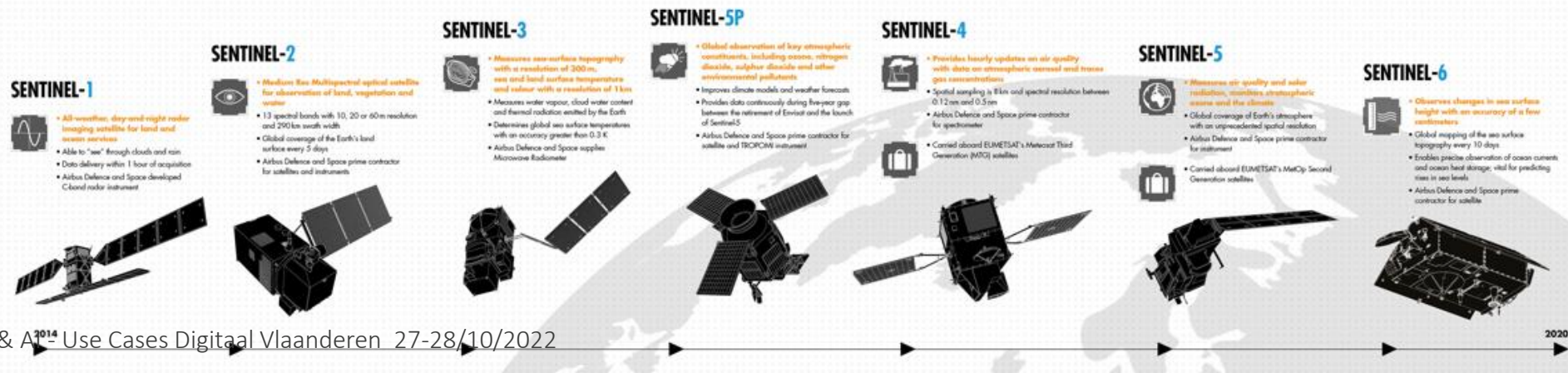
Data continuity > 2023 .



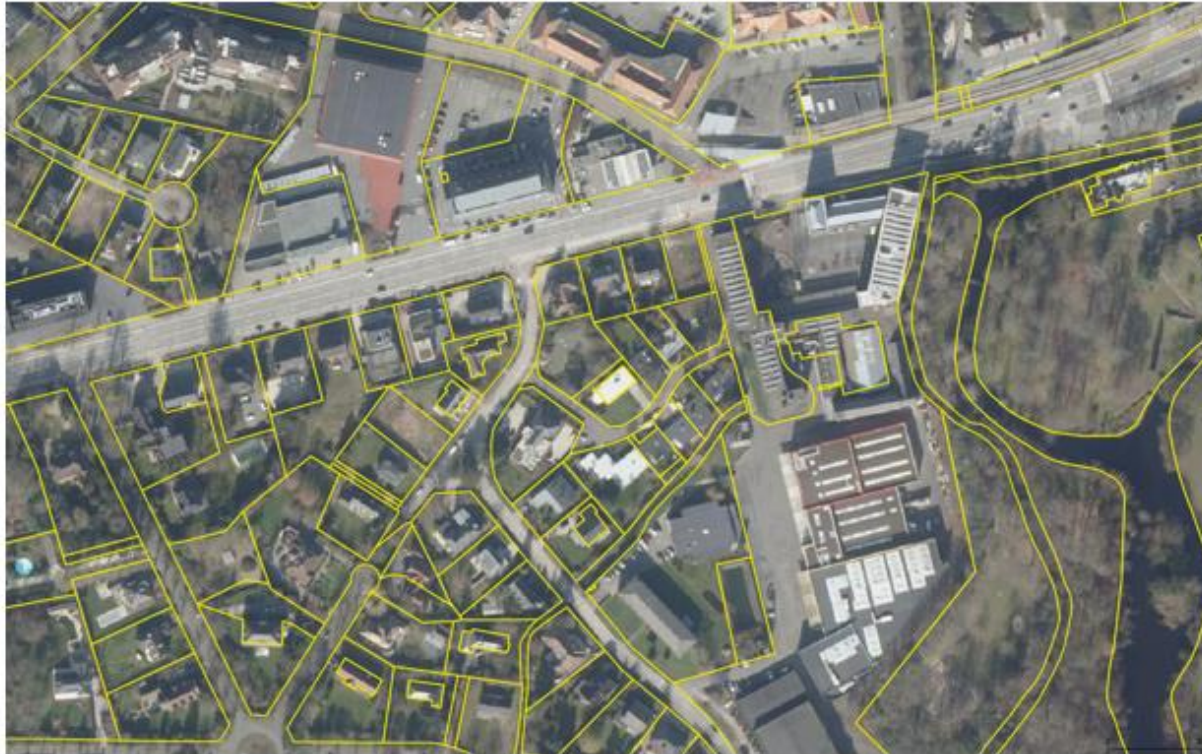
## COPERNICUS AND ITS SENTINELS

European Earth Observation Program

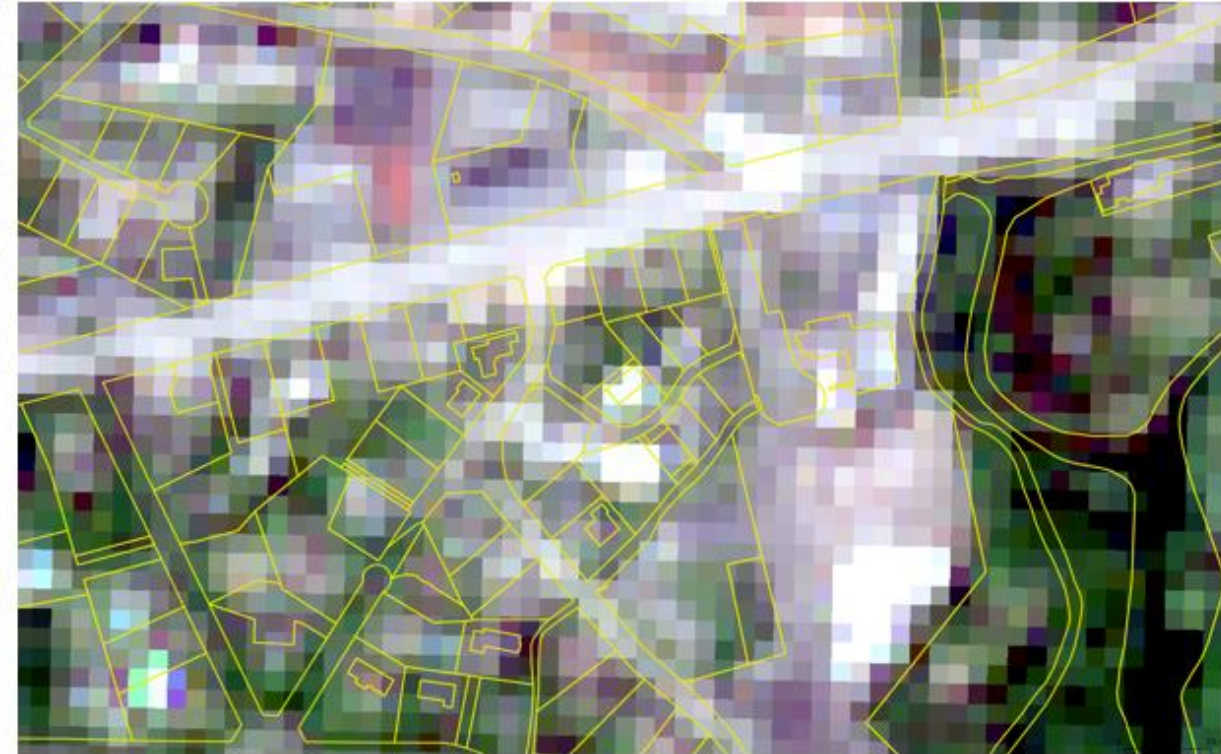
- Known as GMES until 2012: Global Monitoring for Environment and Security
- 50 Public and Private missions are also contributing data
- 16 years of development and testing
- Sentinel-Missions at the heart of the space component
- Civil Security: allowing early warning and crisis prevention in conflict and disaster zones
- Emergency Management: Accurate and timely data for emergency plans and rescue for disaster management
- Land Surface Monitoring: Geographical information on land cover, related variables and urban development
- Marine Environmental Monitoring: Observations and forecasts on the state of the physical oceans and regional seas
- Climate Change Monitoring: Helps to understand the reasons for climate change, rising sea levels and melting ice caps
- Earth Atmosphere Monitoring: Only information on the global atmospheric composition and when Sentinel-4 is in service this will be hourly



# Images : specifications

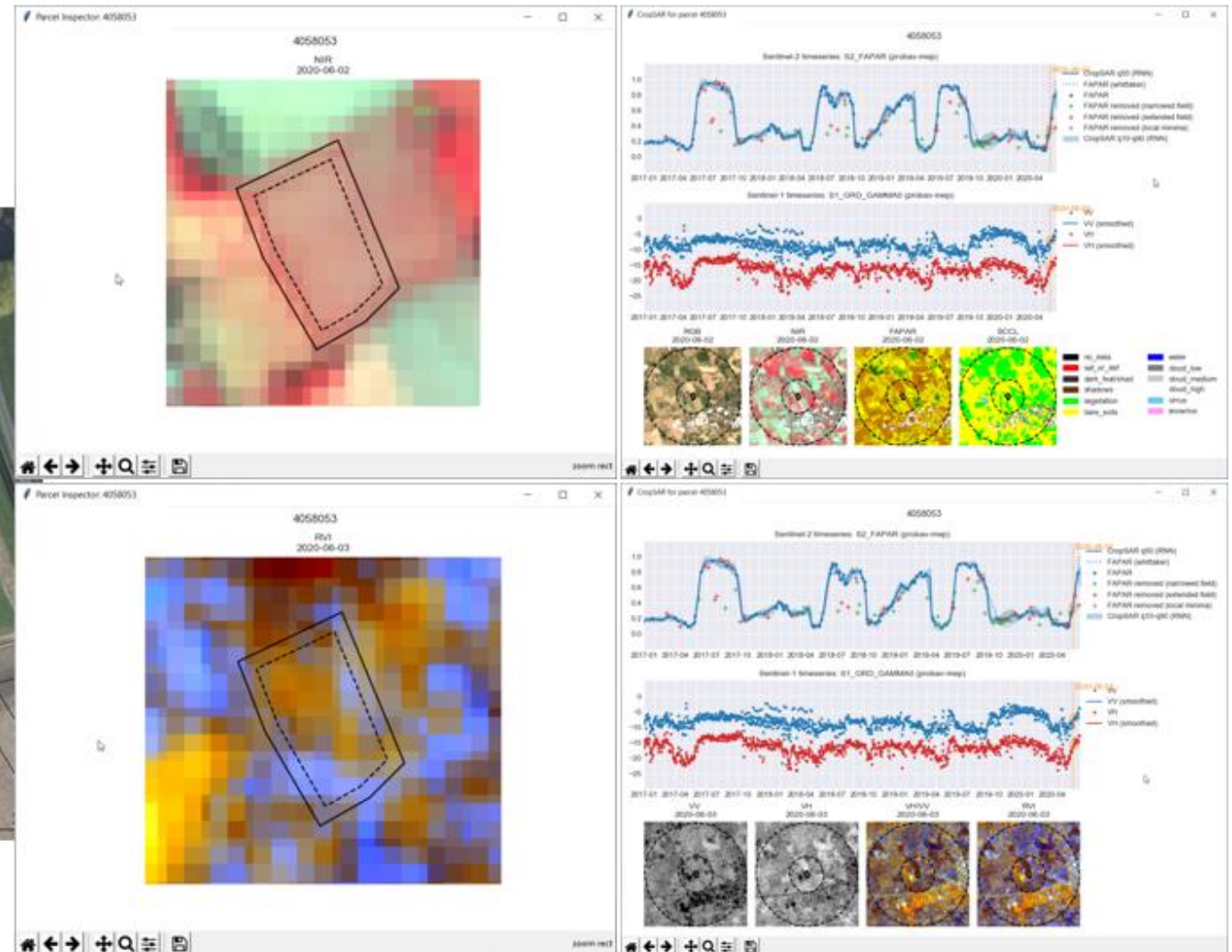


Aerial images :  
 - 25cm resolution  
 - 1x year



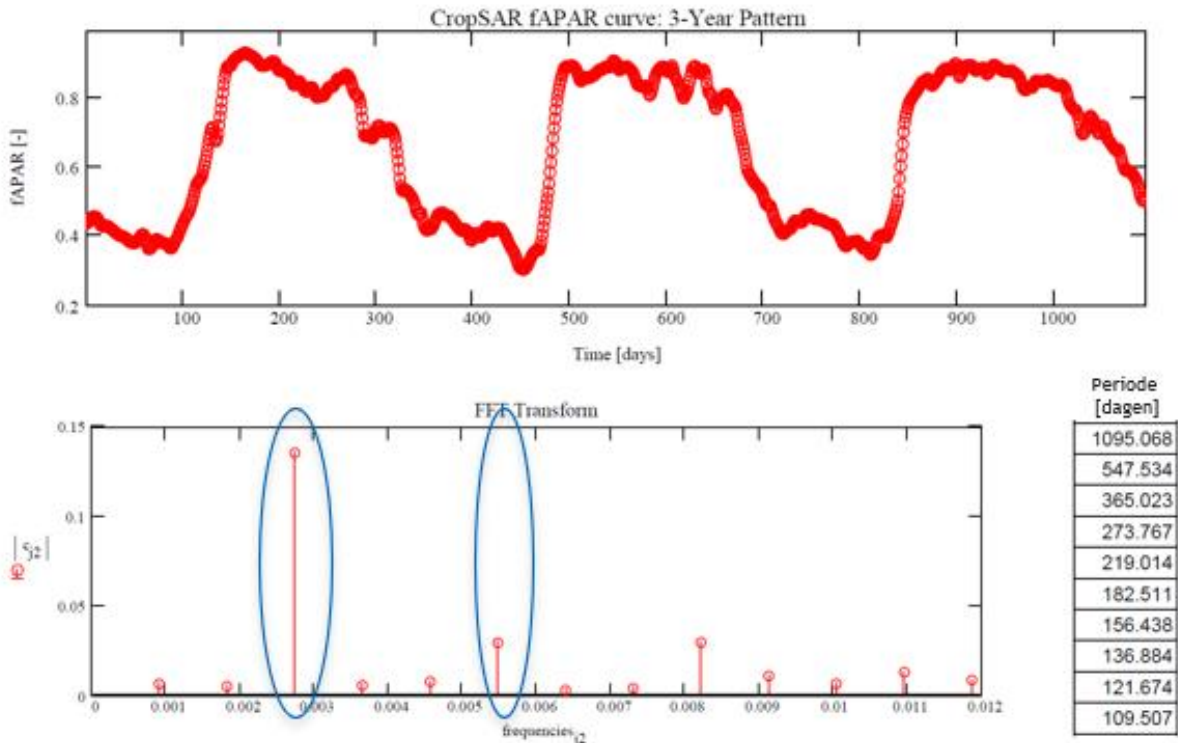
Sentinel-2:  
 - 10m resolution  
 - Via terrascope-Cropsar 1X day (fusion S1 + S2 day)

- Request of S1 & S2 time series via web-services
- No download necessary



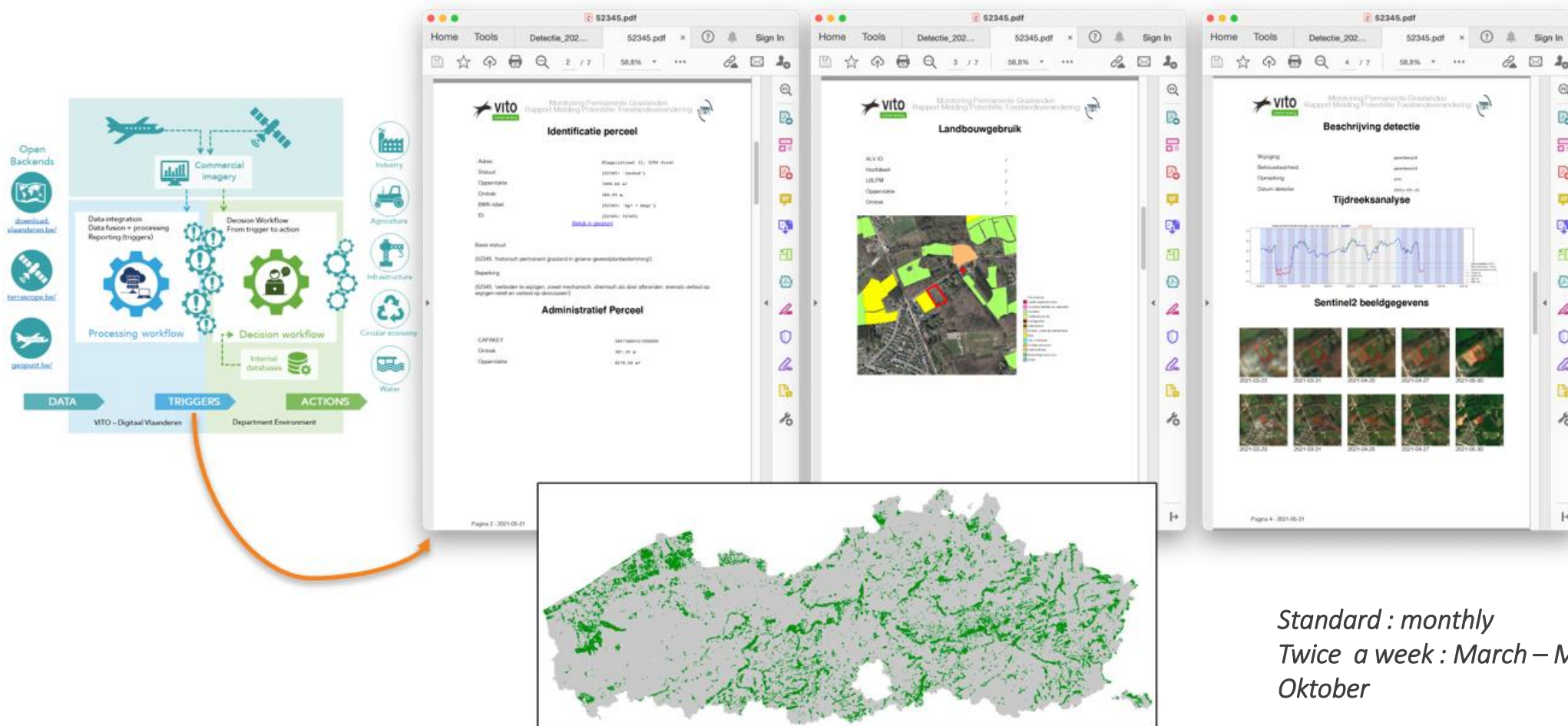
# Triggers of changes

SEASONALITY → FREQUENCY DOMAIN



Zeer duidelijke 3<sup>de</sup> golffunctie verbonden aan een periode van 365 dagen, de 6<sup>de</sup> golffunctie corresponderend met een periode van 182 dagen wordt naar de achtergrond verdronen (duidelijk verschil met landbouwvelden).

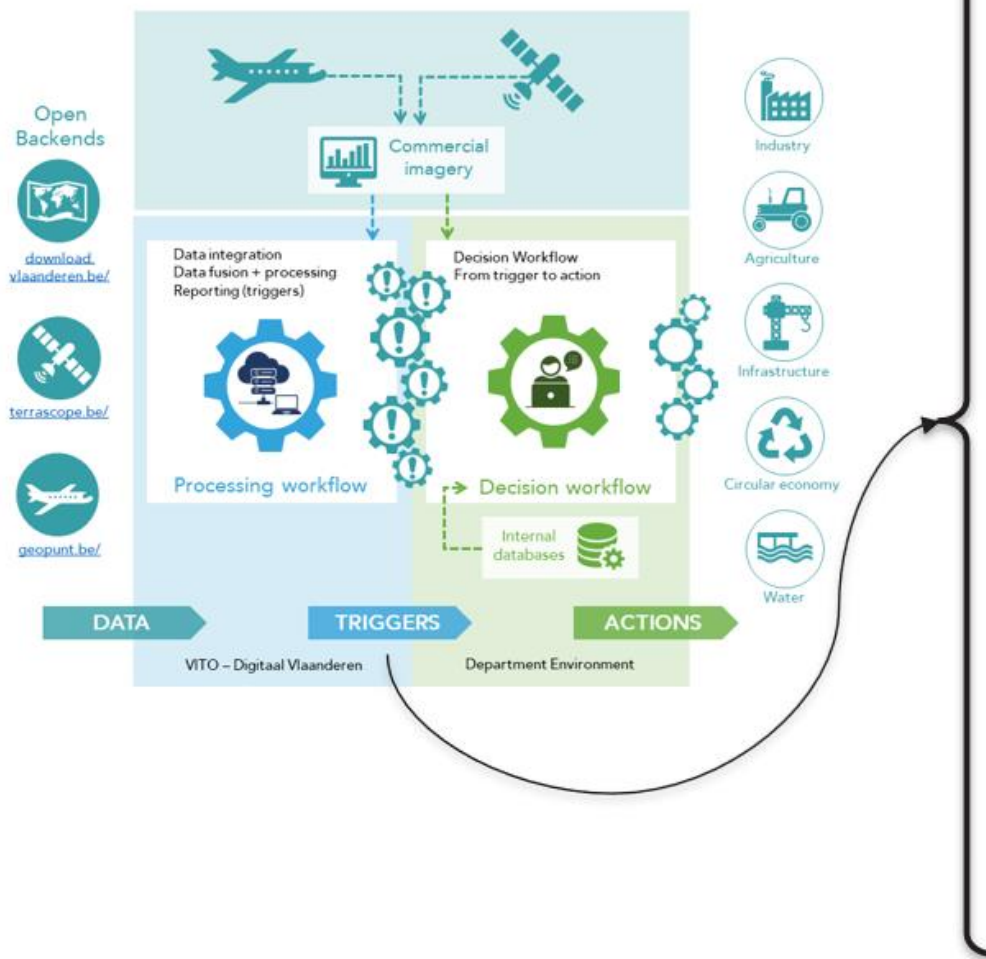
# Agency Nature and Forest (ANB) : landuse/land cover maintaining permanent grasslands



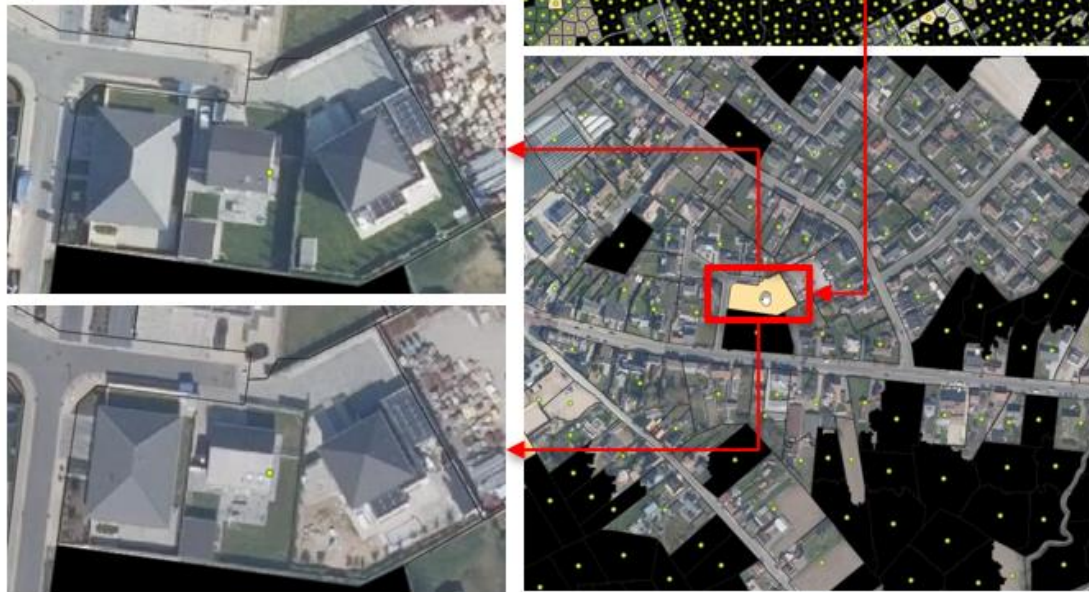
Standard : monthly  
Twice a week : March – May, September -  
Oktober

# Policy Development and legal Support

## Department environment : Controll imperviousness



Operational scenario :  
monthly delivery of GIS  
layers reporting the  
changes to be verified

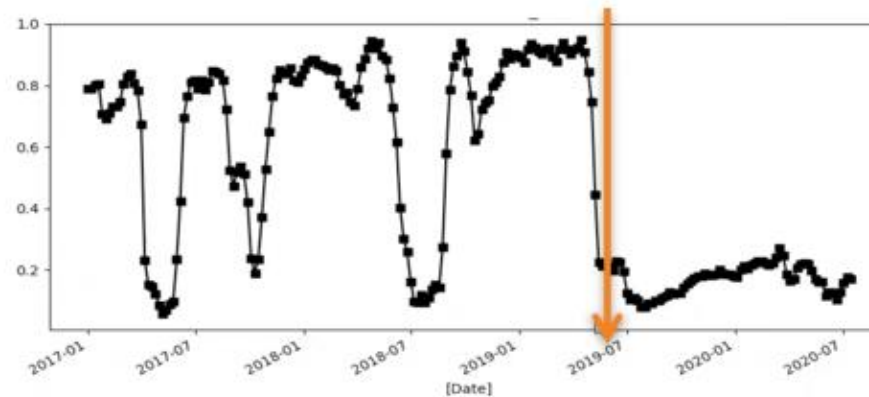


DEPARTEMENT  
OMGEVING

# Digitaal Vlaanderen : GRB GBG/GBA change detection > Large scale Reference Data Base of Flanders (LRD)

## Step 1 :

The LRD administratieve layer is base for further segmentation, mean area 10 -20 Sentinel pixels (1000 – 2000 m<sup>2</sup>)

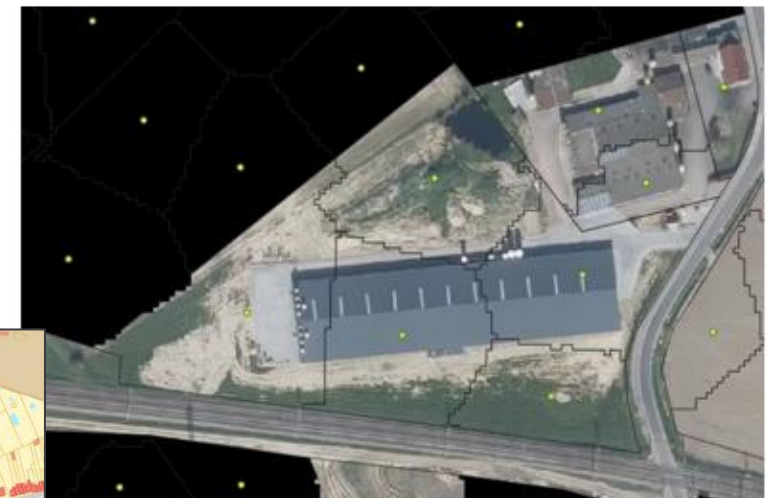
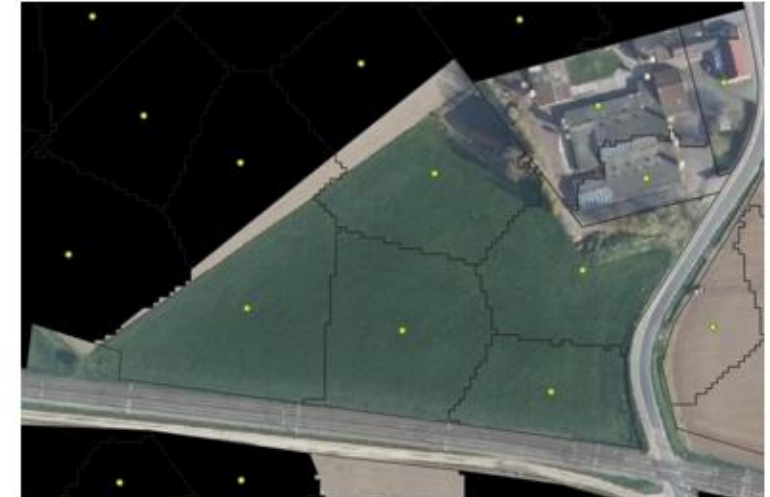


## Step 2 :

Request for the Terrascope-Cropsar S1/S2 fuses time series of the “green index” for each parcel

## Step 2 :

Time series analysis makes it possible to investigate changes in land-use / land-cover. Changes are embedded in GIS-dataset.



# Digitaal Vlaanderen : GRB GBG/GBA change detection

## RESULTS NEGATIVE CHANGES

Studiegebied Gent-Zuid

Totaal: 20171 perceel segmenten met geldig tijdsignaal

Maandelijkse detectie van 01/2019 tot 10/2021 (34 analyses):

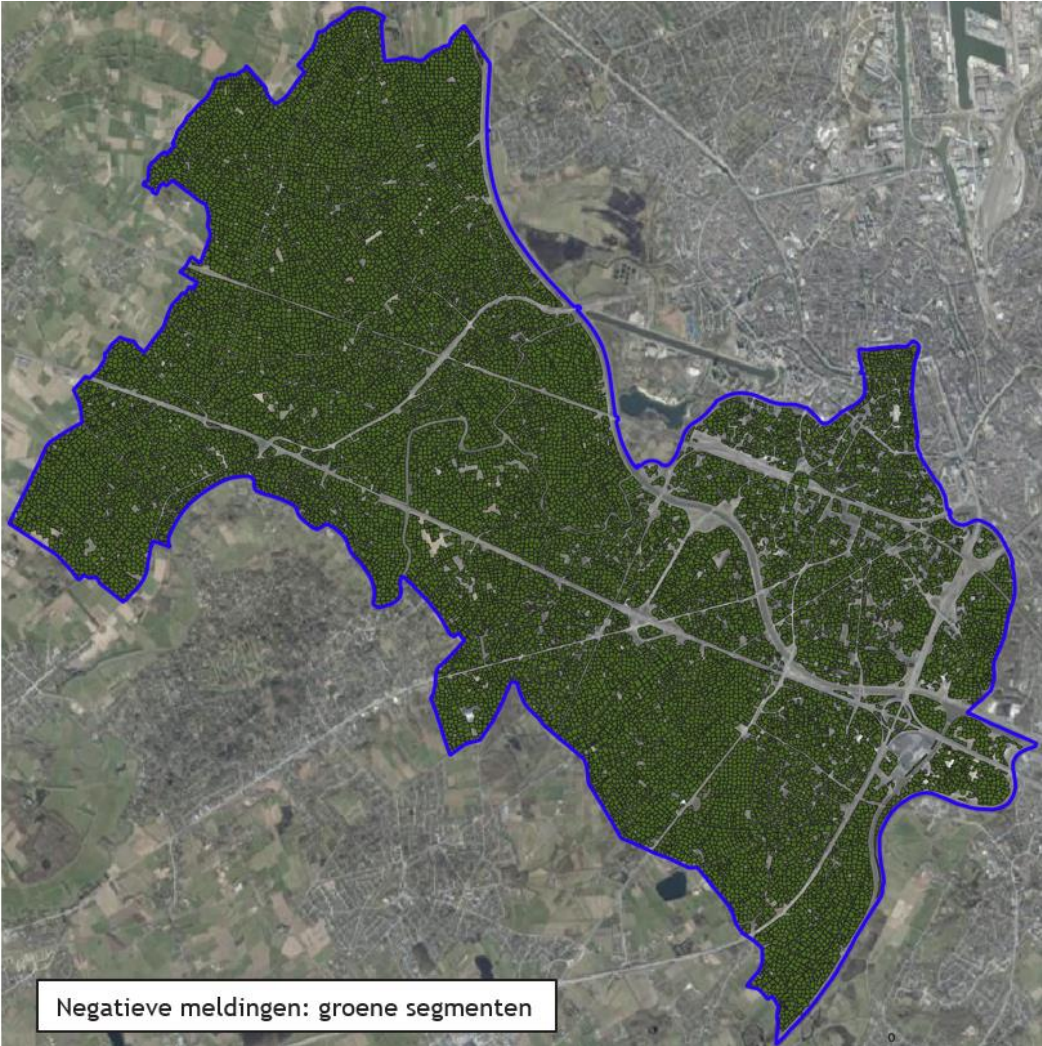
- 18820 negatief (deel is vals negatief)
- 1351 segmenten positief (deel is vals positief)

**Mostly negative**

Mostly in the arable, grassland, forest/nature classes. These classes are easy to detect, so the vast majority will indeed be “Truly Negative”. In a time series analysis across all field segments in a search region, more than 90% of the field segments will fall into this category by default. This has an impact on the "Confusion Matrix" as a statistical measure: we are dealing with "unbalanced classes": all plot segments have to be followed, but the changes we are interested in are sparse. This can lead to high accuracy, but still with poor correctness and completeness

**False negative**

Frequently occurs when construction works start on areas that were virtually unvegetated or where the surface area of the (re)construction works is small compared to the area of greenery.



# Digitaal Vlaanderen : GRB GBG/GBA change detection

## RESULTATEN POSITIVE CHANGES

Studiegebied Gent-Zuid  
Totaal: 20171 perceel segmenten met geldig tijdsignaal

Maandelijkse detectie van 01/2019 tot 10/2021 (34 analyses):

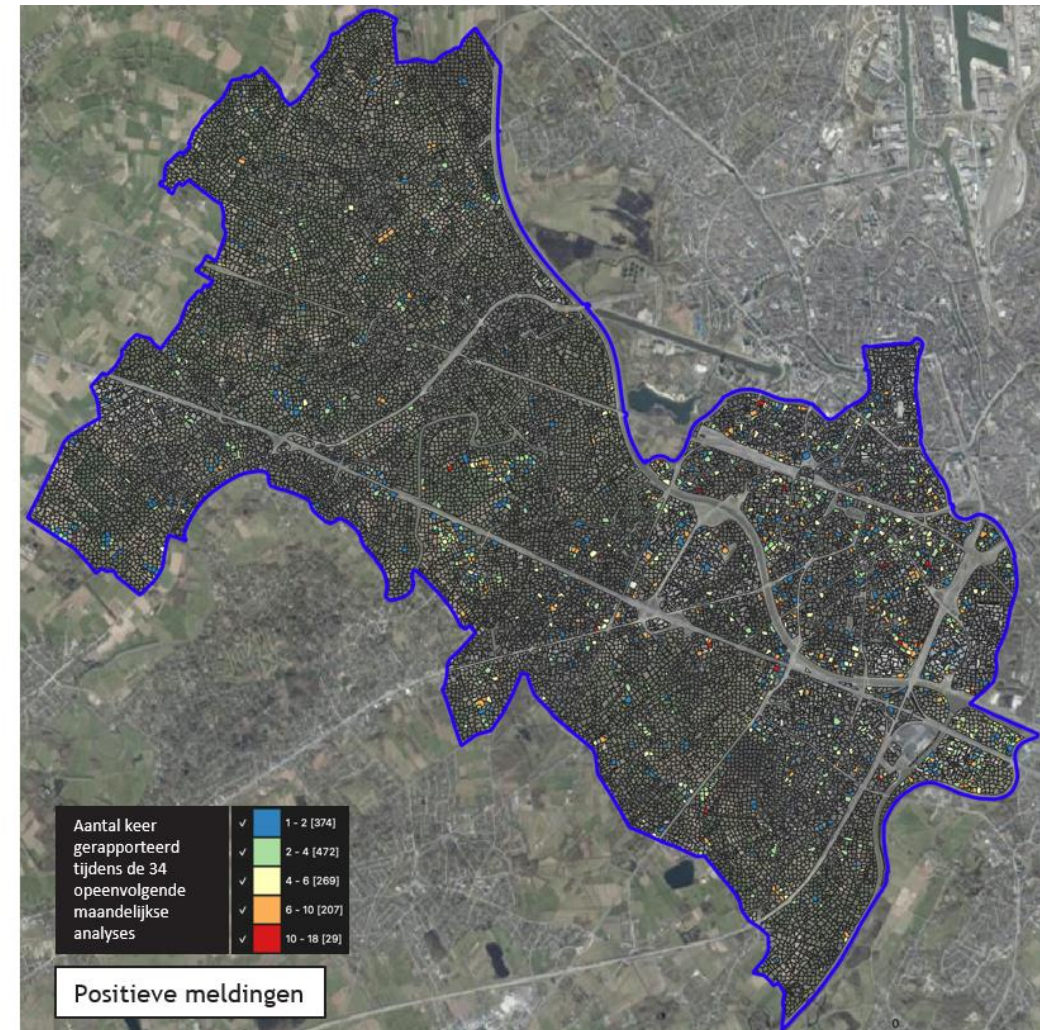
- 18820 negatief (klein deel is vals negatief)
- **1351 segmenten positief (deel is vals positief)**

### Really positive

When structures cause a substantial change in green cover, these are easy to detect.

### False positive

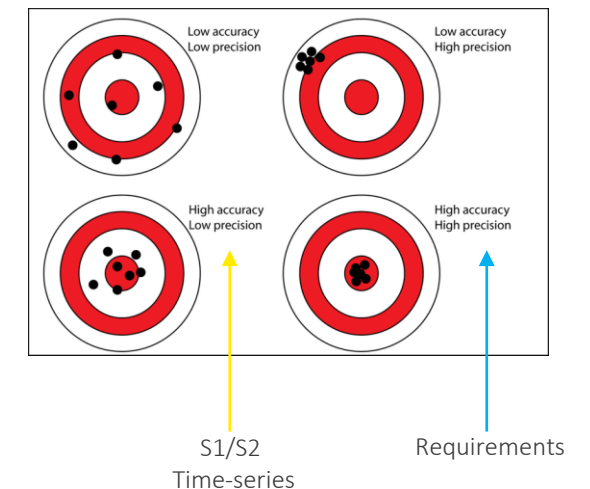
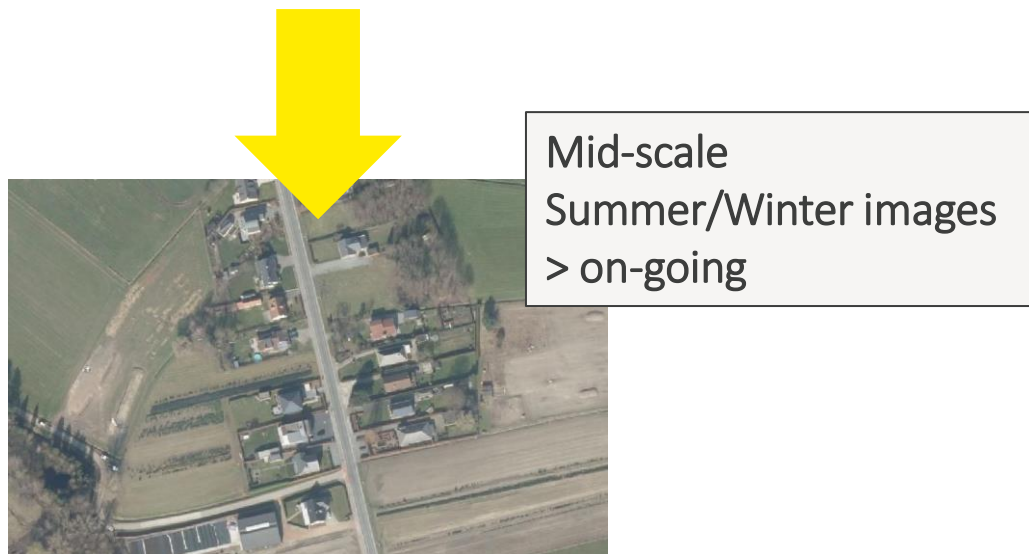
Many false positive reports in agricultural/open areas due to, among other things: headlands, manure storage, storage, cultivation techniques (vegetables, long fallow). In urban areas there are many false positives because the Terrascope-CropSAR S1/S2 data fusion sometimes creates artifacts here, which in turn result in false positives.



# Digitaal Vlaanderen : GRB GBG/GBA change detection

## RESULTS S1/S2 BASES TIME SERIES ANALYSIS

- Algorithmic decisions using only the Terrascope-CropSAR S1/S2 service are not always clear and for now mainly useful in non-urban areas
- The S1/S2-based time series method only meets the requirement of “rapid detection”. Viewed across all plot segments, the method can be said to be accurate (good for general rapid screening), but not very precise for the types of changes the GRB tracking process is interested in. OK for quick trigger function.
- Additional methods are needed to also take into account geometric change parameters, in order to increase the “correctness/precision” of the reports.



# SIGNAL changes > Parcel inspector Flanders

- Sentinel-1 + Sentinel-2: very powerful to detect indicative changes over time for Flanders.



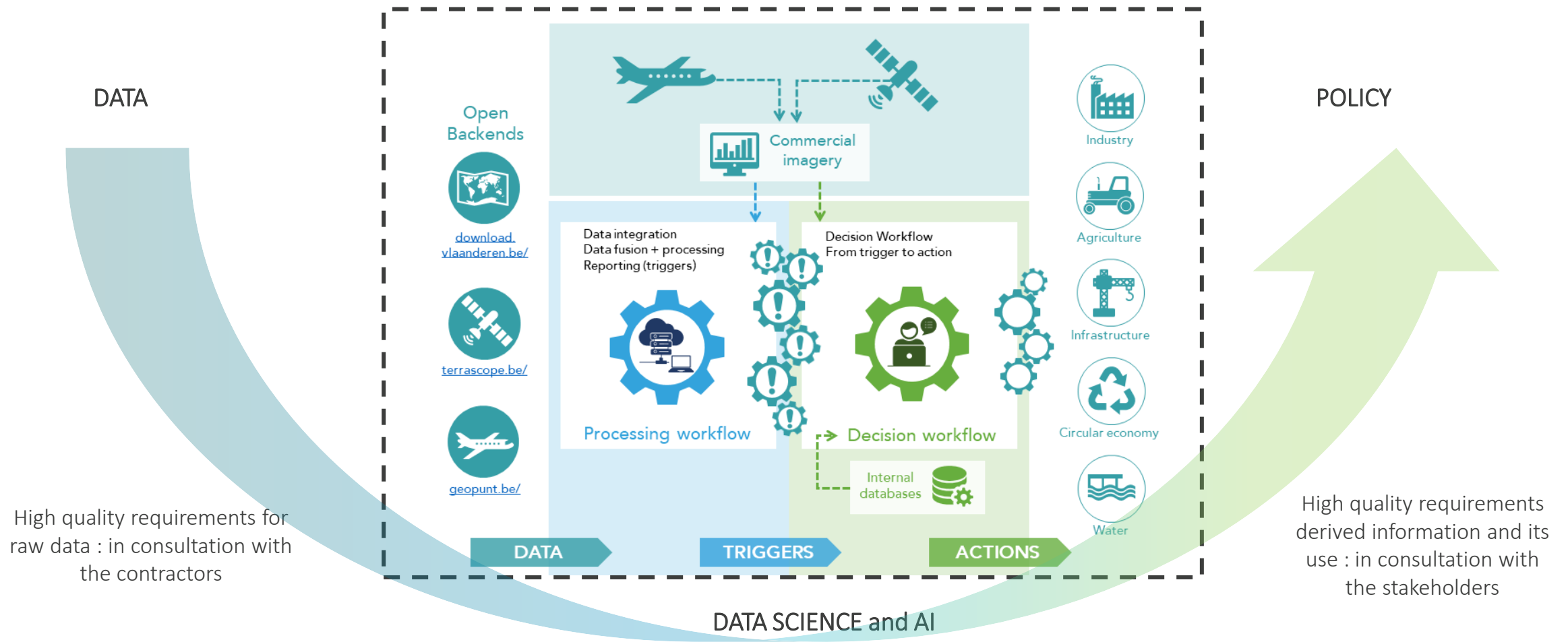
- Plots with mixed land use : additional high-resolution data (better than 50 cm) needed throughout the year to visually/computer vision/AI detect the context fo the change.



- Platform technology necessary tot tailor technology/data to specific use cases and user needs.
- <https://blog.vito.be/remotesensing/cropsar-for-land-infrastructure-management>

# Aerial images & LiDAR

INVENTARISATION, MONITORING, CHANGE DETECTION ... PARCEL, OBJECT, TERRAIN, ...



# Aerial images & LiDAR

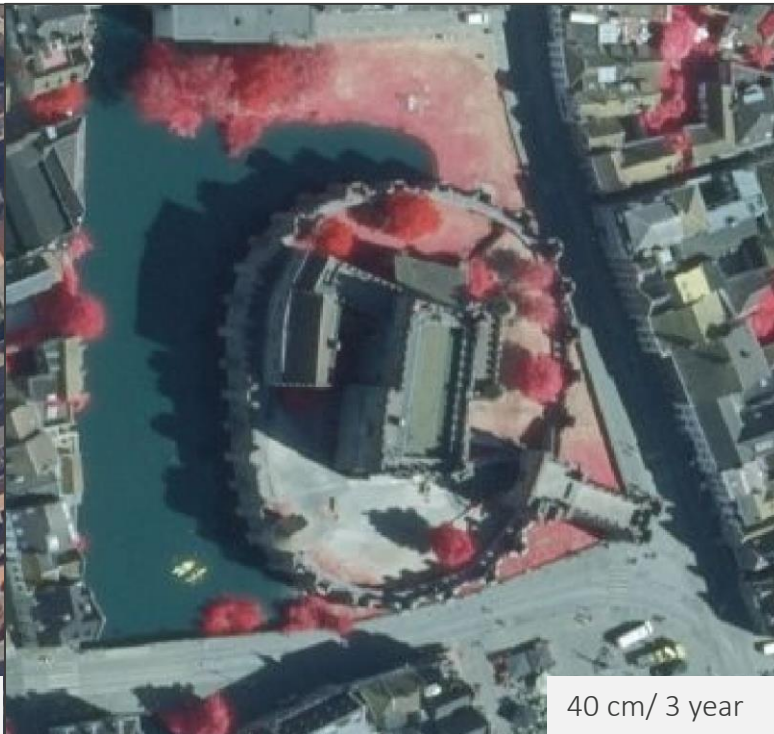
INVENTARISATION, MONITORING, CHANGE DETECTION, ... PARCEL, OBJECT, TERRAIN

Applications en algorithmes are depending sensor, spatial en temporal resolution,

- Multispectral images winter: time series 2008 – 2022
- Multispectral images summer: time series 2009 – 2021
- Multispectral images & LiDAR: DHM V I (2001-2004) – DDHMV II (2013-2015)



25 - 15 cm/ 1 year



40 cm/ 3 year

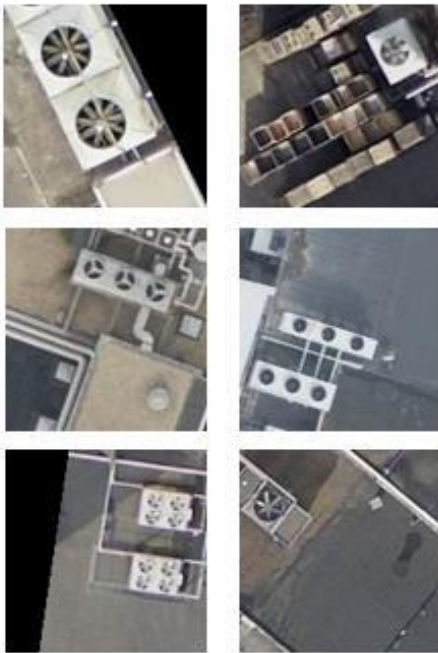


10 cm/ 10 year

# Agency for Care and Health

## DETECTION OF ALL COOLING SYSTEMS (LEGIONELLA CONTAMINATION RISK)

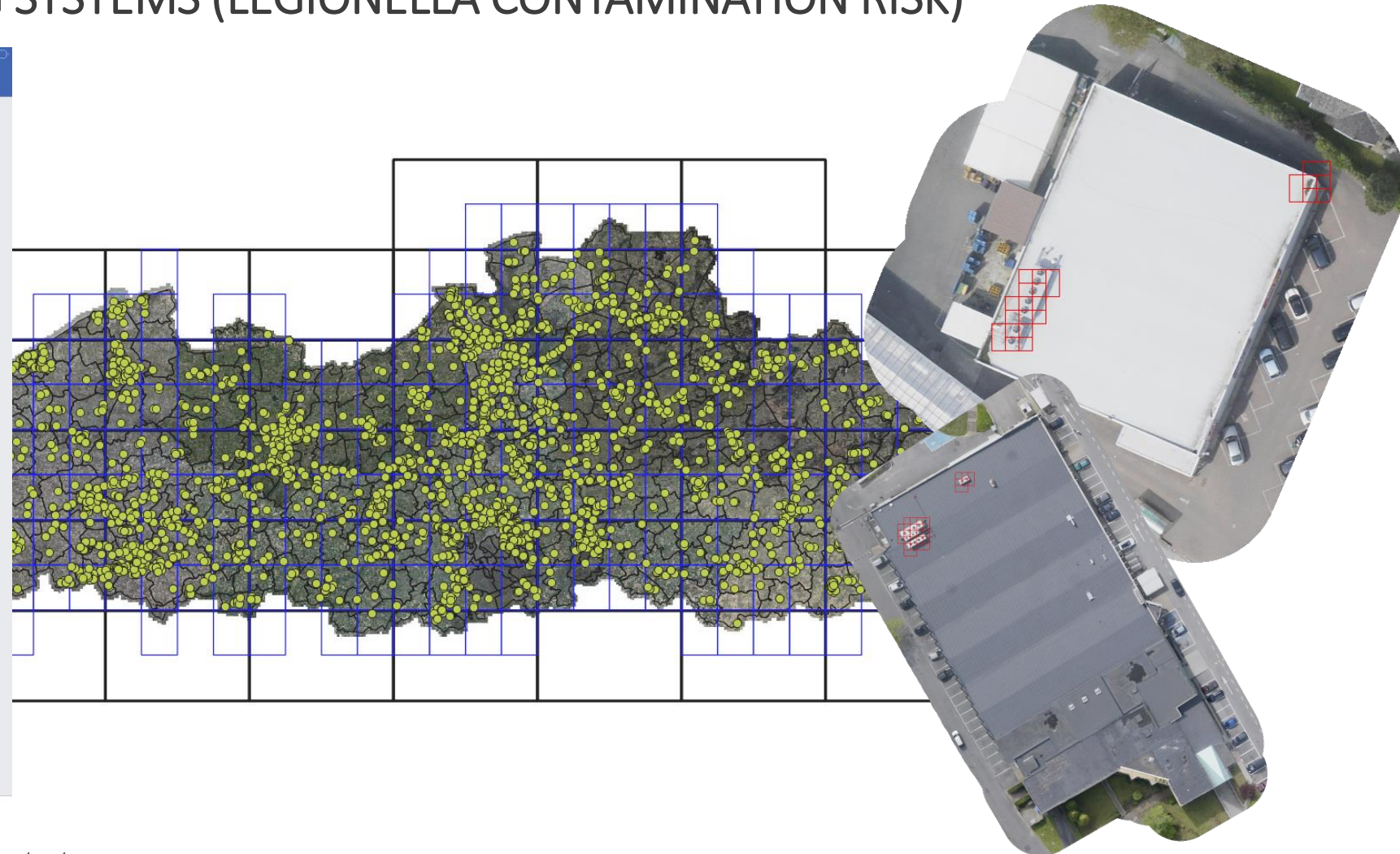
Positive examples



Negative examples

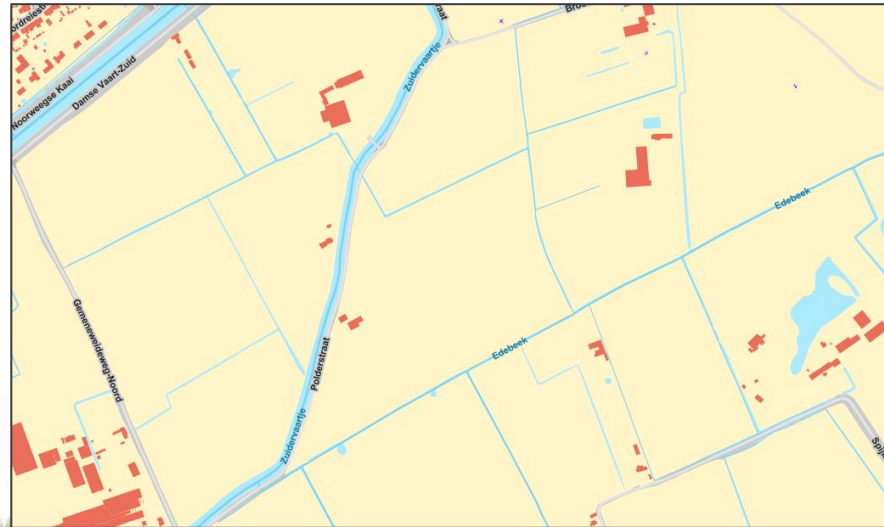


# DETECTION OF COOLING SYSTEMS (LEGIONELLA CONTAMINATION RISK)



# VMM / Flemish environmental agency : inventarisation potential water channels

- Channels/ditches are important water system and object in GRB (large scale Reference database of Flanders (LRD))
  - But diverse &
  - not all present in LRD !
- > Need for update

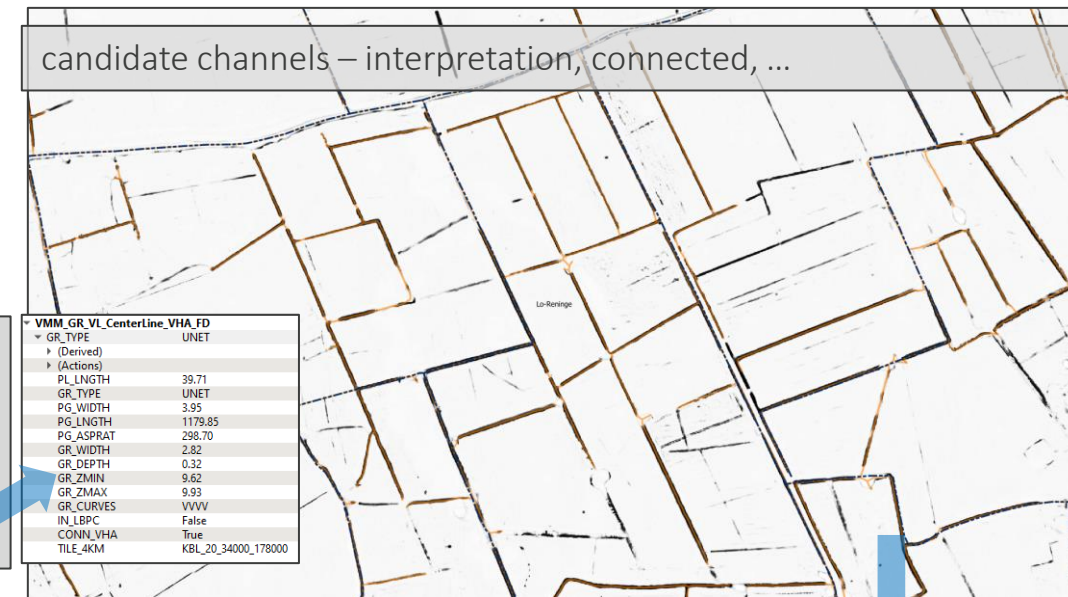


# VMM: inventarisatie



The making of  
a first database  
of water  
channels

Grachtenbestand

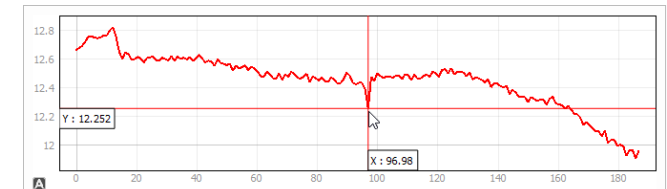


# VMM: inventarisatie

Study area (Zemst) – water channels as drainage system



Dataset Water Channel



Existing watercourses are well found +  
New candidate water channels are found.  
> Validation required



# Info and Feedback

Digitaal Vlaanderen

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