



Innovative surveillance technologies  
in environment protection  
Earth Observation: nature, water, waste

Protecting  
habitats and  
endangered  
species in  
Europe  
through  
tackling  
environmental  
crime

*Giuseppe Sgorbati*

Technical and Scientific Director

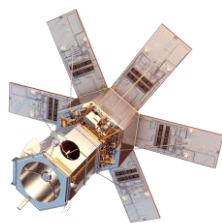
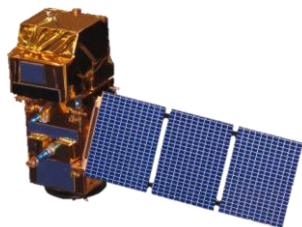
ARPA Lombardia (IT)

IMPEL Water and Land expert team leader

Heraklion – Crete  
23 – 24 October  
2018

# EARTH OBSERVATION

## SATELLITES and SERVICE PROVIDERS



*and  
more*

## DRONES – low altitude

highly manoeuvrable, «high»  
payload



highly  
manoeuvrable, «low» payload



for interiors, «unstoppable»



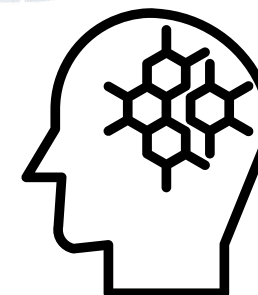
harmless



long range



## DIGITAL IMAGES TREATMENT AND INTERPRETATION: Software, Services and...



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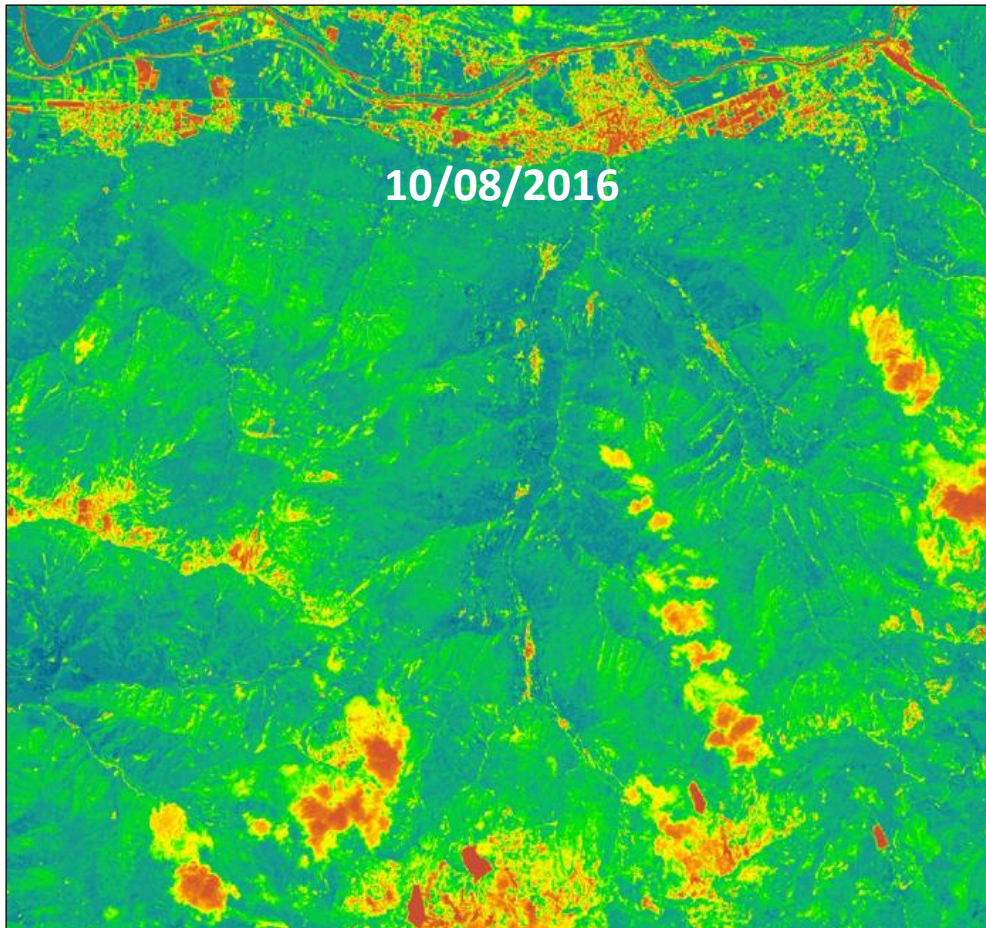
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# Nature: Woods Protection

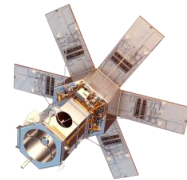
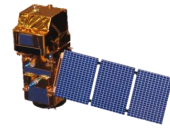
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## Wood Pathologies and Disorder Studies in Lombardia (It) Sentinel-2 Images: comparison of 2016 and 2017 of the Normalized Difference Vegetation Index (NDVI)



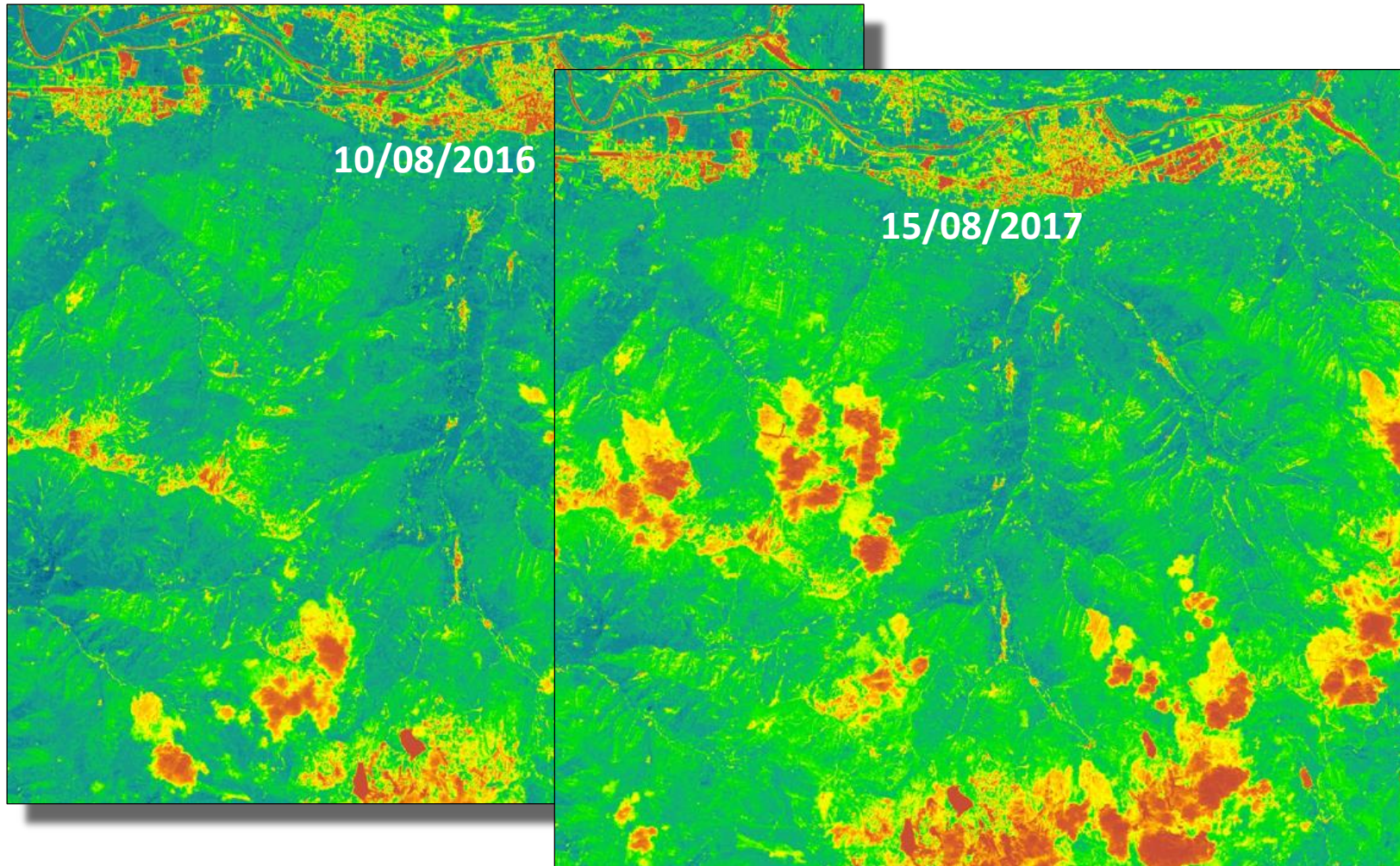
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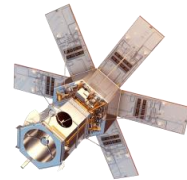
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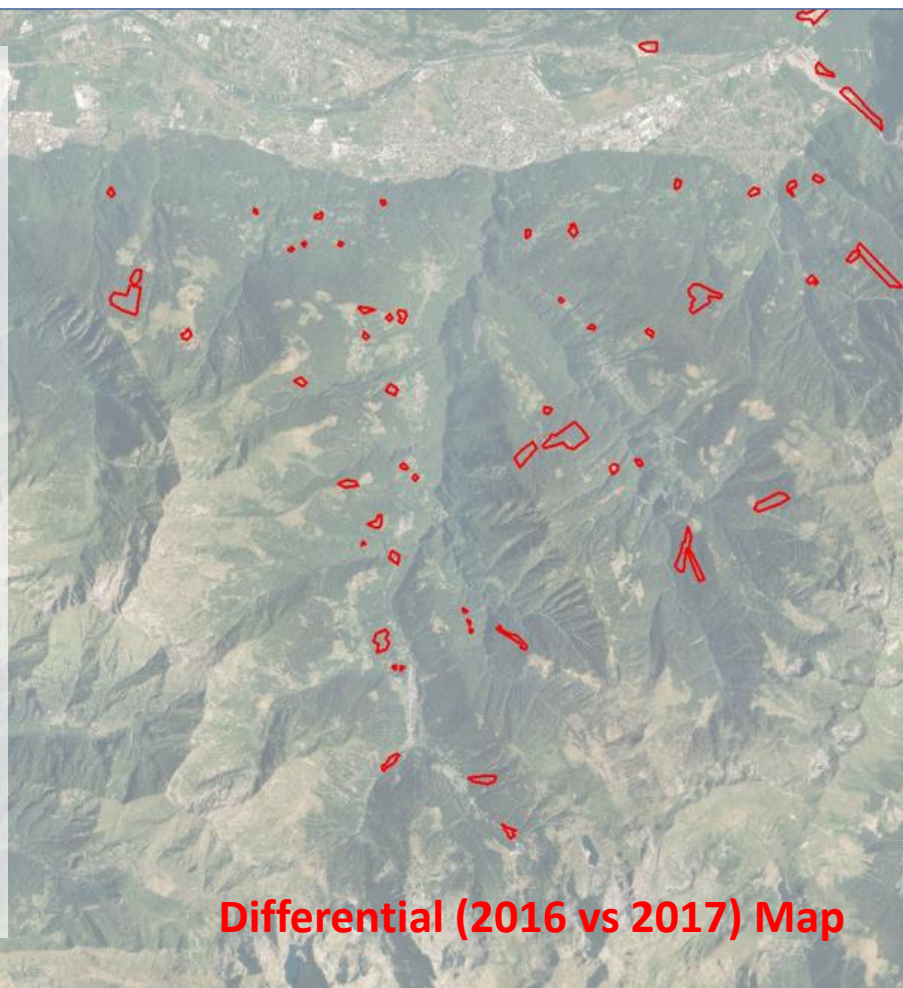
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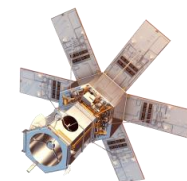
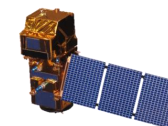
## Wood Pathologies and Disorder Studies in Lombardia (It) Sentinel-2 Images: comparison of 2016 and 2017 of the Normalized Difference Vegetation Index (NDVI)

### DIFFERENCE AND THEIR INTERPRETATION WITH THE USE OF AUXILIARY DATA AS:

- ✓ FORESTRY MAPS
- ✓ FIRES MAP
- ✓ AUTHORIZED LOGGING INFORMATION SYSTEM
- ✓ LANDSLIDE MAP
- ✓ AVALANCHES MAP



Protecting habitats and endangered species in Europe through tackling environm. crime



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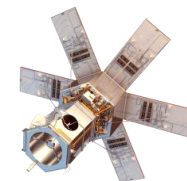
EXAMPLE:  
KNOWN  
REASON

EXAMPLE:  
UNKNOWN  
REASON  
INVESTIGATE!

| Causa probabile |                   |
|-----------------|-------------------|
| □               | Non determinabile |
| ■               | Dissesto          |
| ■               | Incendio          |
| ■               | Taglio            |
| ■               | Fitopatia         |
| ■               | Valanga           |

Differential (2016 vs 2017) Map

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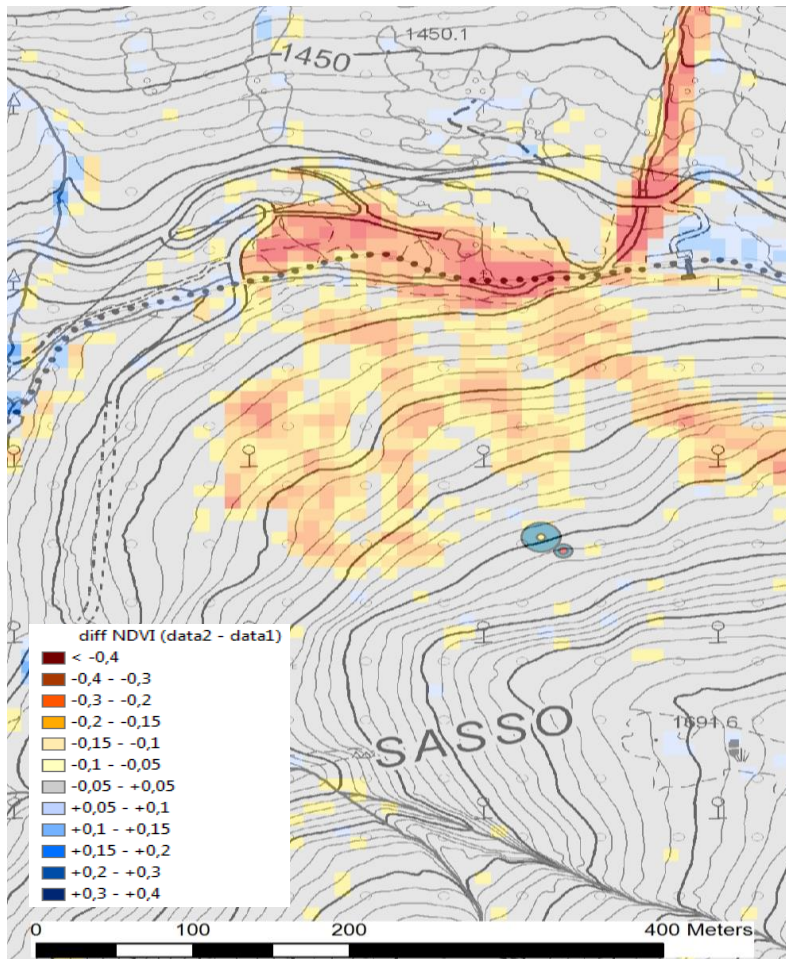


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## LOCAL STUDIES OF ANOMALIES: BEYOND *ON SITE* OPERATORS INSPECTIONS

# TREES CUTTING AND LOGGING



Ground investigation



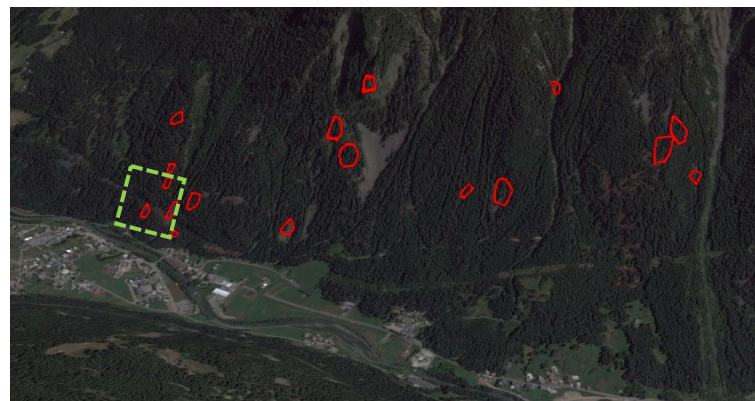
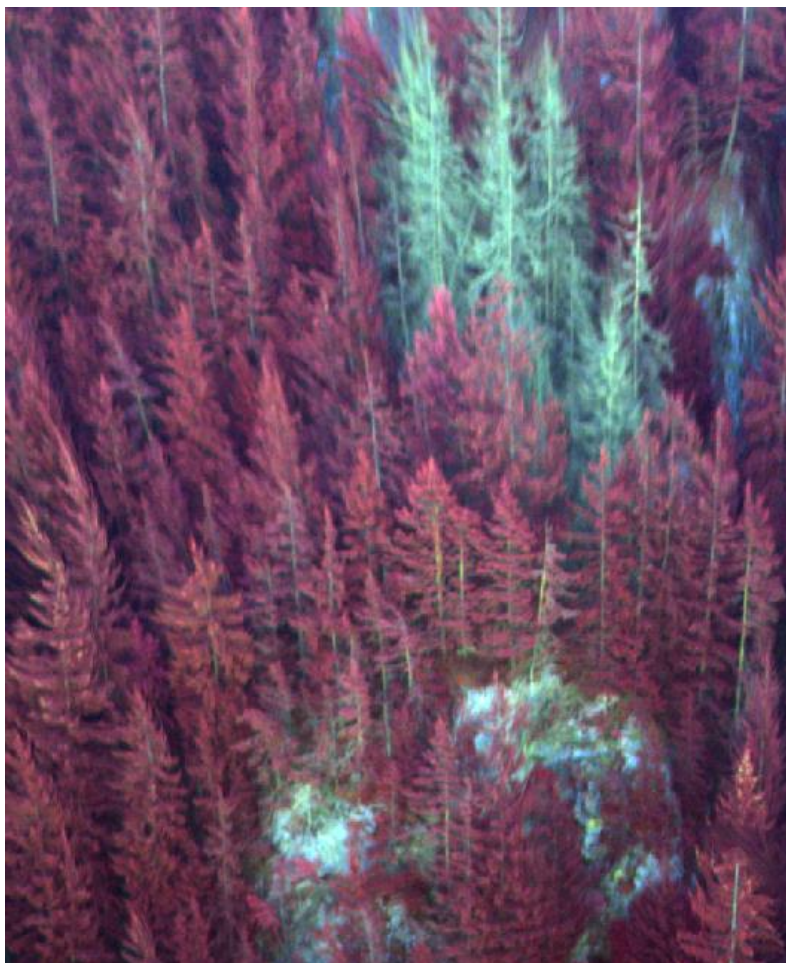
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## LOCAL STUDIES OF ANOMALIES: SUPPORT TO *ON SITE* OPERATORS' INSPECTIONS PARASITIC ATTACK (Bark Beetle)



Area investigation



IRFC image:

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# Water: Illegal abstraction in agriculture

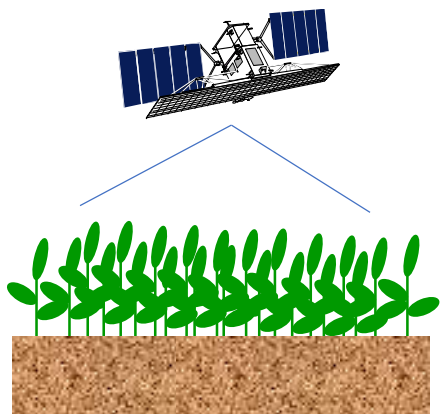
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## DETECTION OF ILLEGAL WATER ABSTRACTION THROUGH SATELLITE OPTICAL REMOTE SENSING

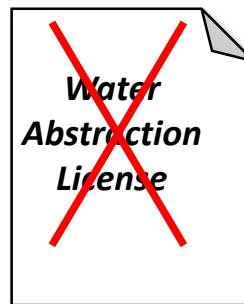
**IF AND AND THEN**



*The Vegetation Index detected through Earth Observation is high*



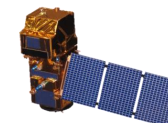
*The contribution of rainfalls is negligible*



*There is no water abstraction licence*

**It could be a case of illegal water abstraction**

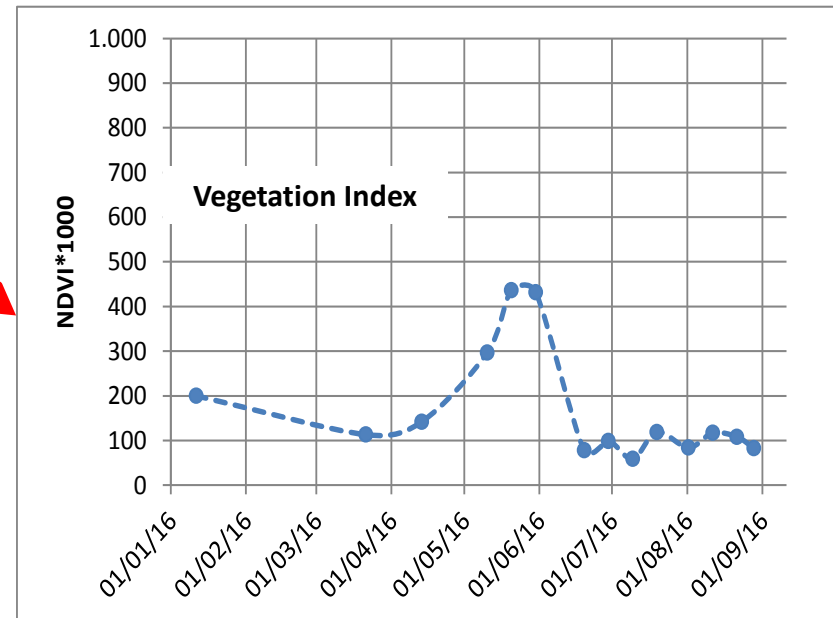
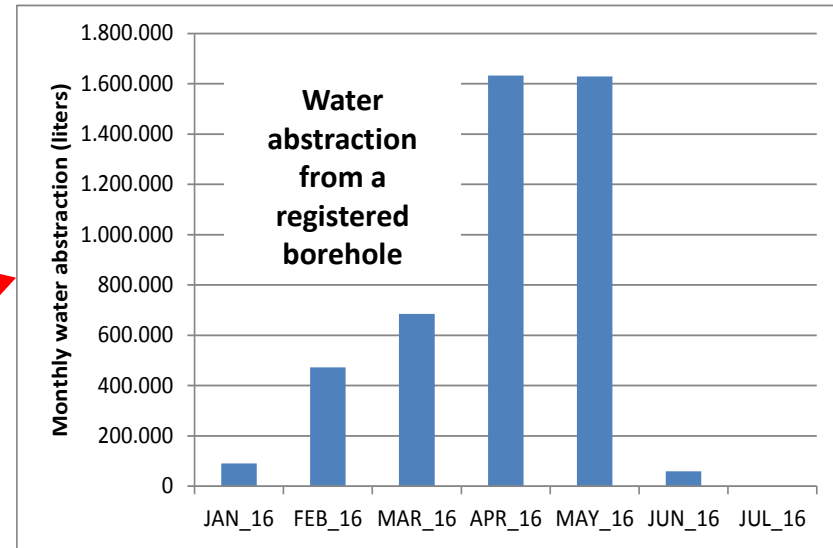
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# An example of legal water abstraction



Pilot Study Malta, Sentinel-2A image 29/07/16



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**WODA1 and WODA2  
IMPEL Projects**

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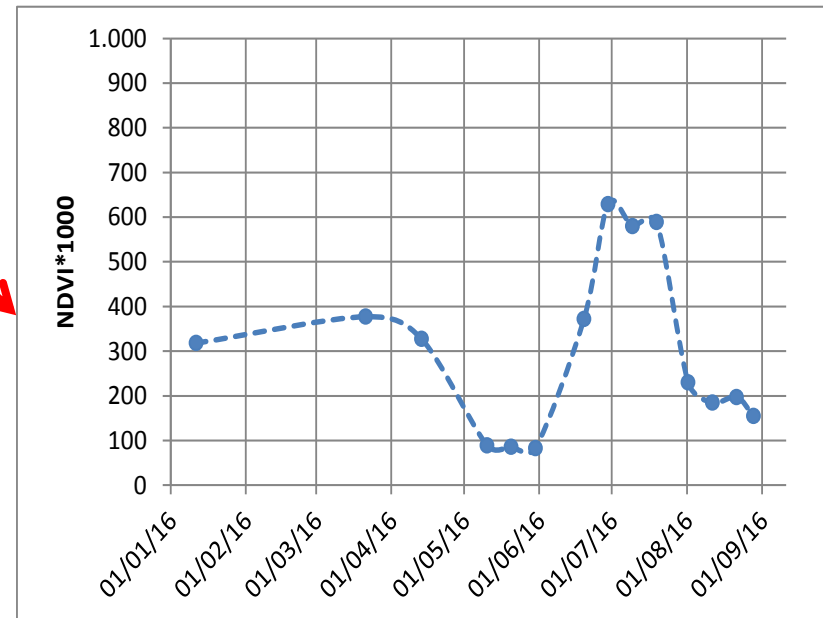


## An example of a potentially illegal water abstraction



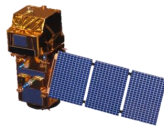
Pilot Study Malta, Sentinel-2A image 29/07/16

No permit - no  
registered  
borehole



**WODA1 and WODA2  
IMPEL Projects**

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# Water: River Monitoring

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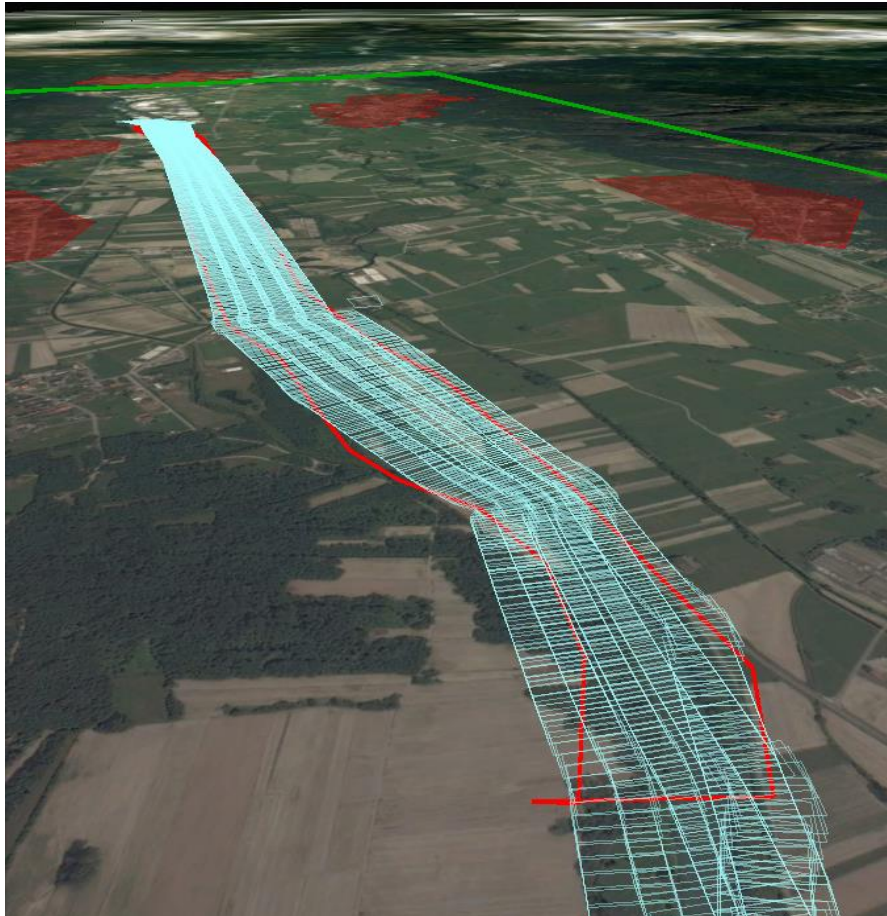
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LOCAL STUDIES OF ANOMALIES: BEYOND *ON SITE* OPERATORS INSPECTIONS

# MONITORING OF LARGE TERRITORIES

EXAMPLE: STUDY OF MERA RIVER BED - 2018



- Fixed wing drone
- 5 km length of the survey
- 40 minutes flight
- Height 100 m AGL
- 1370 images taken
- 4 photogrammetric stripes
- 7 Ground Control Point
- 11 Check Point
- GSD 3 cm



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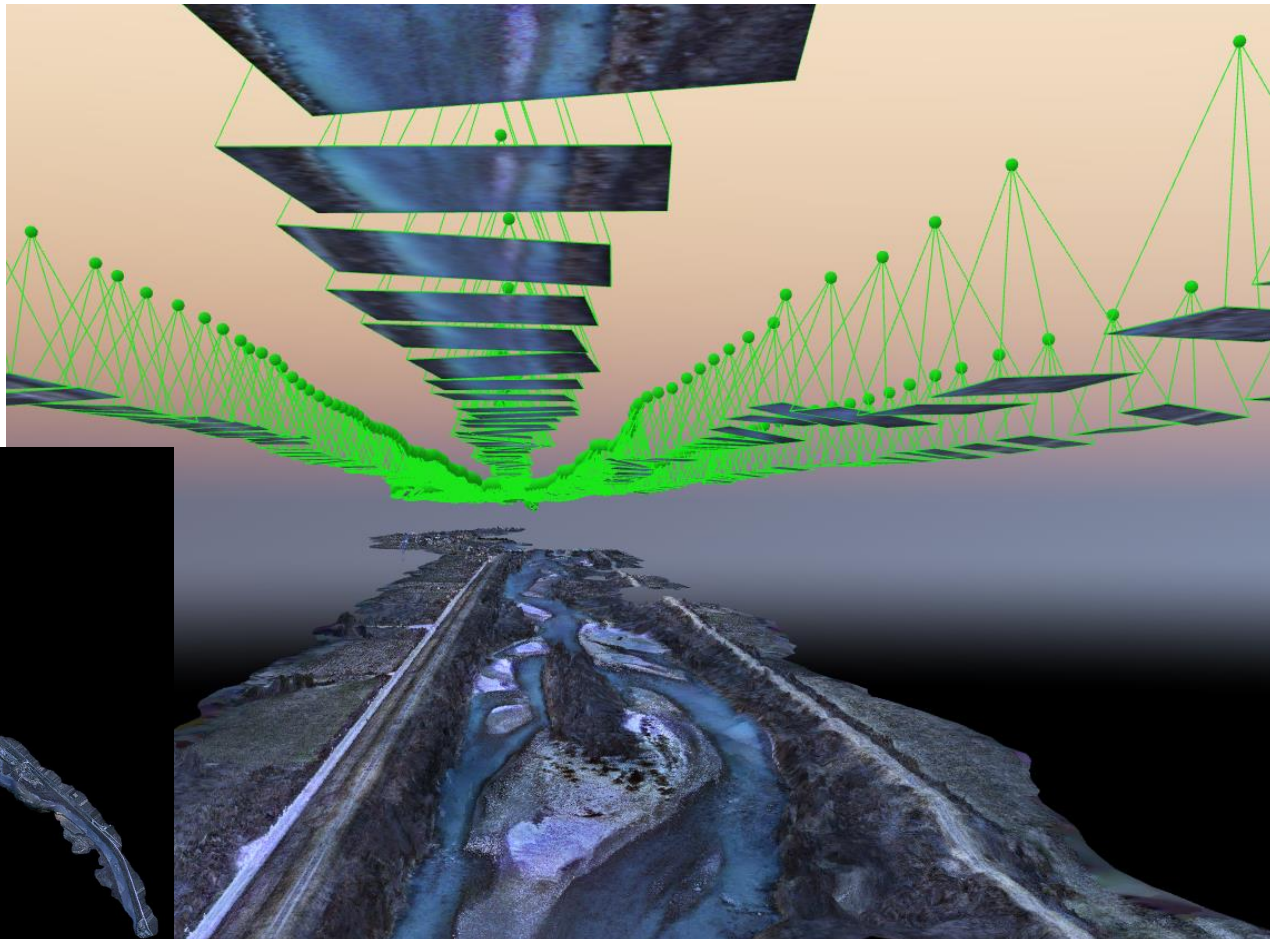
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# LOCAL STUDIES OF ANOMALIES: BEYOND *ON SITE* OPERATORS INSPECTIONS

## MONITORING OF LARGE TERRITORIES

EXAMPLE: STUDY OF MERA RIVER BED - 2018

3D DIGITAL  
RECONSTR.  
OF THE  
RIVERBED



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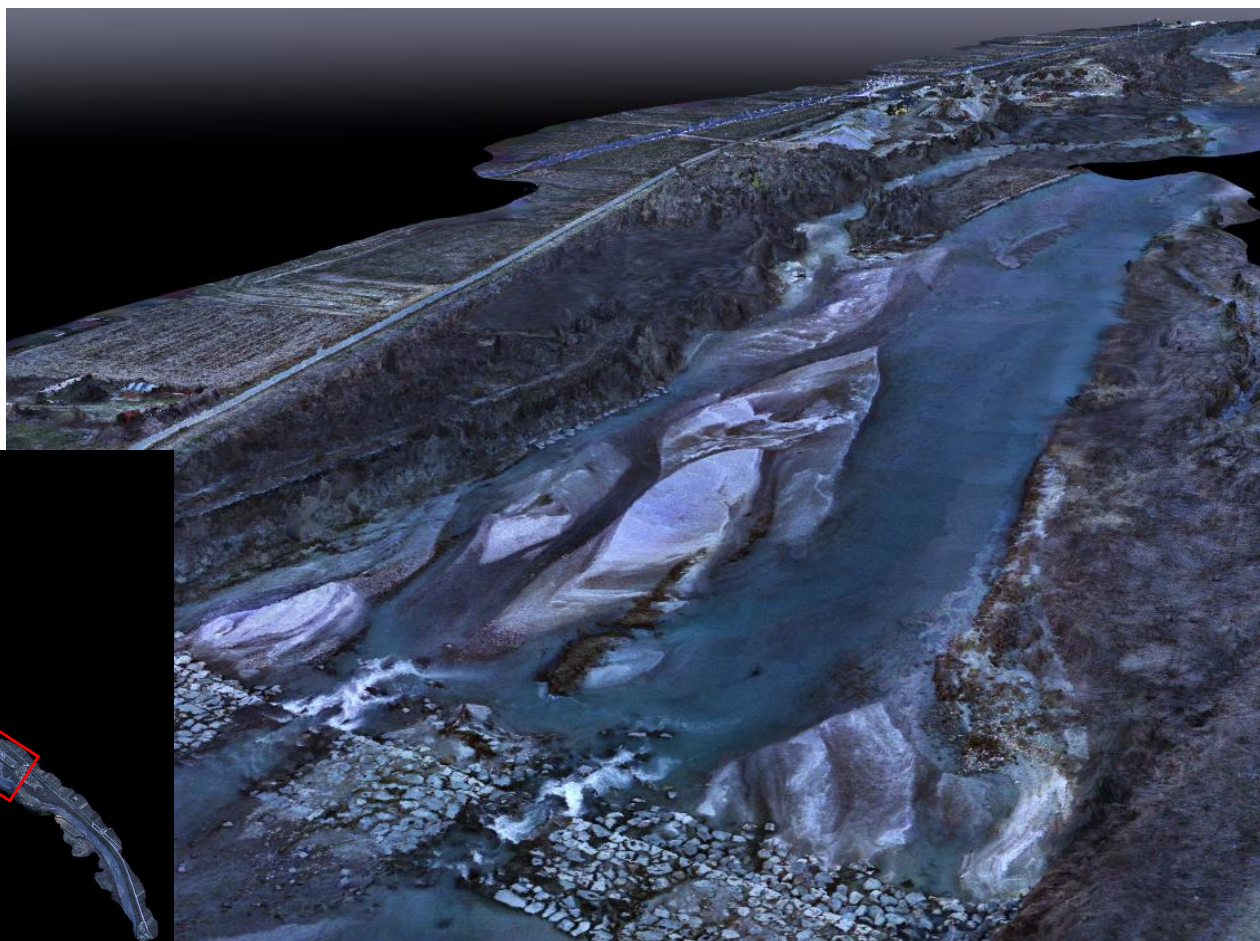


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# Wastes: Landfill Inspections

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# DRONES SUPPORT TO LANDFILL INSPECTIONS

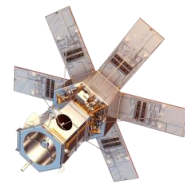


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## Survey missions:

- Independent photogrammetric survey on the whole area of the landfill
- Accuracy analysis and comparisons with traditional methods (GPS-RTK surveys)



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Earth observation: nature, water, waste

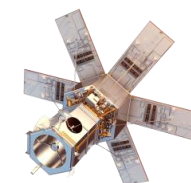


LOCAL STUDIES OF INSTALLATIONS: SUPPORT TO *ON SITE* OPERATORS

# DRONES SUPPORT TO LANDFILL INSPECTIONS

Points Cloud, 3D view from North

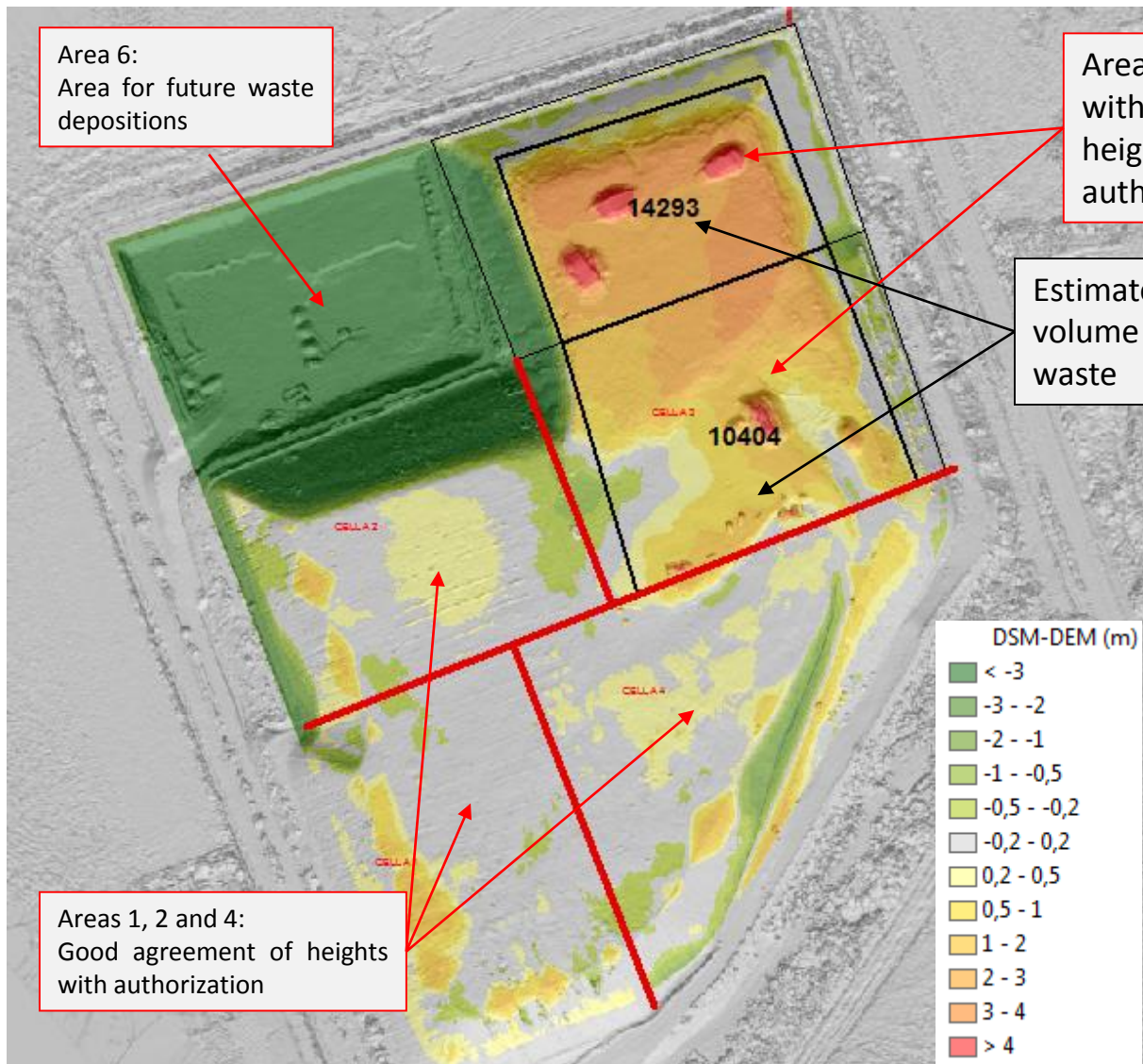
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Outputs use  
for  
compliance  
assurance

Heights difference  
(DSM – DEM) map

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LOCAL STUDIES OF INSTALLATIONS: SUPPORT TO *ON SITE* OPERATORS

## DRONES: THERMAL DETECTION OF LANDFILL ELUATES LEACHING

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# Wastes: Illegal Management

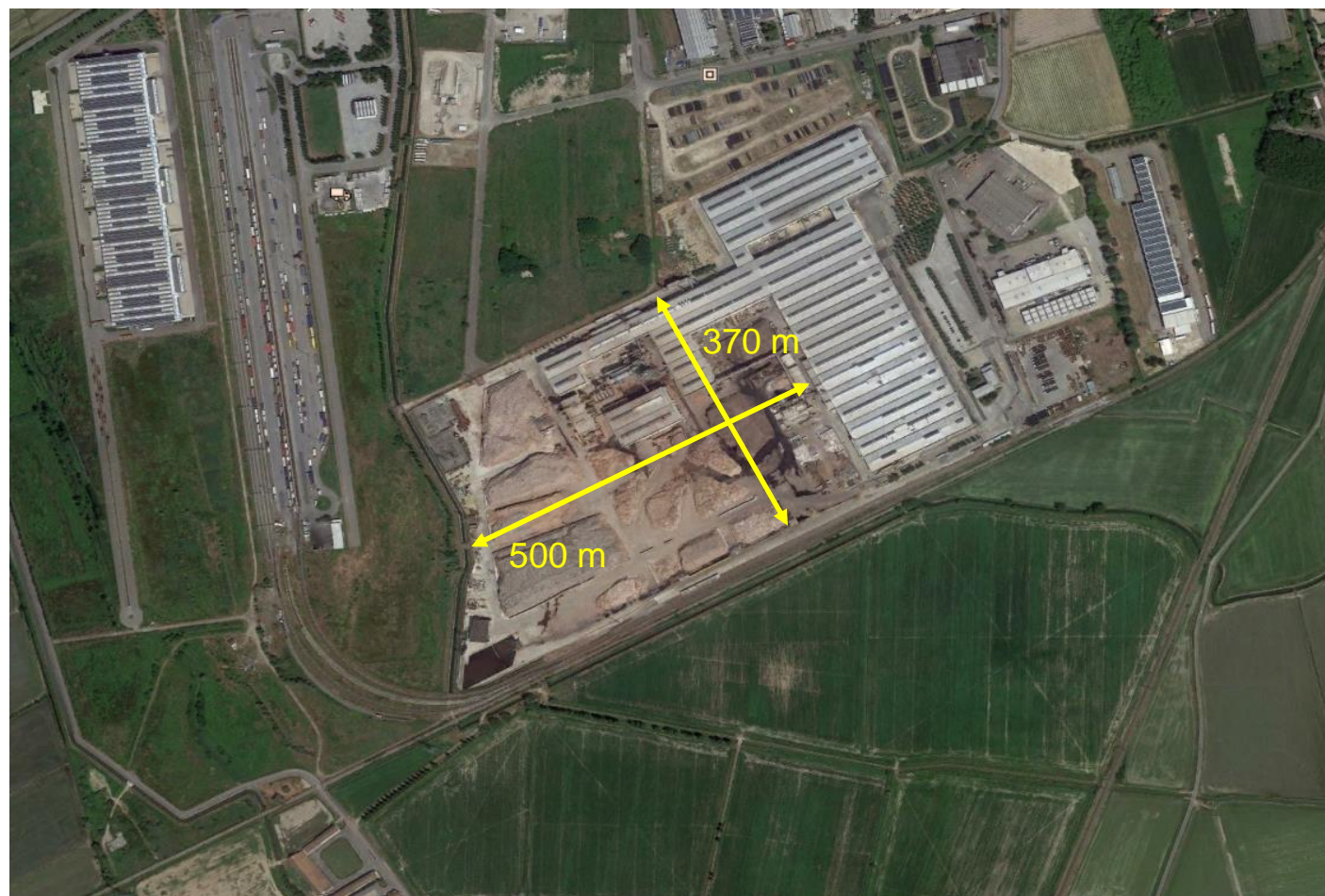
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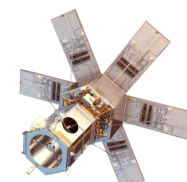
# DRONES and INSTALLATION INSPECTIONS

## Huge wastes installation inspections: high precision measurement



**HOW TO  
DETERMINE  
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WHEN  
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LOCAL STUDIES OF INSTALLATIONS: SUPPORT TO *ON SITE* OPERATORS

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LOCAL STUDIES OF INSTALLATIONS: SUPPORT TO *ON SITE* OPERATORS

# DRONES and INSTALLATION INSPECTIONS

## Huge wastes installation inspections: high precision measurement

DIGITAL MODEL OF THE  
WASTES DEPOSIT



| N° Cumulo     | Superficie (m <sup>2</sup> ) | Volume (m <sup>3</sup> ) | Errore (m <sup>3</sup> ) | Errore (%)    |
|---------------|------------------------------|--------------------------|--------------------------|---------------|
| 1             | 7.665                        | 62.777                   | ± 475                    | ± 0,8%        |
| 2             | 5.584                        | 54.956                   | ± 346                    | ± 0,6%        |
| 3             | 6.022                        | 45.125                   | ± 373                    | ± 0,8%        |
| 4             | 13.351                       | 132.628                  | ± 828                    | ± 0,6%        |
| 5             | 7.213                        | 53.924                   | ± 447                    | ± 0,8%        |
| 6             | 1.591                        | 4.101                    | ± 99                     | ± 2,4%        |
| 7             | 3.383                        | 10.703                   | ± 210                    | ± 2,0%        |
| 8             | 2.372                        | 13.824                   | ± 147                    | ± 1,1%        |
| 9             | 3.658                        | 20.083                   | ± 227                    | ± 1,1%        |
| 10            | 2.355                        | 10.896                   | ± 146                    | ± 1,3%        |
| 11            | 3.332                        | 17.784                   | ± 207                    | ± 1,2%        |
| 12            | 2.408                        | 13.936                   | ± 149                    | ± 1,1%        |
| 13            | 3.722                        | 12.591                   | ± 231                    | ± 1,8%        |
| 14            | 1.585                        | 3.808                    | ± 98                     | ± 2,6%        |
| 15            | 4.599                        | 23.876                   | ± 285                    | ± 1,2%        |
| 16            | 3.063                        | 15.279                   | ± 190                    | ± 1,2%        |
| <b>Totale</b> | <b>71.903</b>                | <b>496.291</b>           | <b>±4.458</b>            | <b>± 0,9%</b> |

ABOUT HALF A MILLION CUBIC METERS OF WASTES MEASURED WITH A **0,9% ACCURACY**, IN 1h 20min FLIGHT (less than a man-day post-elaboration – less than 5 man-day work in total)

**PERMIT EXCEEDED FOR A FACTOR OF 2 - PROSECUTED**

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# DRONES and INSTALLATION INSPECTIONS

**Inspectors dream... TAKE HOME AN ENTIRE INSTALLATION!**



**3D reconstruction of an installation, made elaborating hundreds of photos taken by a drone along a predetermined path**

**You can  
«walk»  
inside the  
installation  
staying in  
your office**



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# DRONES and INSTALLATION INSPECTIONS

**Inspectors dream... TAKE HOME AN ENTIRE INSTALLATION!**

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**You can «walk» inside the installation staying in your office, in a 3D digital virtual reality model**



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# POTENTIAL FOR DETECTION OF ILLEGAL WASTE BURIAL SITES

## A Study in Cooperation with Carabinieri NOE

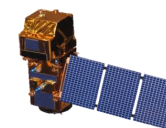
### TEST SITE



2007 (source: Lombardy Region). The quarrying at full capacity.

Re construction, through Earth Observation technologies, of the history of a closed quarry with restoration to agricultural land: how to make visible anomalies possibly related to violations and illegal waste burial

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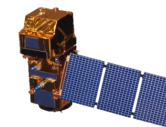
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November 2017. Infrared False Colour image from aerial multispectral scanner survey (source: ARPA Lombardia).

# TACKLING OF ILLEGALITY IN WASTE STORAGE, PREVENTION OF ILLEGAL WASTE STORAGE FIRES

From retrospective studies to surveillance to boost inspection capabilities



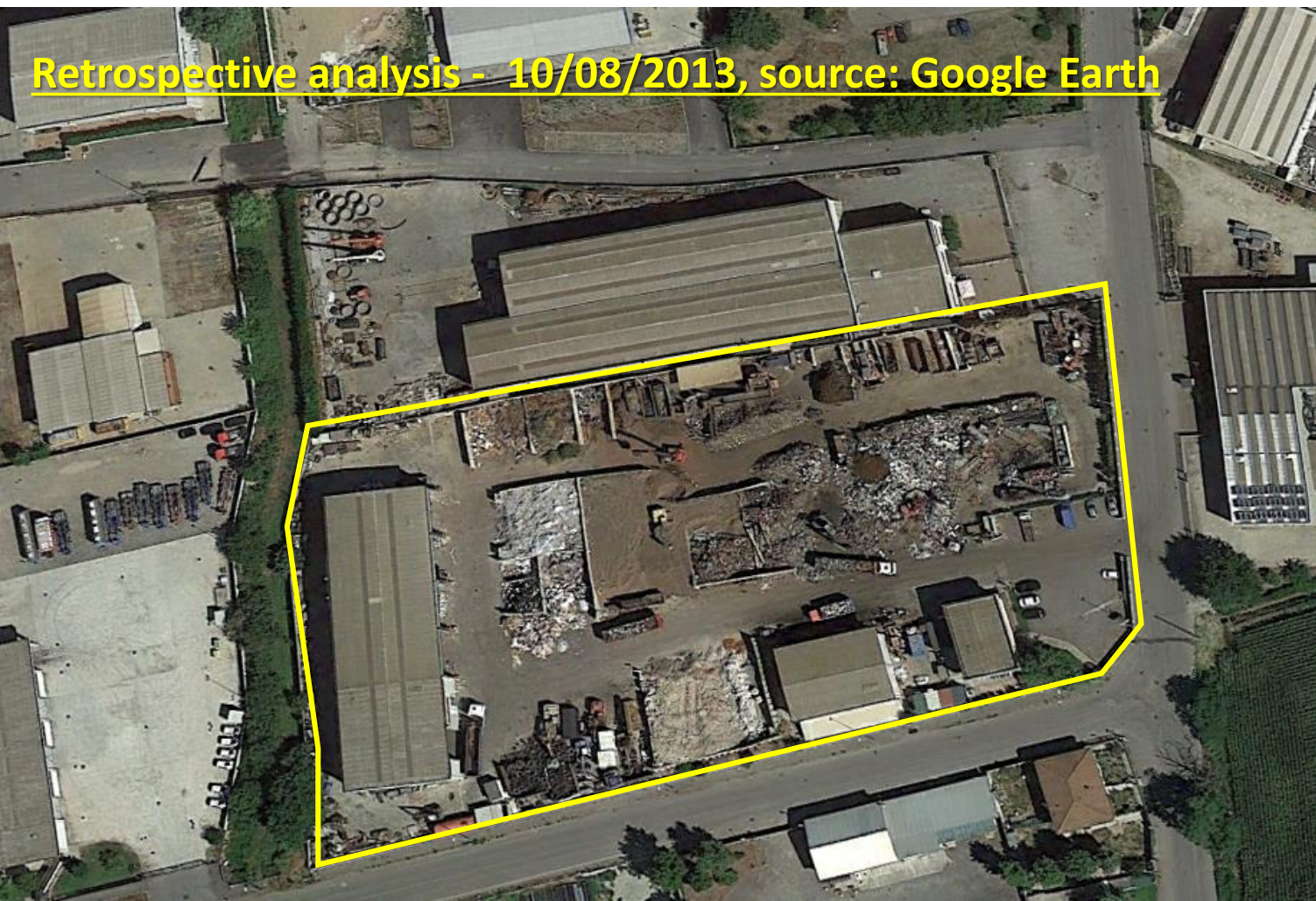
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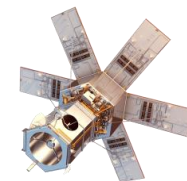


## TACKLING OF ILLEGALITY IN WASTE STORAGE, PREVENTION OF ILLEGAL WASTE STORAGE FIRES: **Surveillance of auth. Inst.**

Retrospective analysis - 10/08/2013, source: Google Earth



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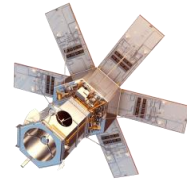


## TACKLING OF ILLEGALITY IN WASTE STORAGE, PREVENTION OF ILLEGAL WASTE STORAGE FIRES: **Surveillance of auth. Inst.**

**Retrospective analysis - 14/04/2016, source: Google Earth**



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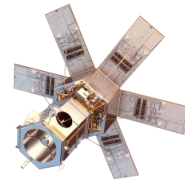
# TACKLING OF ILLEGALITY IN WASTE STORAGE, PREVENTION OF ILLEGAL WASTE STORAGE FIRES: **Surveillance of auth. Inst.**

Retrospective analysis - 10/06/2017, source: Google Earth

**EVIDENCE OF A  
SITUATION OUT OF  
CONTROL**



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crime



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23 – 24 October  
2018



# TACKLING OF ILLEGALITY IN WASTE STORAGE, PREVENTION OF ILLEGAL WASTE STORAGE FIRES: **Abandoned Sheds Surveillance**

Protecting habitats and endangered species in Europe through tackling environm. crime



PERIURBAN AREA

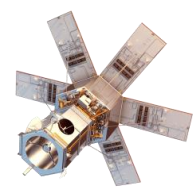
ANOMALIES AS POOR MAINTENANCE

CLUES OF PRESENCE OF VEICHLES

WASTES AROUND THE SHED

ABENDONED SHED?  
POSSIBLE ILLEGAL WASTES STORAGE?

indicators that could be considered as clues of illegalities. Base for the development of automatic images analysis based on Artificial Intelligence to optimize «ground inspections»



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## TACKLING OF ILLEGALITY IN WASTE STORAGE, PREVENTION OF WASTE STORAGE FIRES: Installation and Abandoned Sheds

### Surveillance

#### LOMBARDIA REGION IS DEVELOPING A PROJECT ON ADVANCED SURVEILLANCE ON WASTE MANAGEMENT («SavaGeR» project) BASED ON:

- Earth Observation
- Geospatial Intelligence
- Artificial Intelligence & Machine learning
- **Advanced cooperation among**
  - **ARPA (EPA) Lombardia**
  - **Administrative Bodies**
  - **Police Bodies**
  - **Prosecutors**

Protecting habitats and endangered species in Europe through tackling environment crime



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Innovative surveillance technologies  
in environment protection  
Earth observation: nature, water, waste



# TAKE OFF TO THE FUTURE

**DONE!**



Protecting  
habitats and  
endangered  
species in  
Europe  
through  
tackling  
environm.  
crime

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