



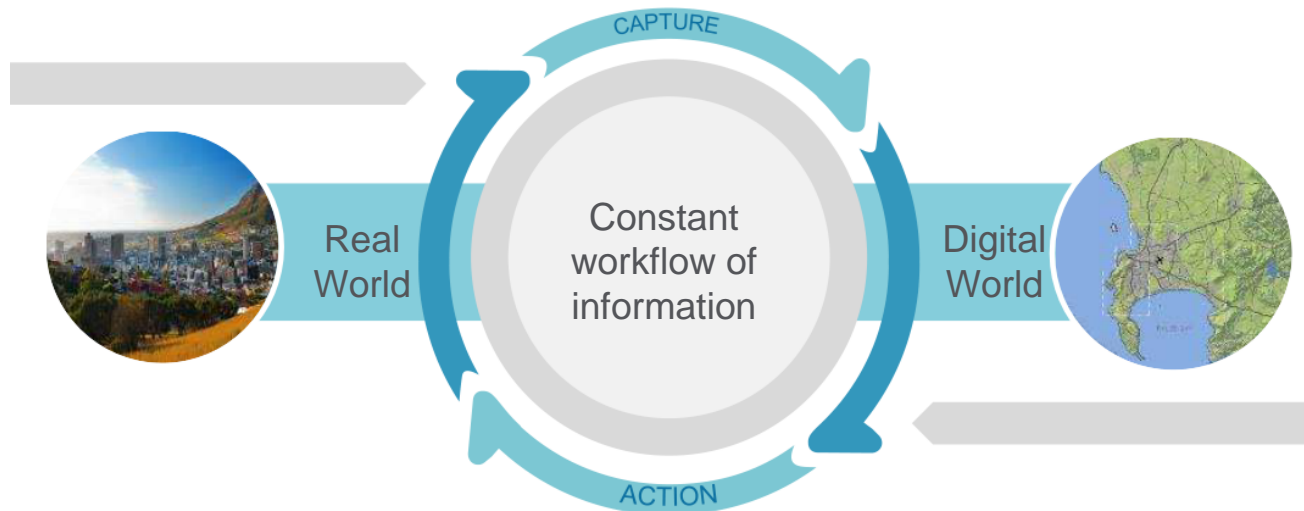
“5G and the State-of-the-Art of Earth Observation Methodologies”

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Geosystems Hellas S. A.
CEO
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**Ensuring our Rapid Response
to Change
The Role of Geospatial
Information**

GEOSYSTEMS HELLAS S.A. (GSH) was established in November 2009 as GEOSYSTEMS EU GROUP Member (www.geosystems-group.eu).

Is a Greek SME with 9 engineers. Has three main activities : 1. acting commercially as Hexagon Geospatial & Luciad and Hexagon Airborne Solutions authorized reseller and as consultant in Greece and Cyprus on subjects of Environmental Monitoring, GIS, Photogrammetry and Remote Sensing working also with Big Data/Fused Data 2. participating in service projects and 3. participating in R&D projects for land management.

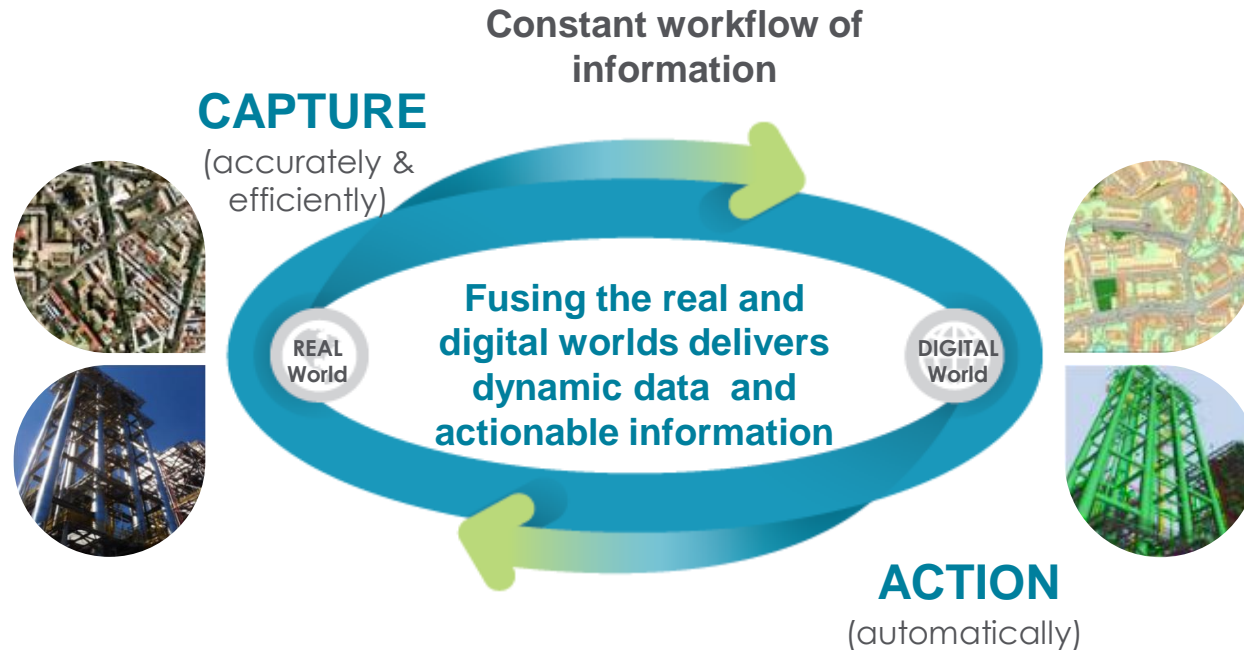


Member



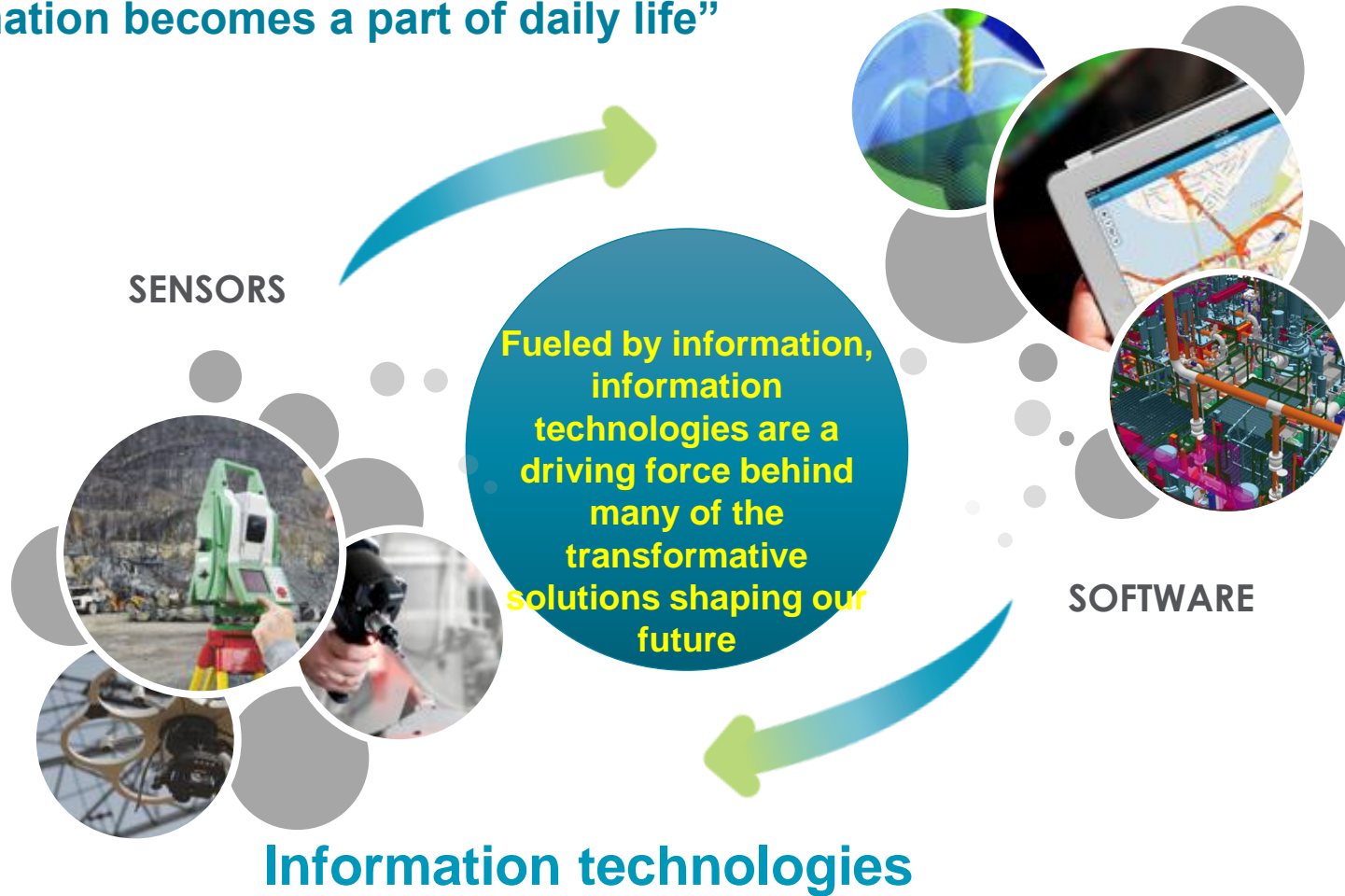
Following Working Groups in the Technical Chamber, ESA, H2020 SPACE, FIG, GEO etc

Fusing the real and digital worlds



- Remote Sensing and photogrammetry applications
- Big Data, Data Fusion and Data Analytics techniques
- 3D monitoring techniques

**“Location and Change, A New source of
Business Intelligence location
Information becomes a part of daily life”**





5G ... the fifth generation of cellular mobile communications.

5G performance targets high data rate, reduced latency, energy saving, cost reduction, higher system capacity, and massive device connectivity.

The first phase of 5G specifications in Release-15 will be completed by March 2019, to accommodate the early commercial deployment. The second phase in Release-16 is due completed by March 2020, for submission to the ITU as a candidate of IMT-2020 technology.

The Digital Economy - an opportunity for everyone?

The road to digital transformation:

Challenges & opportunities & a lot of unanswered questions...

- ✓ *Provide the digital infrastructure- Develop the **platforms** types of investment? Metropolitan areas? rural areas? benefits? **connectivity** & **density** (people & business)*
- ✓ *Engage governments: affordable **energy** to enable connectivity,*
- ✓ ***Informal sector**? regulations, openness & stability to attract investors,*
- ✓ *Enable **digital financial inclusion**? To support sustainable digital and technological entrepreneurship*
- ✓ *Create the **digital society**: Skills? The **young** generation*
- ✓ ***Information**: mapping the jobs & training facilities to measure the gaps*
 - job cuts? New jobs? retraining? Skill flow?*
- ✓ *Education? **on-line training** ? certification?*

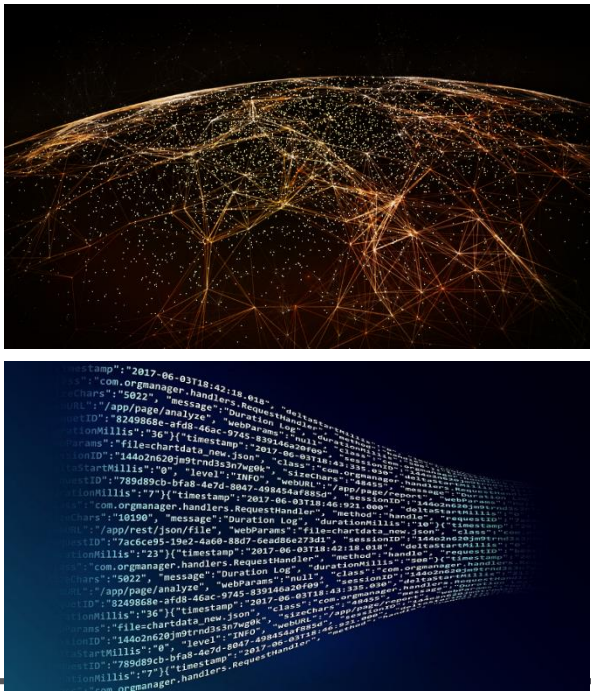


From the need for providing society with

- reliable, evidence-based, open or low cost data

for decision-making, toward the need to manage a “tsunami” of geodata

- extended use of affordable smart devices ; crowdsourcing
- 5G mobile network technology, 40-60% higher speeds by 2020: massive creation & consumption of data
- the Internet of **Me**, Internet of **Things**,
- Internet of **Value**, **Blockchain & Distributed Ledger Technology** (DLT)
- Machine learning, cognitive computing for all to improve human decision-making
- Autonomous vehicles & drones



See the opportunity not the complexity

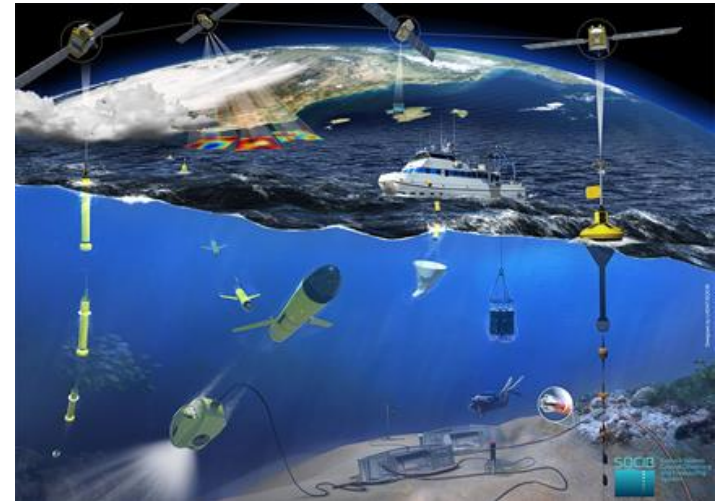
1. *“with a 10% increase in high-speed Internet connections, economic growth increases by 1.3%” and leads to “democratization of innovation.”*
2. *“in a world where only 40% of the population have access to the internet; we could boost the global GDP by \$1 trillion by connecting another 327 million people.” 5G will enable low-cost, low-power sensors to be embedded in building, appliances, and vehicles. It will be a key enabler of the “internet of things.”*

The World Economic Forum



Analyst-Ready Building Footprints

More than 40 million precision-polygons per month for rapid, scalable analysis



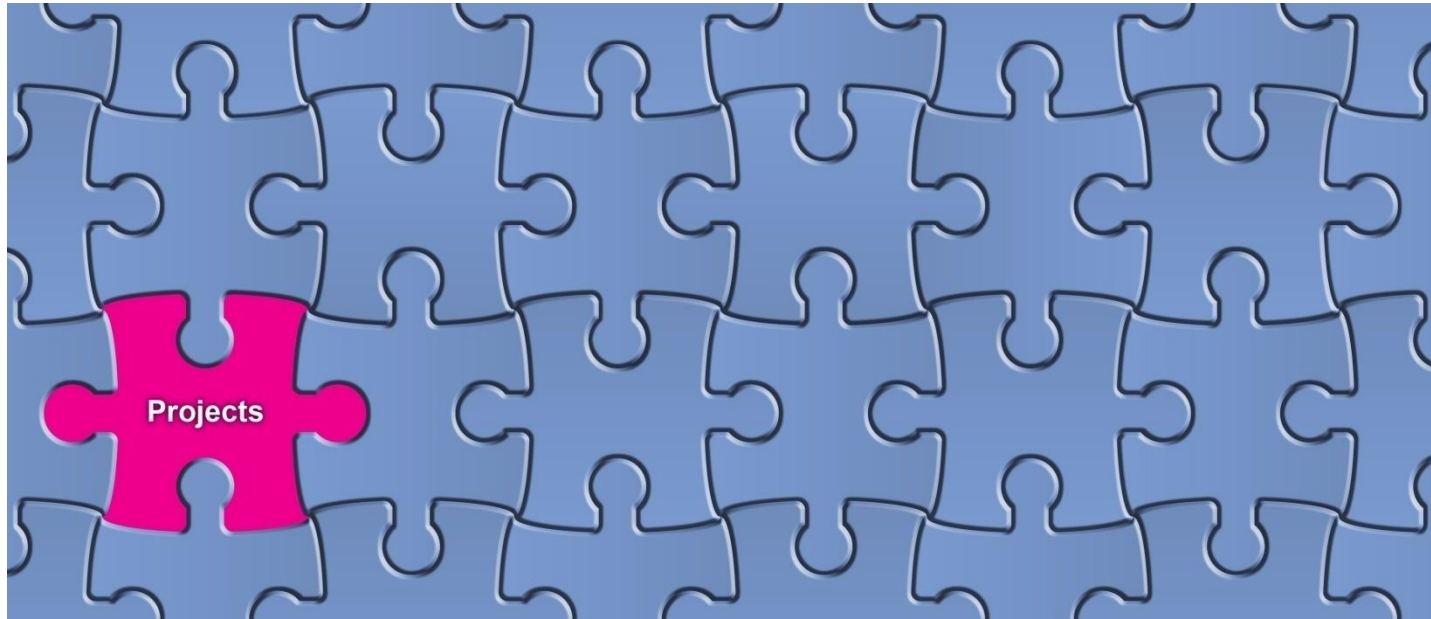
There are many data collection devices we collect: Authoritative and non-authoritative data, good enough for various purposes

Population mapping

Find and quantify the people or communities that matter to your organization to better reach or serve them.

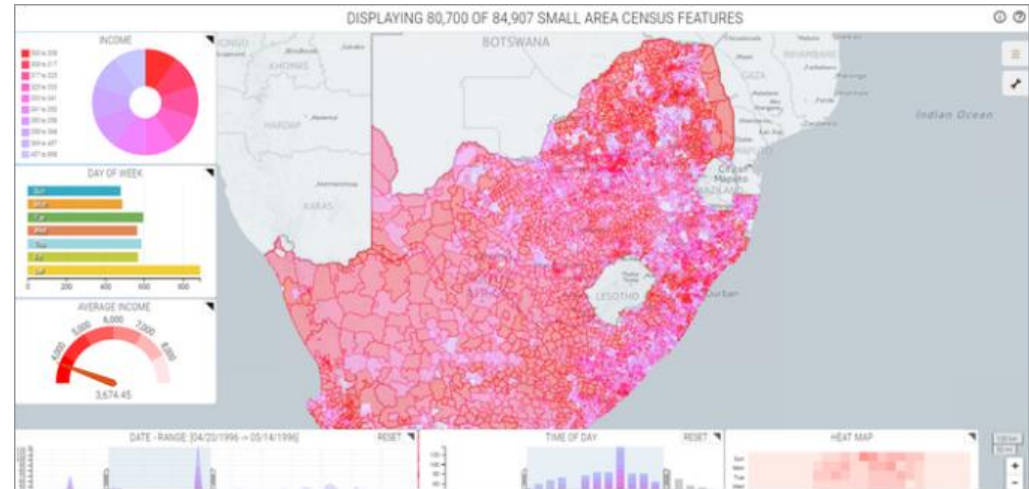


Product/solutions Case Studies



Area Analyzer

Use polygon and attribute data to help customers explore how measures, such as population density, vary within an area.



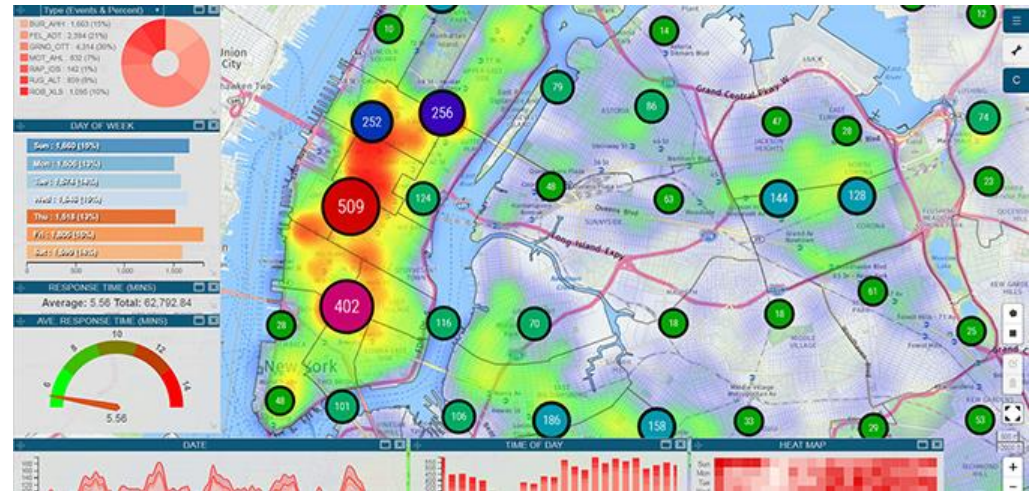
Network Analyzer

Use linear networks to create thematic maps to help customers understand the nuances and anomalies within a network.



Feature Analyzer

Feature Analyzer combines the power of Incident Analyzer, Area Analyzer, and Network Analyzer into a single easy-to-use application to dynamically explore spatial data.



Analyzer Viewer

Analyzer Viewer offers an effective way to provide individuals within your organization access to reports created with Incident Analyzer, Area Analyzer and Network Analyzer.

Analyzer Public

Analyzer Public provides a simple and effective way to share your Incident Analyzer, Area Analyzer and Network Analyzer reports with individuals outside your organization using publicly accessible websites.

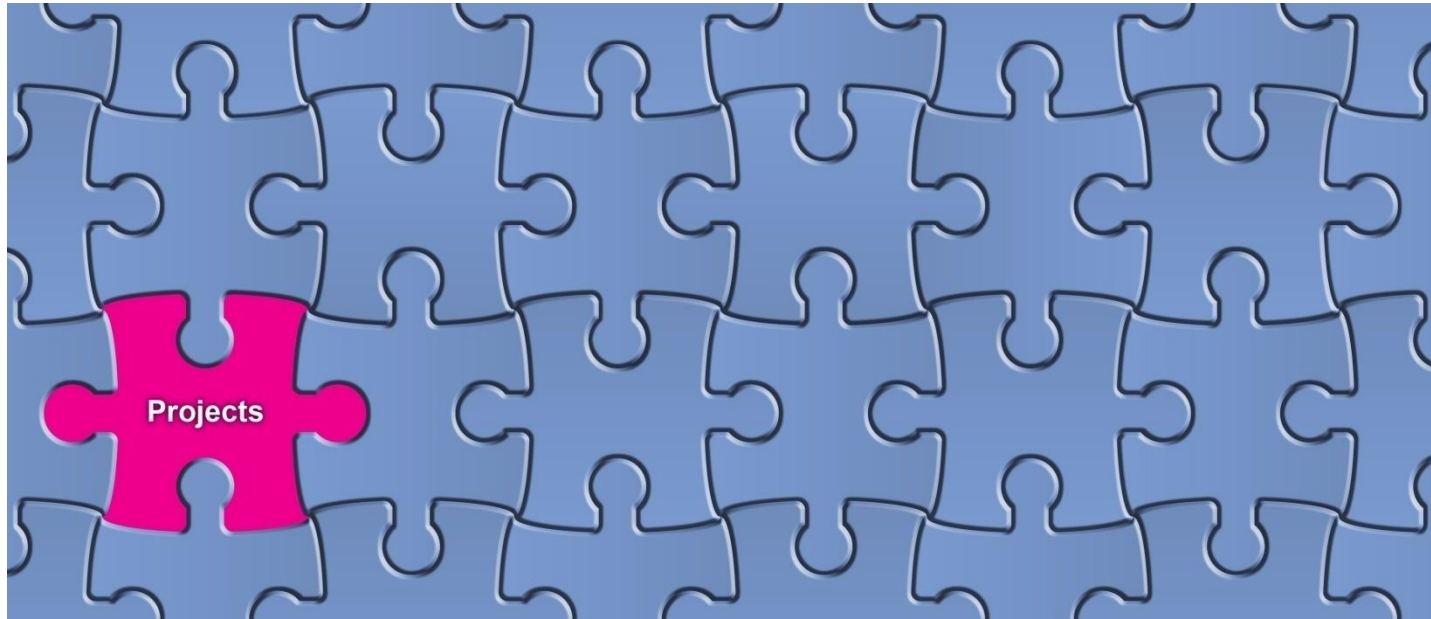
Feature Analyzer combines the proven power of Incident Analyzer, Area Analyzer, and Network Analyzer into a single easy-to-use application. Feature Analyzer takes the power of investigative learning through interactive thematic mapping to a new level.

With Feature Analyzer, non-technical users can quickly create a wide range of stunning spatial reports. You can use a wide array of charts to effectively explore your multi-dimensional data in a self-guided and interactive fashion and in turn assemble intelligence products that have insight and meaning.

Feature Analyzer



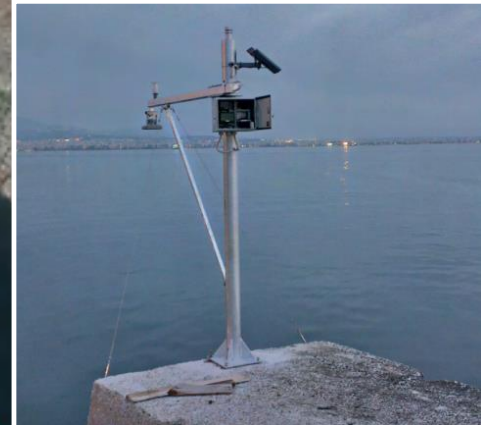
Product/solutions Case Studies

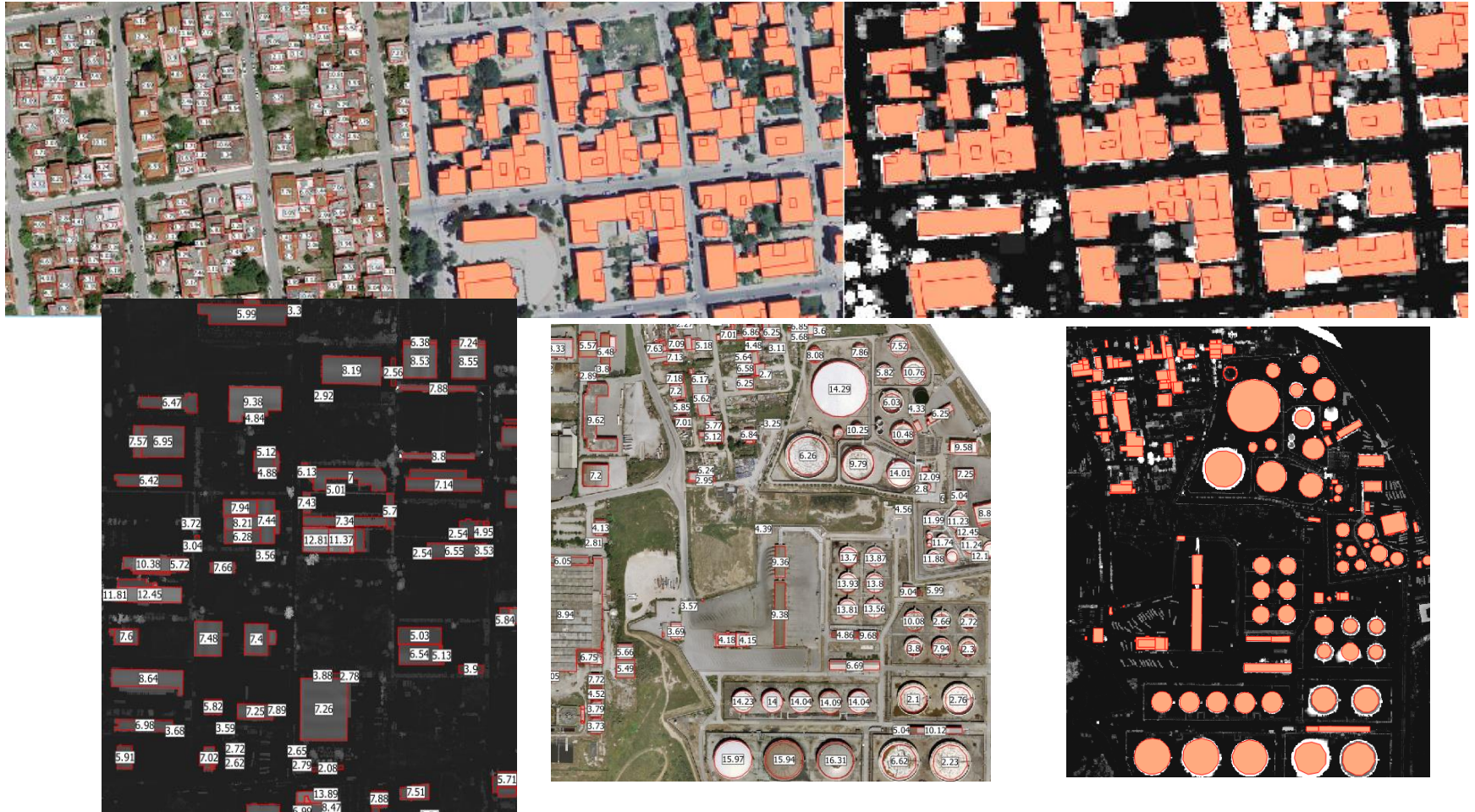




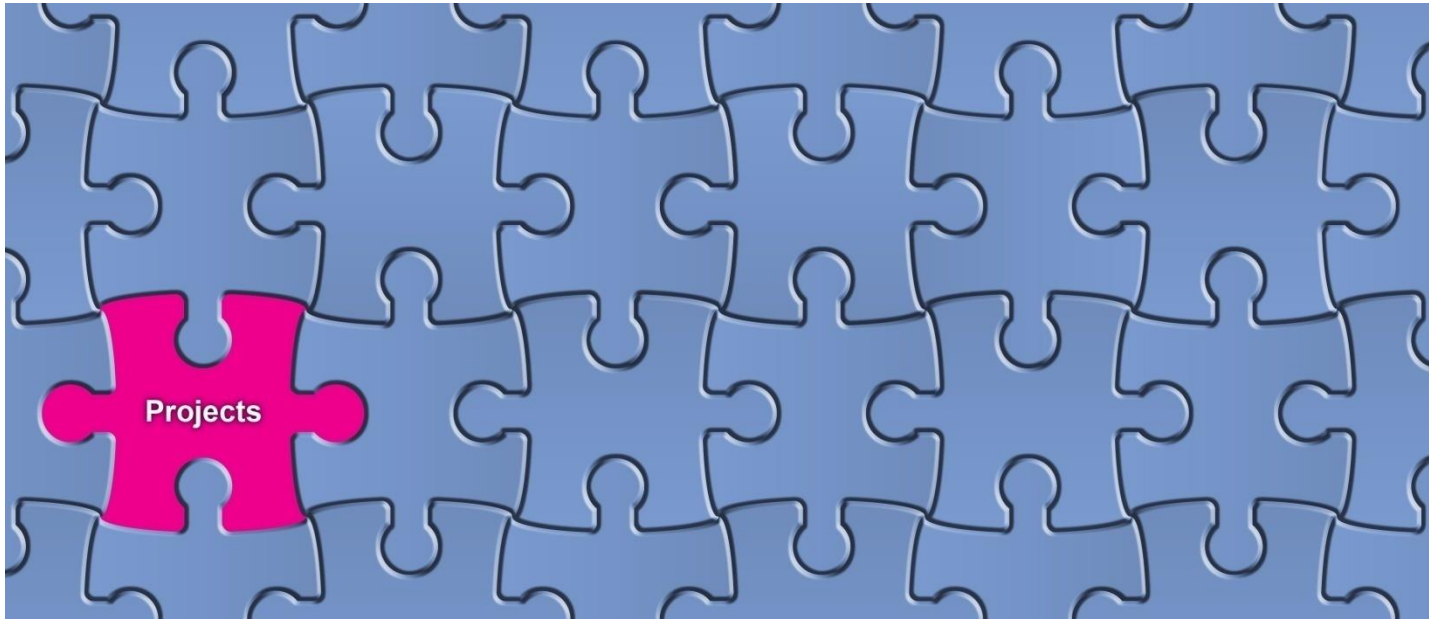
INDES MUSA : INnovative multi-sensor network for DEformation and Seismic Monitoring of Urban Subsidence-prone Areas.

www.indes-musa.gr





Product/solutions Case Studies





5DMuPLIS

5 Dimensional Multi-Purpose Land Information System, [5DMuPLIS]

contribution to the Sustainable Development Agenda 2030:

MAEOS/eoMALL : EVERSIS

Project 5DMUPLIS (5D Multi-Purpose LIS, Land information System, <http://www.5dmuplis.gr>), high scientific content of the innovation is the vision of the future for city sustainable growth and affordable housing especially under EU policy for young couples, since the low birth rate is a “major issue” for Greece and other EU countries. The scientific idea combines : property rights and property values on land and real estate (3d-cadastre) and their transformation through time (4th dimension), land-use zoning regulations and construction development plans in various levels of detail (LOD) (5th dimension). Is following the developed urban area that create high quality of life by excellent environment, people, living, (Coordinator).



3D Modelling at Various LoDs

3D models of internal and external parts of buildings



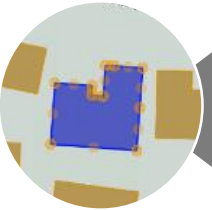
Dimensions of each part of a building



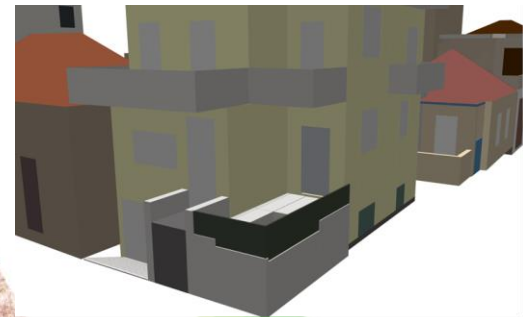
Color or textural information



Footprints of each inner part of building



3D models at LoD2 and LoD3



3D models at LoD2 (top) and LoD3 (bottom)

3D model at L





Urban readjustment –
redistribution of property rights

Future
scenario



Descriptive information for an apartment – connection with database



14 2014

Εξάγει από την παραβολή επιπέδου εδάφους

Shape

Name	Shape
wallColor	#E0D1BA
PROP_VE_2	0
KA EK	050580147013
OROFOS	2
roofColor	#C0C0C0
PROP_HO_2	3
PARCELID	050580147013
ID	050580147013000300101002
ruleFile	2010/050580147013/LOD2_2ndFloor.c
startRule	Lot
USE_DESC	APARTMENT
door_color	#D1D1D1
wll_wdt_12	0.000000000000
PROP_VER	0.000000000000
009MSRMNT	0.000000000000
blcn_width	0.000000000000

Examples of crowdsourced

- every person has something of value to contribute; what is the “**risk**”?
- work may be done **faster** and **cheaper** and with **fewer errors** when **validation** systems are in place
- **validation is critical** in surveying
when crowdsourcing is used in surveying, **it requires training of volunteers**
easy application for data-collection that is not positionally critical

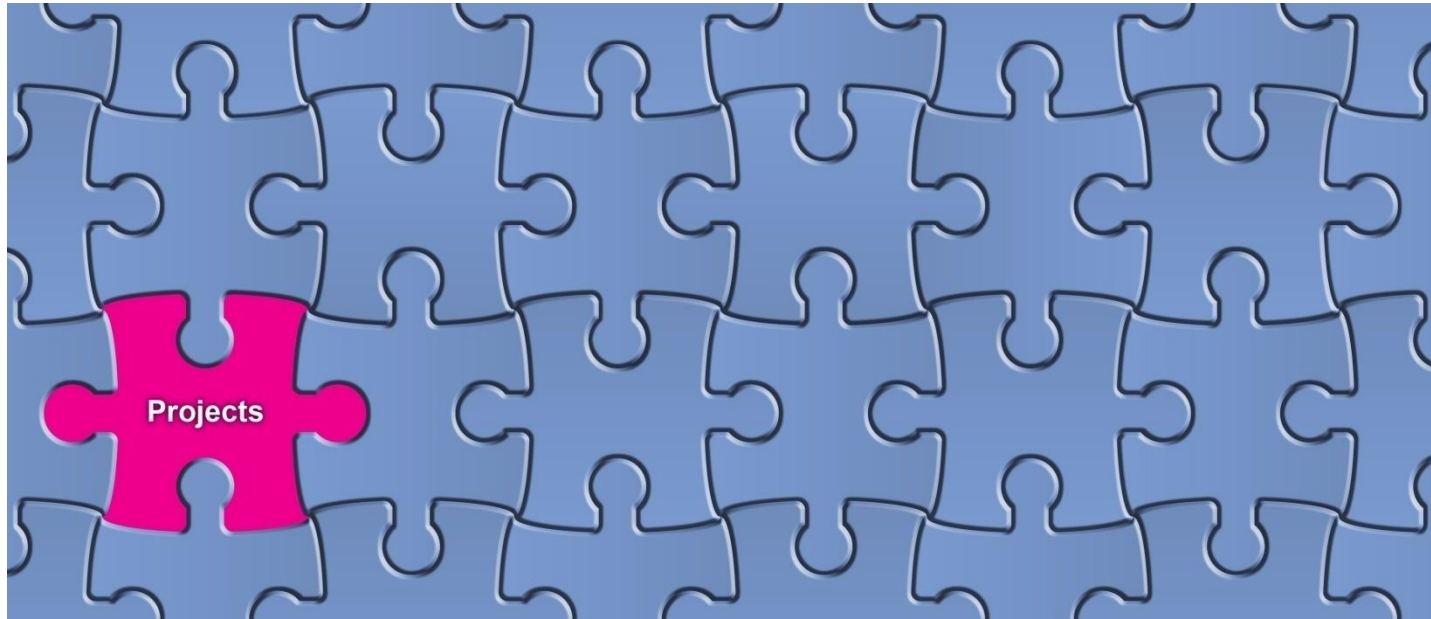
General Rule

it may involve the collection of information that is required to be neither positionally precise nor dimensionally accurate, **yet, important enough to achieve the SDGs**, and

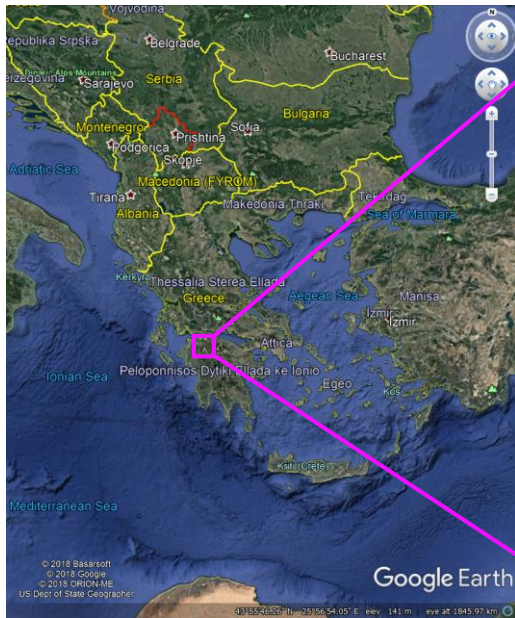
- as long as positioning and validation improve the use of VGI information will be extended.



Product/solutions Case Studies



- **Aim of the study :** This study discuss the complementary use of Sentinel-2 data with ALS point clouds at industrial scenes for:
1) 2D/3D mapping ,
2) Feature extraction , 3) Object detection

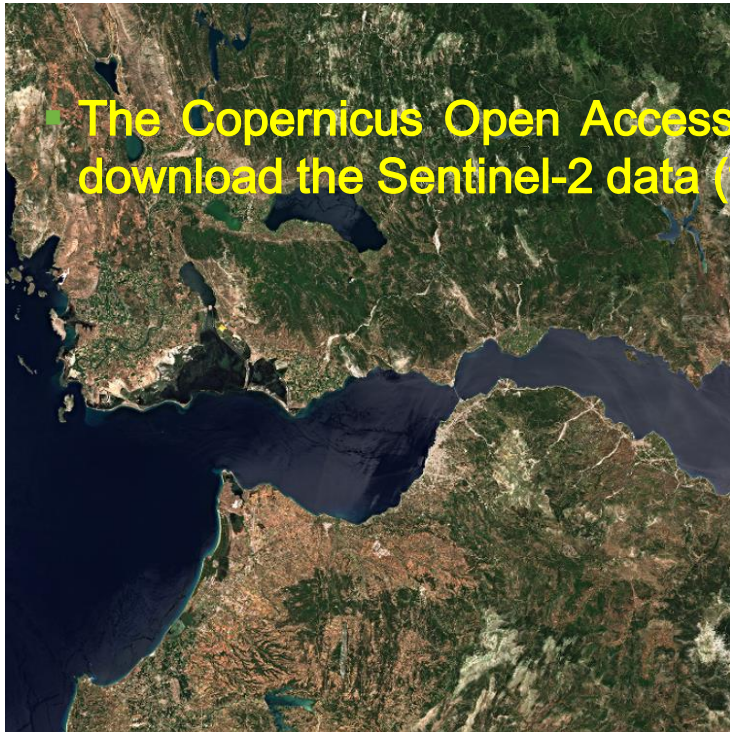


A complex industrial area of 4.3 km² located in Greece was used as case study.



Data description – Sentinel 2

- The Copernicus Open Access Hub (<https://scihub.copernicus.eu/>) was used to download the Sentinel-2 data (type MSIL2A, date: 28/6/2017)

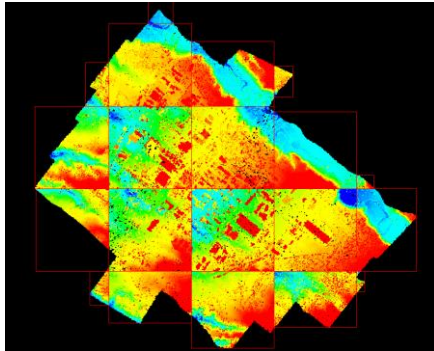
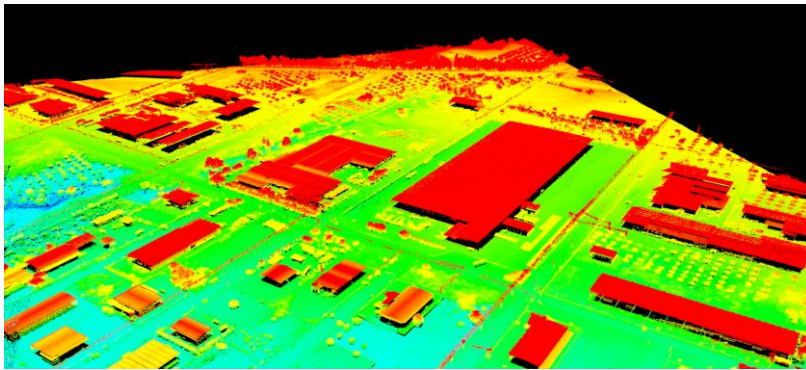


Sentinel-2 image

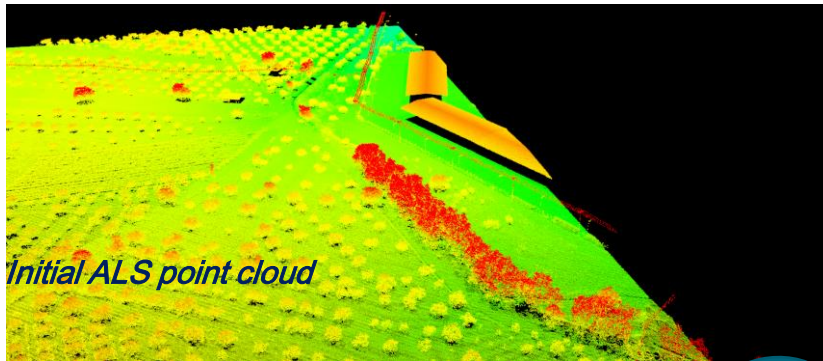
Data description – ALS data

- ALS point density: 5 points/m² (covered from one strip) and 30 points/m² (covered from multiple strips). Multiple echoes and intensities were recorded.

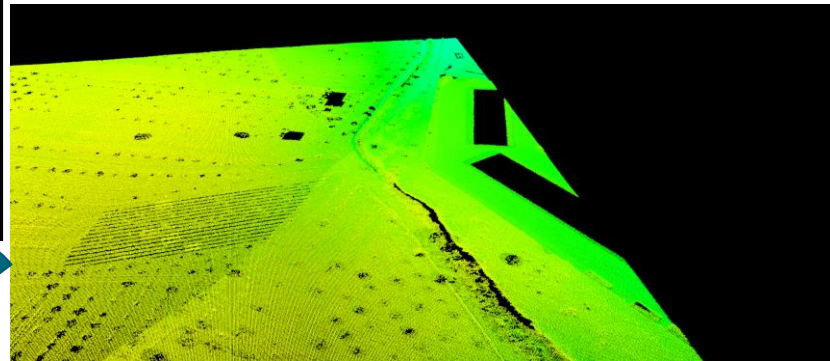
ALS point cloud coloured by the point height and the intensity



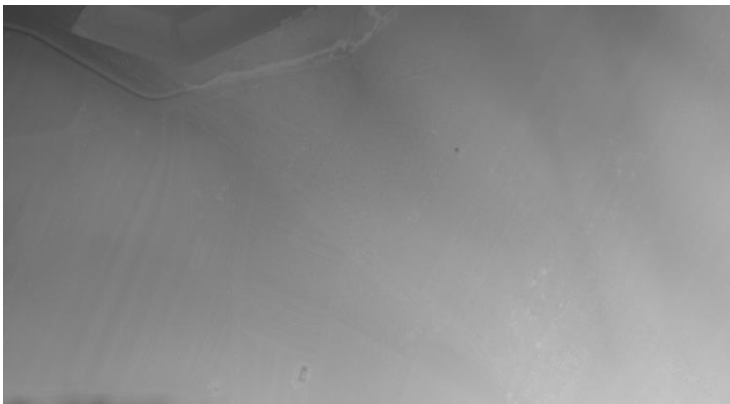
2D/3D Mapping



*Automatic extraction of bare-earth points
via ALS point cloud classification*



*Rasterization process to
extract the DTM*

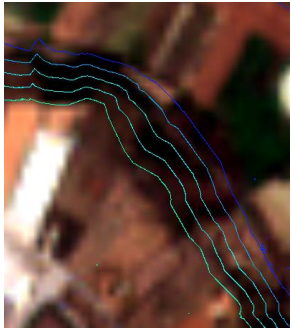


*Generation of
the orthoimage*

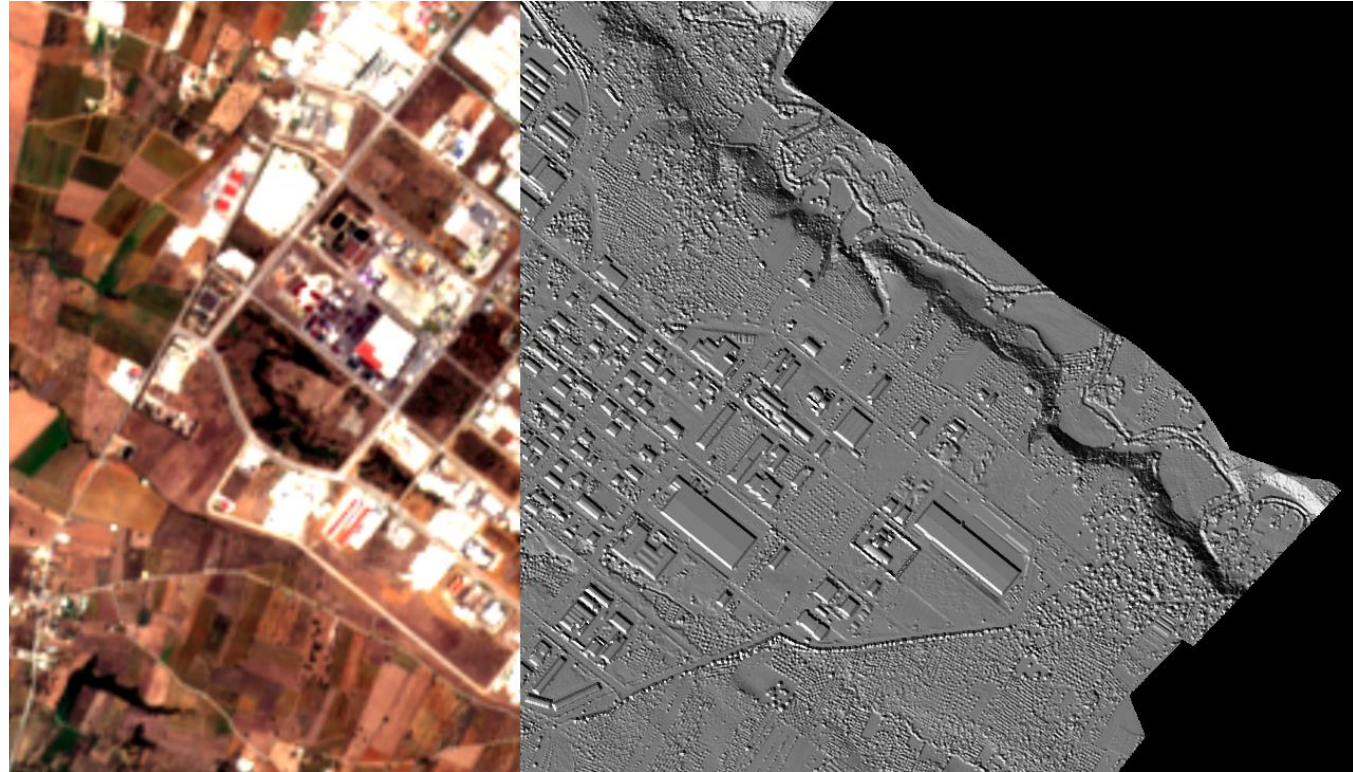


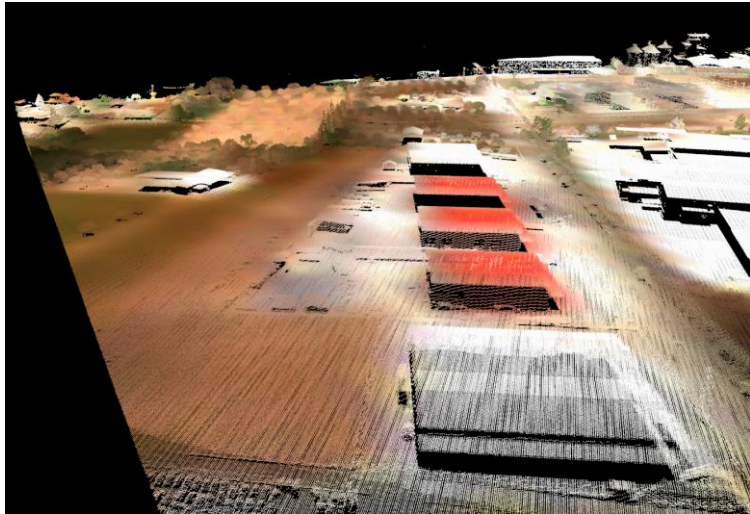
2D/3D Mapping

Contour extraction



Superimposition of the DSM to the orthoimage



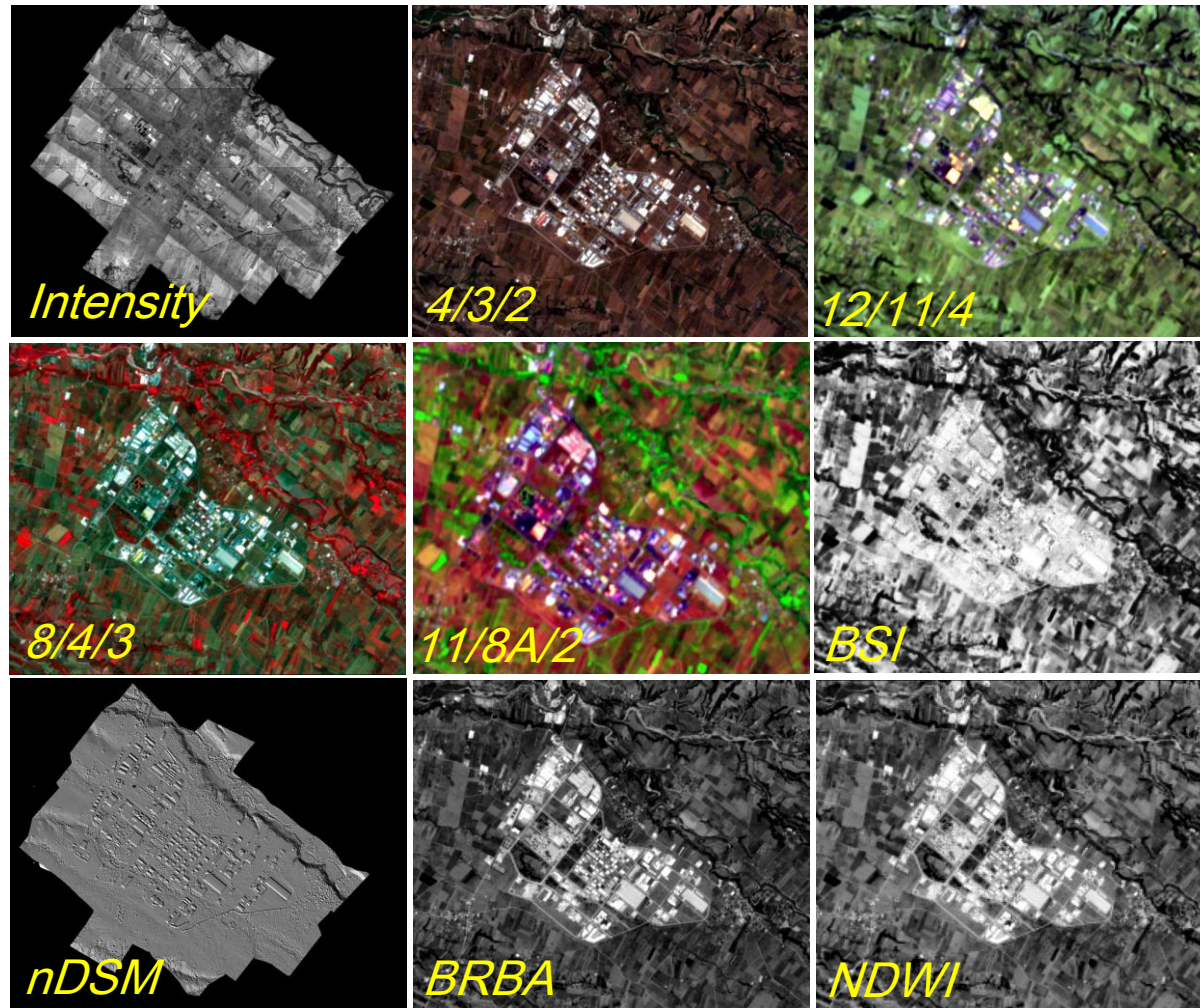


*ALS point clouds coloured
(RGB) from Sentinel-2 data*

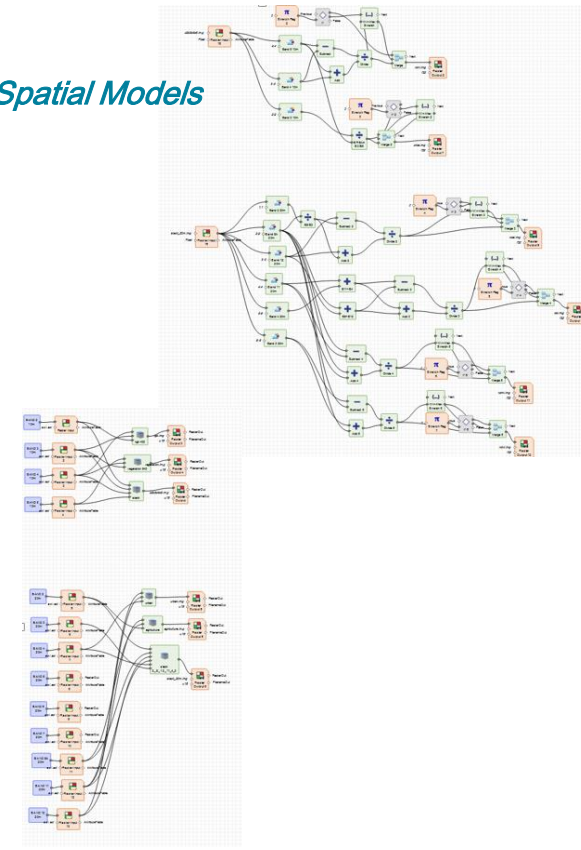


2D/3D Mapping

Feature extraction

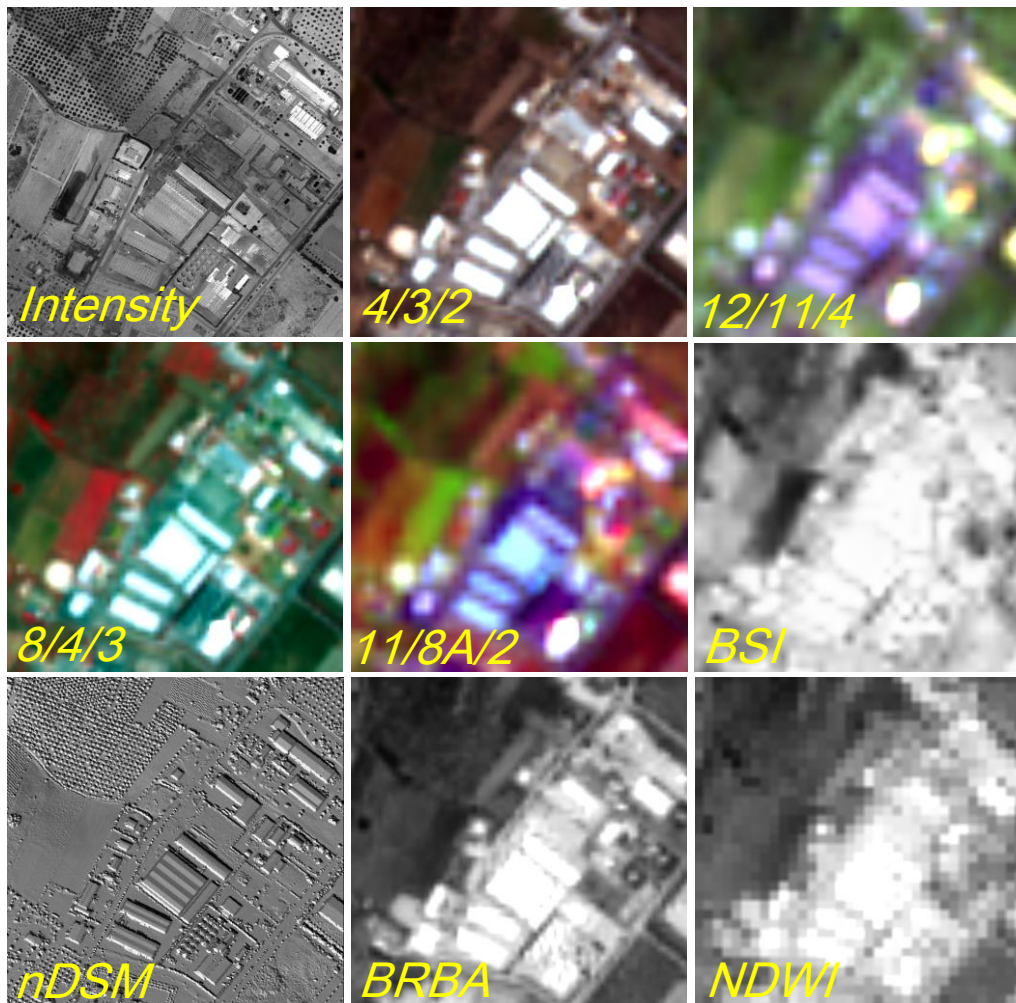


Spatial Models



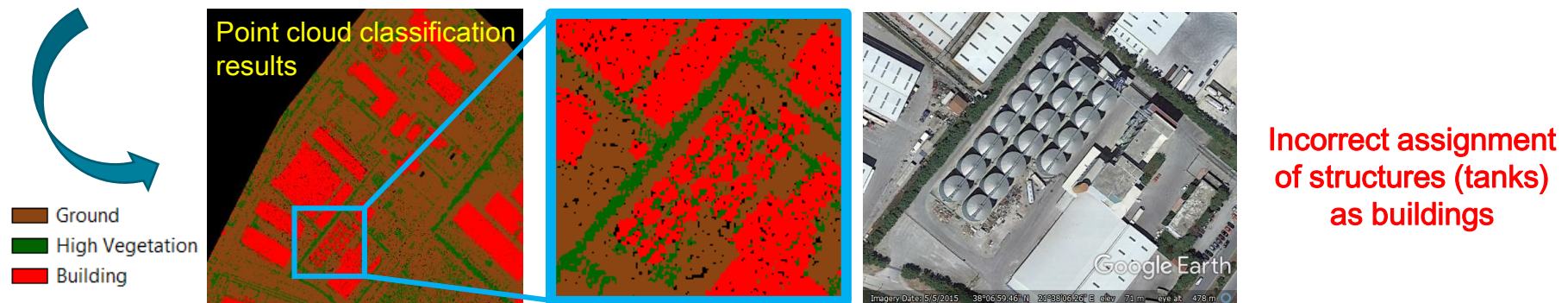
Feature extraction

Zoom-in to a
sub region



Object detection for a selected sub-region

- The industrial areas include buildings premises and structures with several complex shapes (e.g. tanks, etc).
- Typical ALS point cloud classification techniques cannot distinguish buildings from such structures.



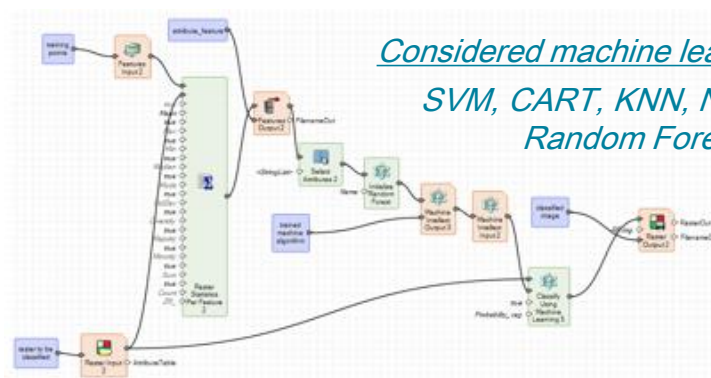
Incorrect assignment
of structures (tanks)
as buildings

➔ The main advantage of the machine learning approaches is that they are flexible and data driven methods, requiring only training samples to generalize well the building's and the structure's properties and thus to perform an accurate classification. On the contrary, model based schemes consist of many parameters needed to be tuned for each study area. Therefore supervised learning paradigms provide higher generalization capabilities, that is, robustness against data being outside training set.

Training samples: 118 collected points for all the classes



- Image Block tile: 357×362 x (depth of the MDFV)
- The class "Ground" includes low height objects, roads, low vegetation, etc.

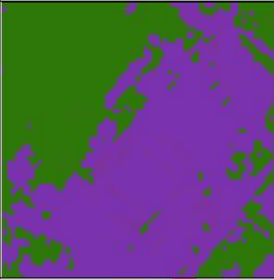
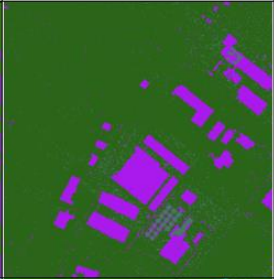

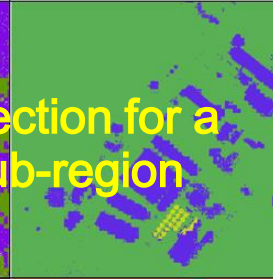
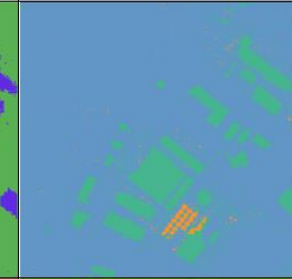
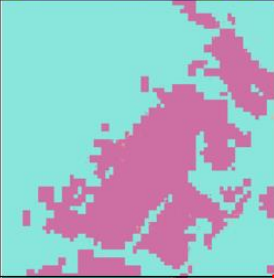
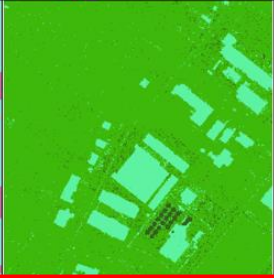

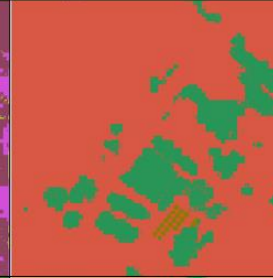
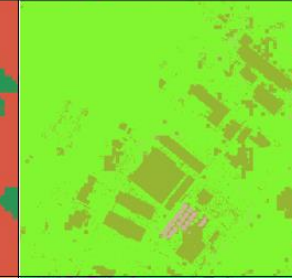

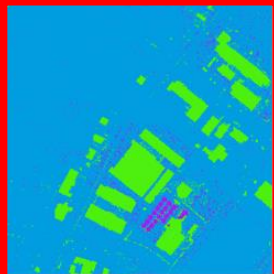


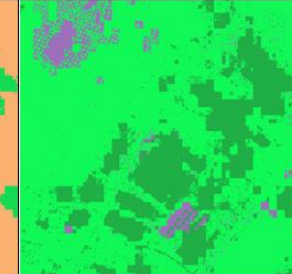


Considered machine learning methods:
SVM, CART, KNN, Naïve Bayes,
Random Forest

Spatial Model

Considered MDFVs: Each MDFV includes several features

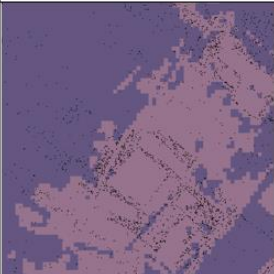
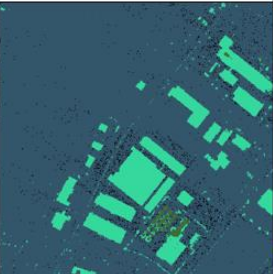
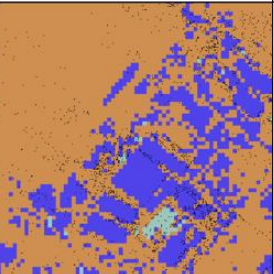
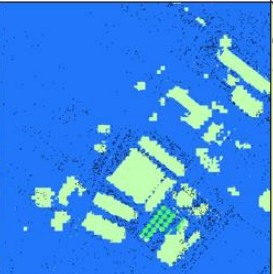
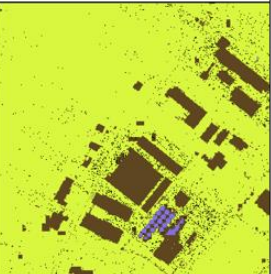

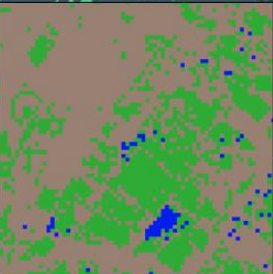
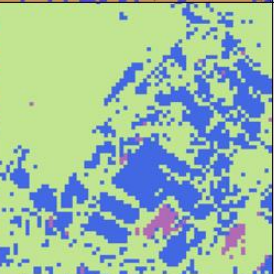

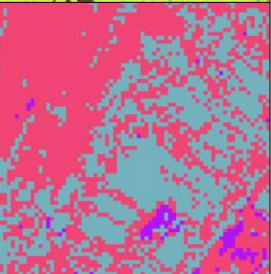

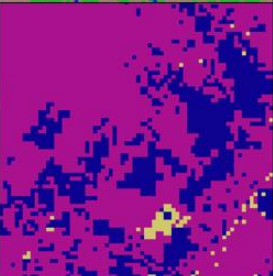
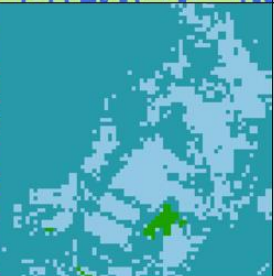
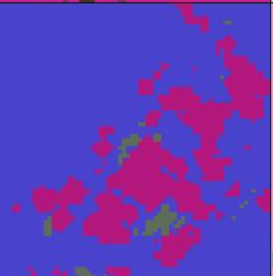
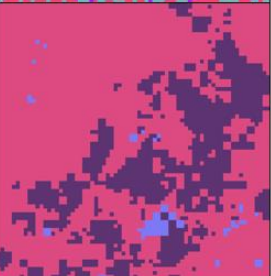
		Multi Dimensional Feature Vector (MDFV)					
	Features	MDFV 1	MDFV 2	MDFV 3	MDFV 4	MDFV 5	MDFV 6
ALS point cloud	Intensity	✓	✓	✓	—	—	—
	nDSM	✓	✓	✓	✓	—	—
Sentinel-2	4/3/2	✓	✓	✓	✓	✓	✓
	8/4/3	✓	✓	✓	✓	✓	✓
	BRBA	—	—	✓	—	—	✓
	12/11/4	—	✓	✓	—	—	✓
	11/8A/2	—	✓	✓	—	—	✓
	BSI	—	—	✓	—	—	✓
	NDWI	—	—	✓	—	—	✓

Multi Dimensional Feature Vector (MDFV)	Machine learning method				
	SVM	CART	KNN	Naive Bayes	Random Forest
MDFV 1					
MDFV 2					
MDFV 3					

Object detection for a
selected sub-region



Object detection for a selected sub-region

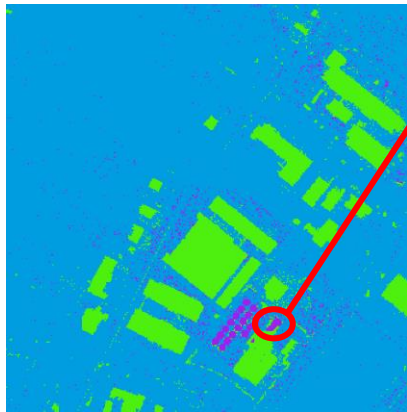
Multi Dimensional Feature Vector (MDFV)	Machine learning method				
	SVM	CART	KNN	Naive Bayes	Random Forest
MDFV 4					
MDFV 5					
MDFV 6					

Object detection for a selected sub-region

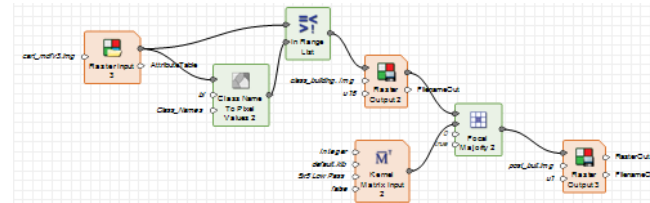
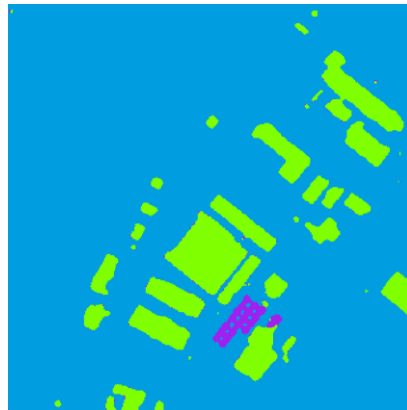
Spatial Model

*Best results achieved
via CART/MDFV3*

Remaining false
positive entries

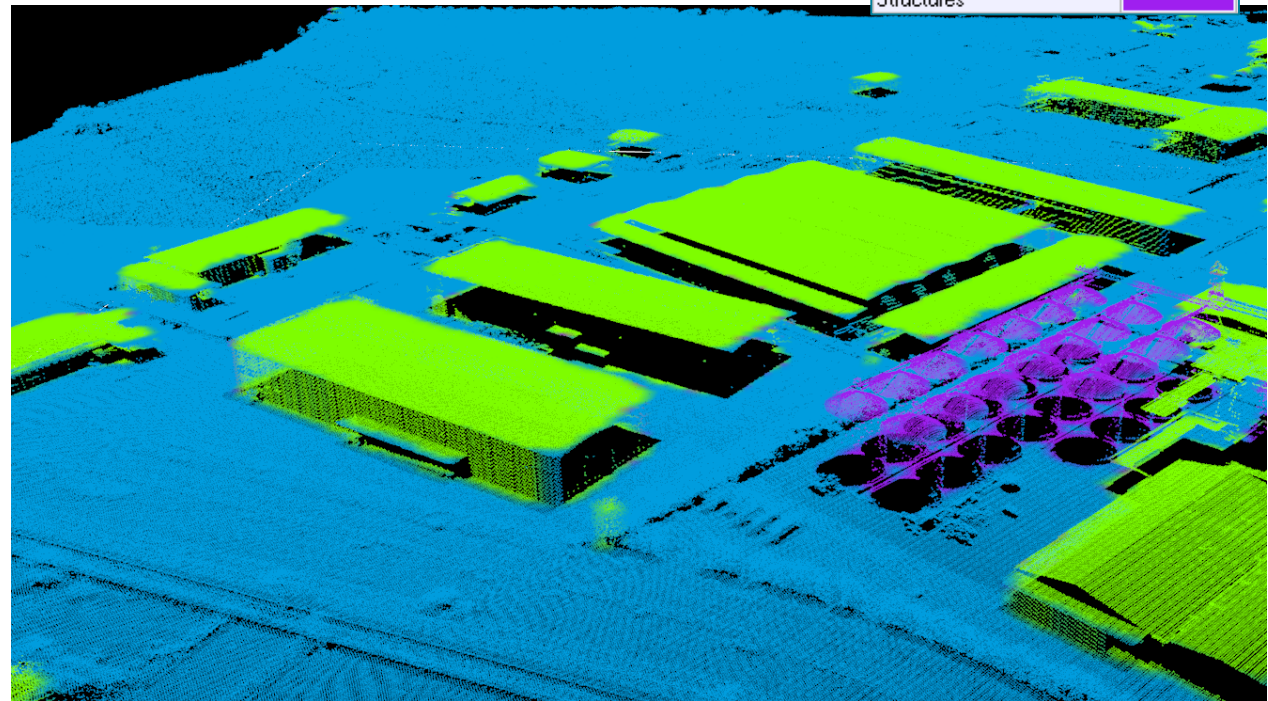


Majority voting filter

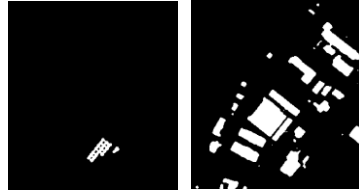


Coloured ALS point clouds using the classified image

Buildings	Green
Ground	Blue
Structures	Purple

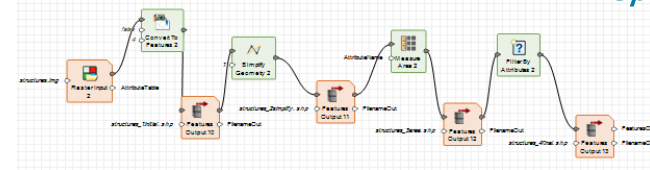


Selection of pixels for the classes:
"Buildings" and "Structures"



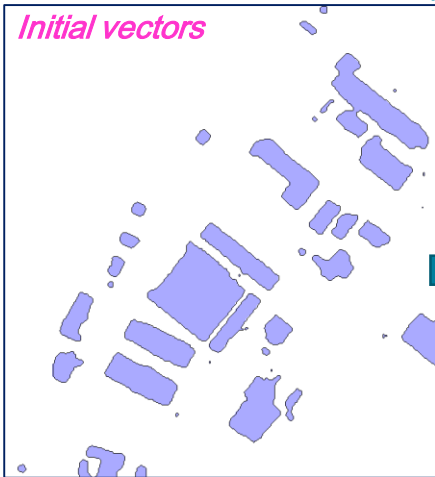
Object detection for a selected sub-region

Spatial Model

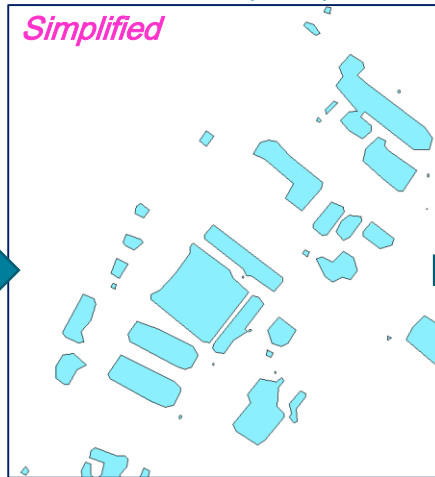


BUILDINGS: Raster to Vector process + automatic post-processing

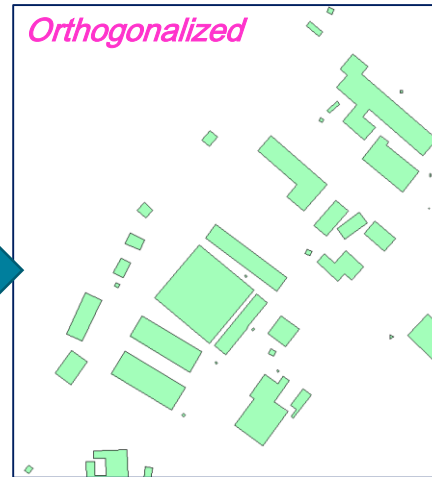
Initial vectors



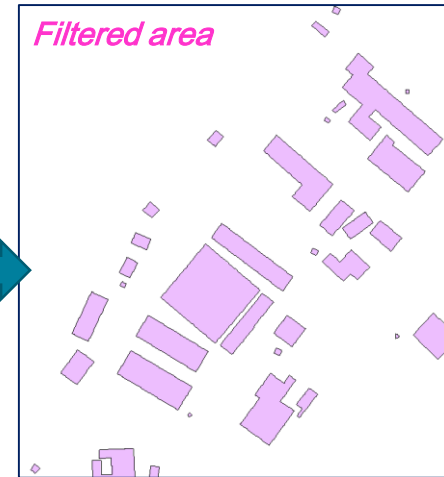
Simplified



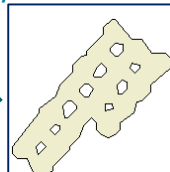
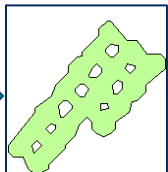
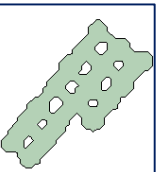
Orthogonalized



Filtered area



STRUCTURES: Raster to Vector process + automatic post-processing



Initial vectors

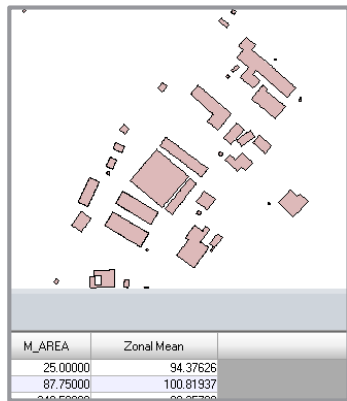
Simplified

Filtered area

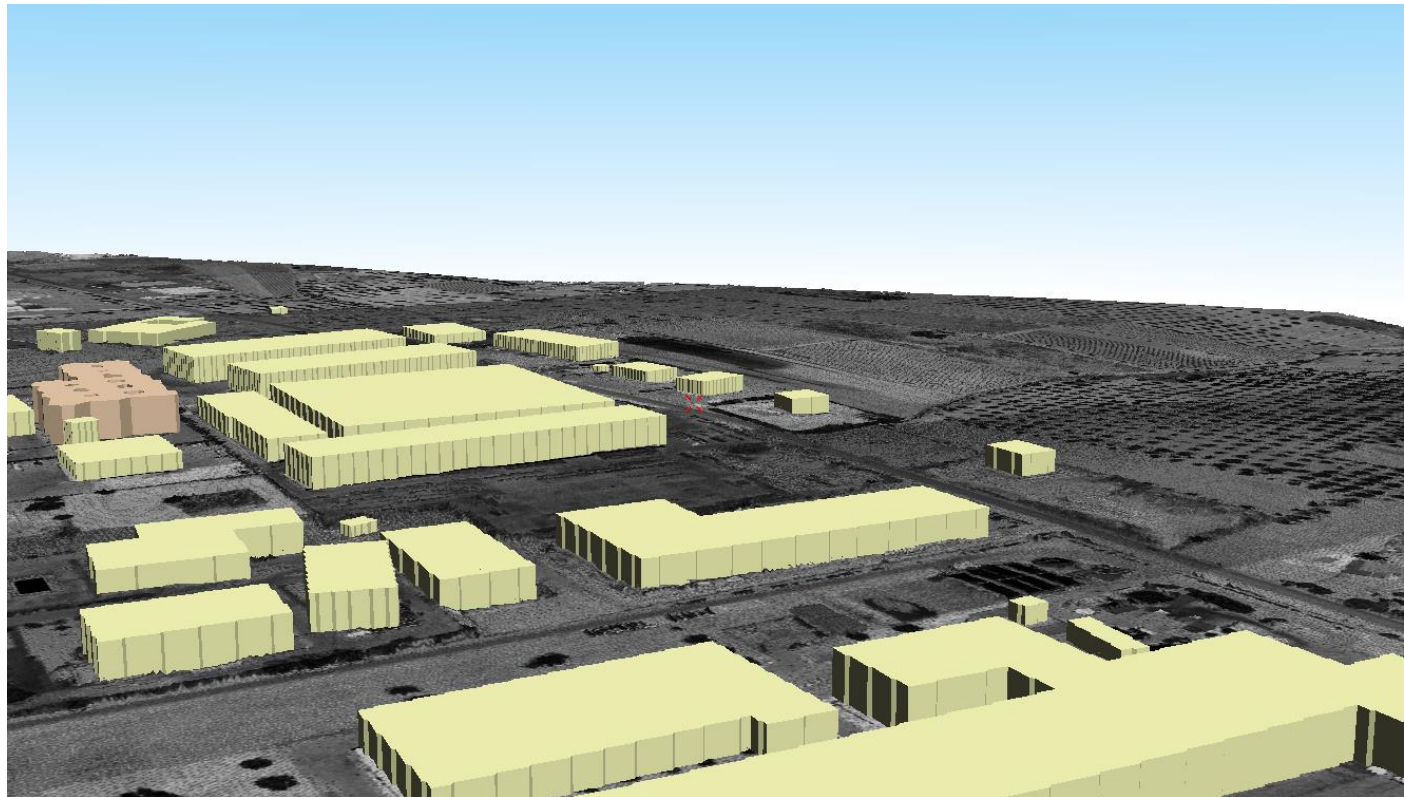
Object detection for a selected sub-region

3D models of "Buildings" and "Structures"

Zonal statistics to derive the height information from the nDSM



Filtered area





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innovation,
community,
technology





**Thank you for
your attention**

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