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EMBRACING OUR SMART WORLD WHERE THE CONTINENTS CONNECT:
ENHANCING THE GEOSPATIAL MATURITY OF SOCIETIES

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Advantages of Identifying Urban Footprint using Sentinel-1

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Study

- **urban monitoring** - an increasing number of people in urban areas → the major cities are growing (from 2011 to 2050 world's urban population is expected to grow from **3.6** billion to **6.3** billion and 83 % of governments are concerned about their population distribution in the country)
- looking for a more **economic choice** to identify areas where large cities are developing
- using **open data** and **open source software** for satellite images

Study

- In Romania, **datasets** needed to assess the urban environmental quality - are often **unavailable for urban planning**
- the **Copernicus Sentinels** - the potential to provide high quality free of charge data capable of estimating parameters related to both **urban structure and environmental quality**

Copernicus

- European Program
- developed by European Space Agency (ESA)
- Sentinels – designed to monitor various elements of the Earth System in a fully operational manner

S1A/B: Radar Mission	3 Apr 2014 / 25 Apr 2016
S2A/B: High Resolution Optical Mission	23 June 2015 / 6 March 2017
S3A/B: Medium Resolution Imaging and Altimetry Mission	16 Feb 2016 / Q1 2018
S4A/B: Geostationary Atmospheric Chemistry Mission	2021/2027
S5P: Low Earth Orbit Atmospheric Chemistry Mission	Oct 2017
S5A/B/C: Low Earth Orbit Atmospheric Chemistry Mission	2021/2027
S6A/B: Altimetry Mission	2020/2025

(adapted from ESA)

SENTINEL 1

- radar mission
- two satellites - Sentinel-1A and Sentinel-1B
- images of the Earth's surface regardless the weather conditions
- day or night images
- 6-day revisit

Statistics (1)

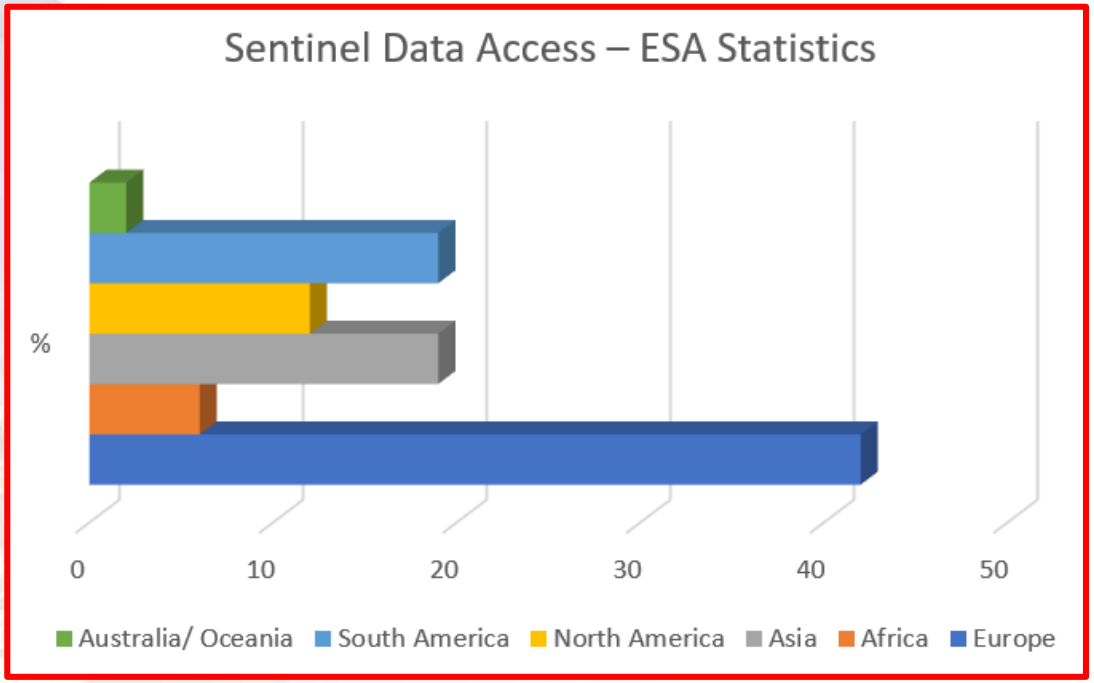
Google Trends | Explorați

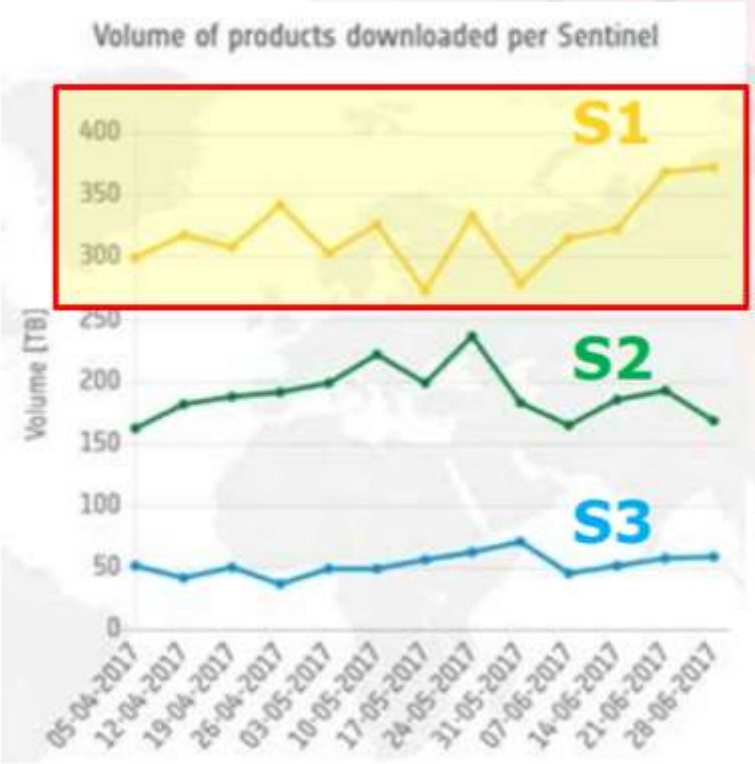
Sentinel-1A — Întreaga lume, Ultimele 12 luni

Interesul în funcție de regiune — Regiune

1	Austria	100
2	India	56
3	Brazilia	52
4	Canada	39
5	Regatul Unit	39

Statistics (2)





(adapted from ESA)

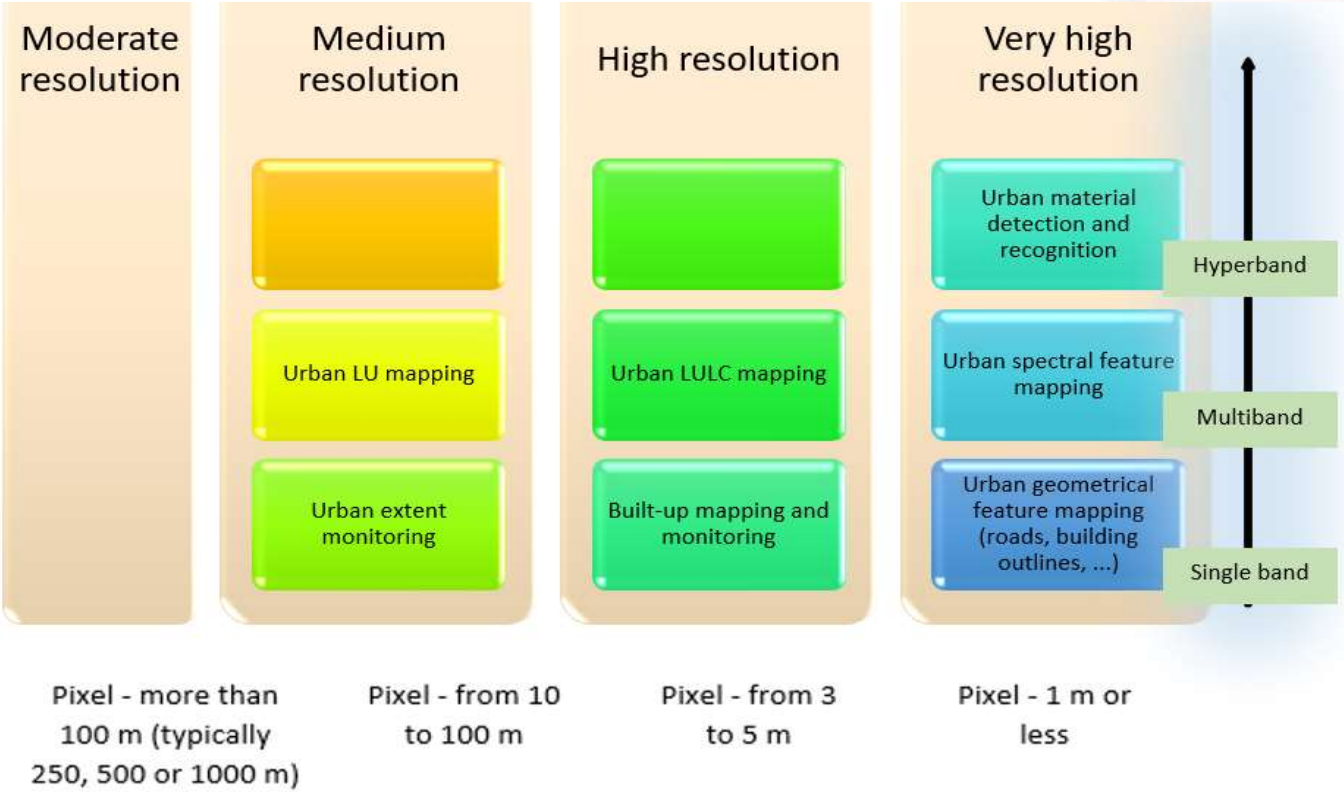
SENTINEL 1 parameters

Satellite	Sentinel-1
Centre Frequency (GHz)	5.405
Polarization	VV
Incidence angle range	29.1 - 46
Swath Mode	Interferometric Wide swath (IW)
Swath width(km)	250
Spatial resolution (single look)(m)	5 × 20
Product used	Level-1 SLC Product

SENTINEL 1 Data Products

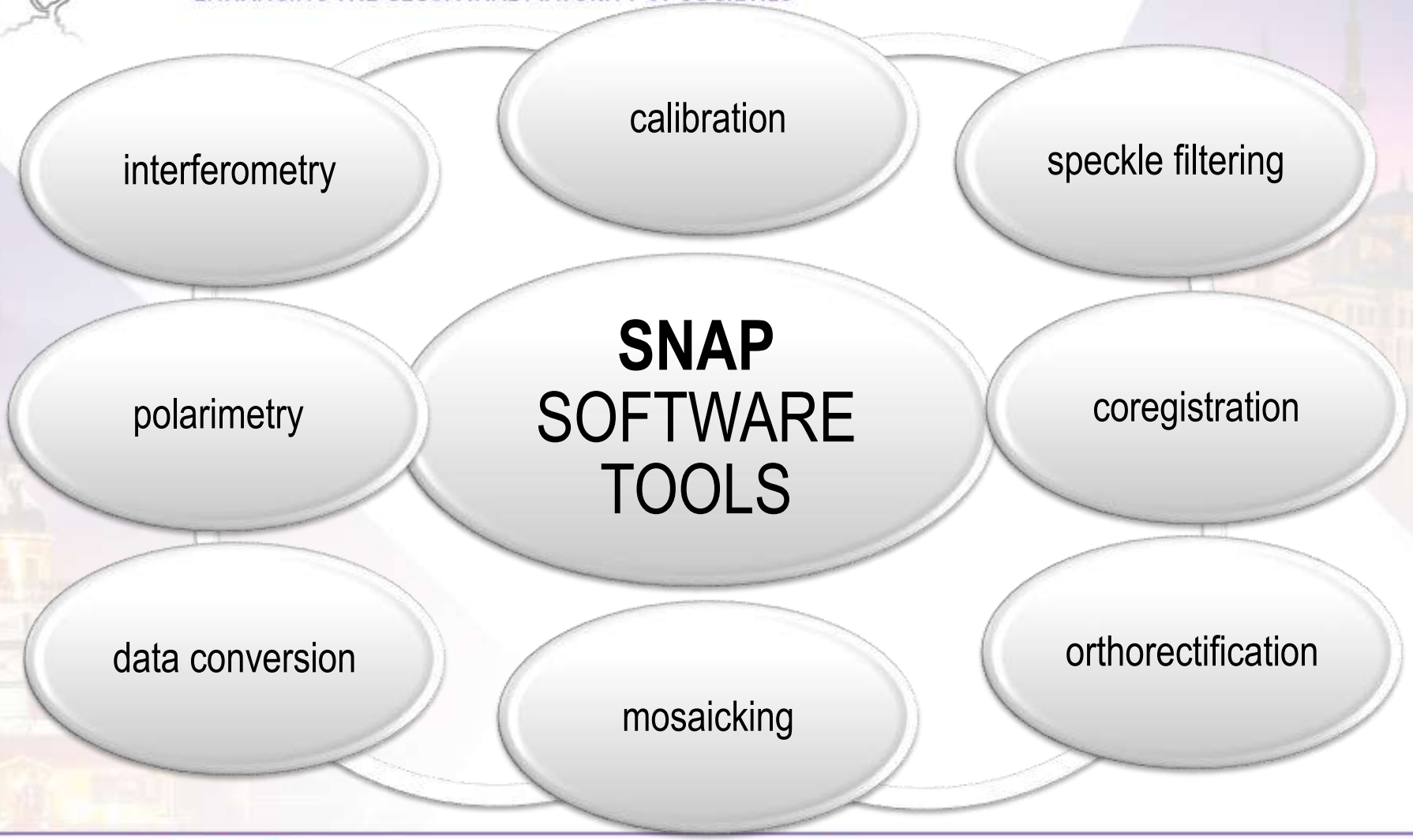
- focused SAR data
- geo-referenced using orbit and attitude data from the satellite
- provided in slant-range geometry (natural radar range observation coordinate, defined as the line-of-sight from the radar to each reflecting object)

Correlation between spatial and spectral resolution of EO data and the mapping task



CASE STUDY

- images for free - ESA through Sentinels Scientific Data Hub
- software for free - SNAP, Sentinel-1 Toolbox (S1TBX) - by ESA


interferometry
calibration
speckle filtering
polarimetry
SNAP
SOFTWARE
TOOLS
coregistration
data conversion
mosaicking
orthorectification

MAIN TYPES OF CHANGE DETECTION ALGORITHMS

- extraction of detailed from-to change information using post-classification comparison algorithm
- unsupervised change detection
- change detection using multichannel SAR images
- speckle reduction in the context of change detection
- change detection using polarimetric SAR images
- spatio-contextual change detection
- the fusion of SAR and optical images for change detection
- change detection by combining feature-based and pixel-based techniques
- object-based change detection
- comparison of multitemporal images

(according with Yousif, O., 2015)

Case Study (1)

- in and around Bucharest, capital of Romania
- population of Bucharest in 2017 – 1,826,506 people

Rezultatele cautarii - Populatia rezidenta la 1 ianuarie pe grupe de varsta si varste, sexe si medii de rezidenta, macroregiuni, regiuni de dezvoltare si judete				
Varste si grupe de varsta	Sexe	Medii de rezidenta	Macroregiuni, regiuni de dezvoltare si judete	Ani Anul 2017 UM: Numar persoane Numar persoane
Total	Total	Urban	Municipiul Bucuresti	1826506

Rezultatele cautarii - Populatia rezidenta la 1 ianuarie pe grupe de varsta si varste, sexe si medii de rezidenta, macroregiuni, regiuni de dezvoltare si judete				
Varste si grupe de varsta	Sexe	Medii de rezidenta	Macroregiuni, regiuni de dezvoltare si judete	Ani Anul 2017 UM: Numar persoane Numar persoane
Total	Total	Total	Ilfov	460355

(according with http://statistici.insse.ro)

Case Study (2)

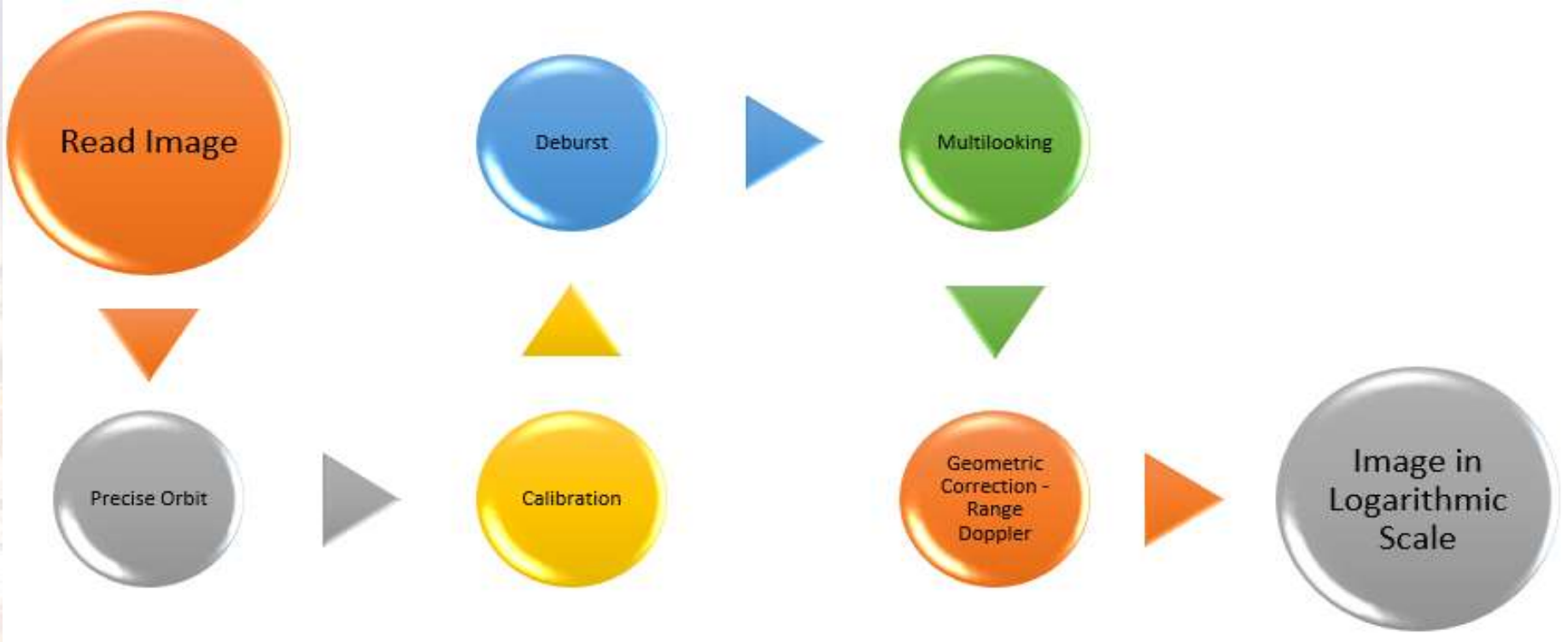
- the reference data for the administrative boundaries - INIS geoportal – Romanian National Agency of Cadastre and Land Registration

Case Study (3)

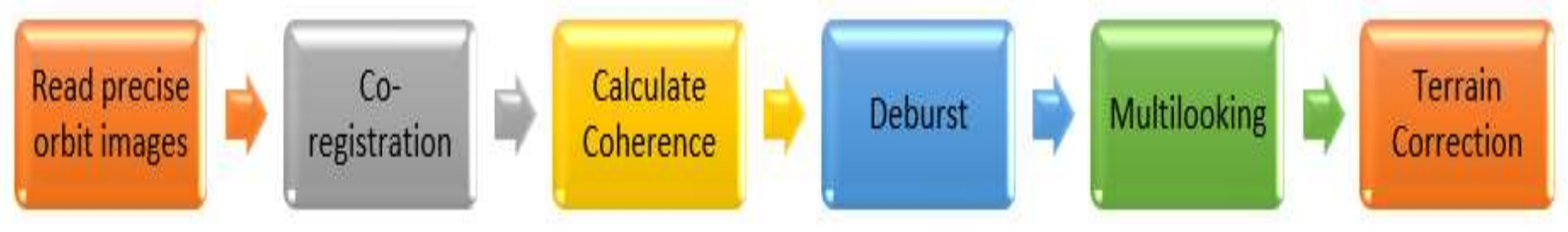
- Level-1 Single Look Complex (SLC) products with VV polarization
- IW mode - because bursts are synchronized from pass to pass to ensure the alignment of interferometric pairs

Parameter	Interferometric Wide-swath mode (IW)
Polarisation	Dual (HH+HV, VV+VH)
Access (incidence angles)	31° – 46°
Azimuth resolution	20 m
Ground range	5 m
Azimuth and range	Single
Swath	250 km
Maximum Noise-Equivalent Sigma Zero (NESZ)	-22 dB
Radiometric stability	0.5 dB (3cT)
Radiometric	1 dB (3cT)
Phase error	5°

Case Study (4) - Workflow for each image

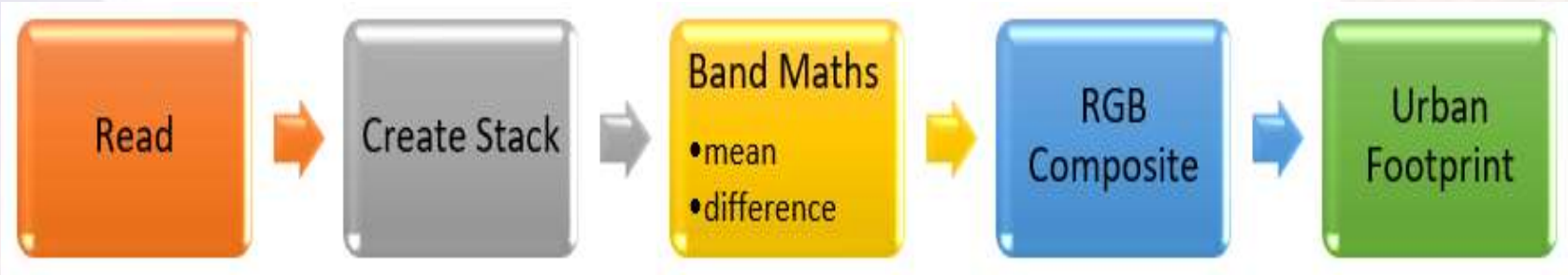


Case Study (5) - Workflow - Creating coherence image

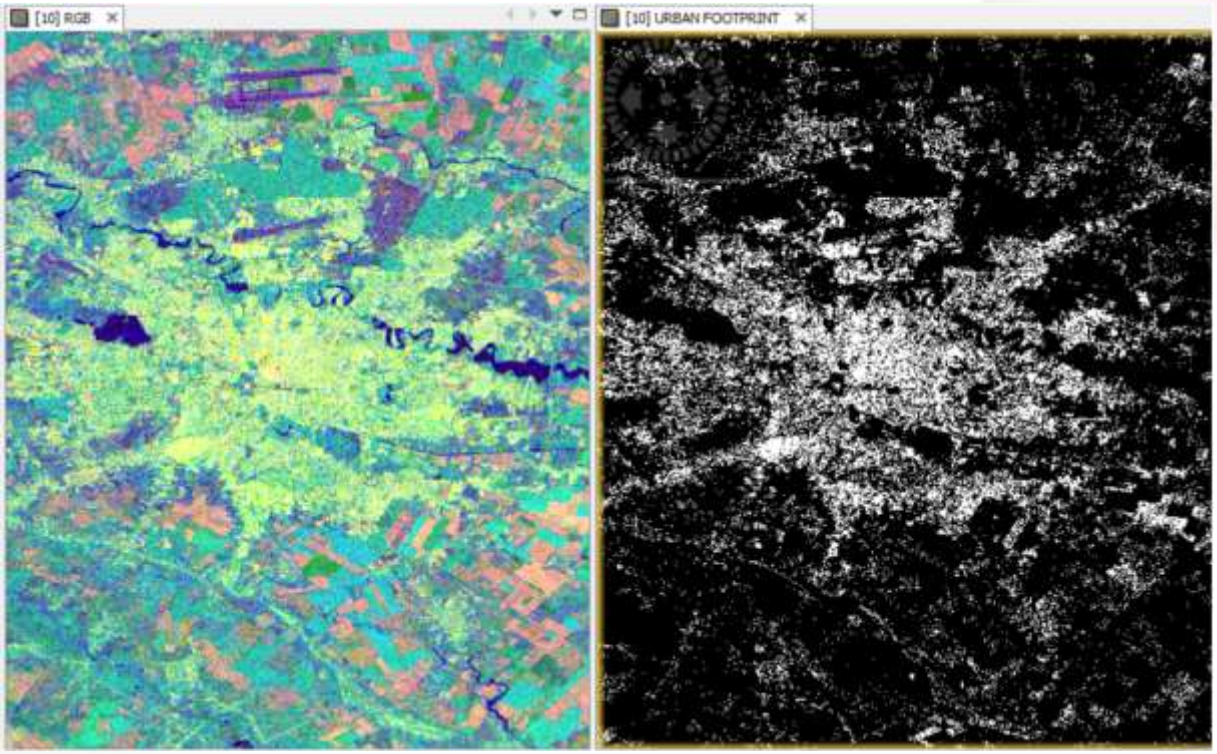


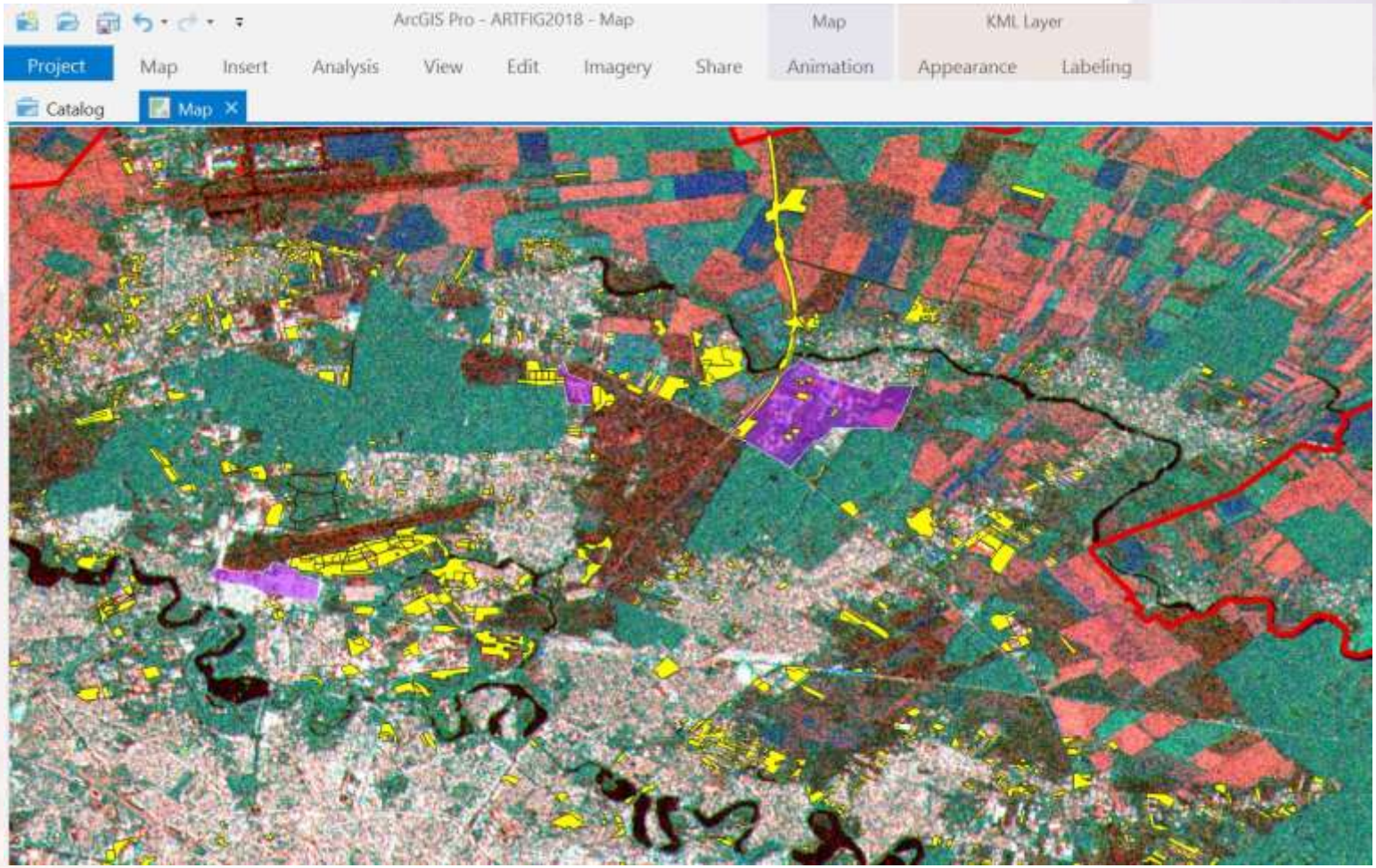
Co-registration process is used in order to combine two images having the same polarization and projection system, being **used mostly for InSAR processing**.

Case Study (6) - Workflow - obtaining the urban footprint



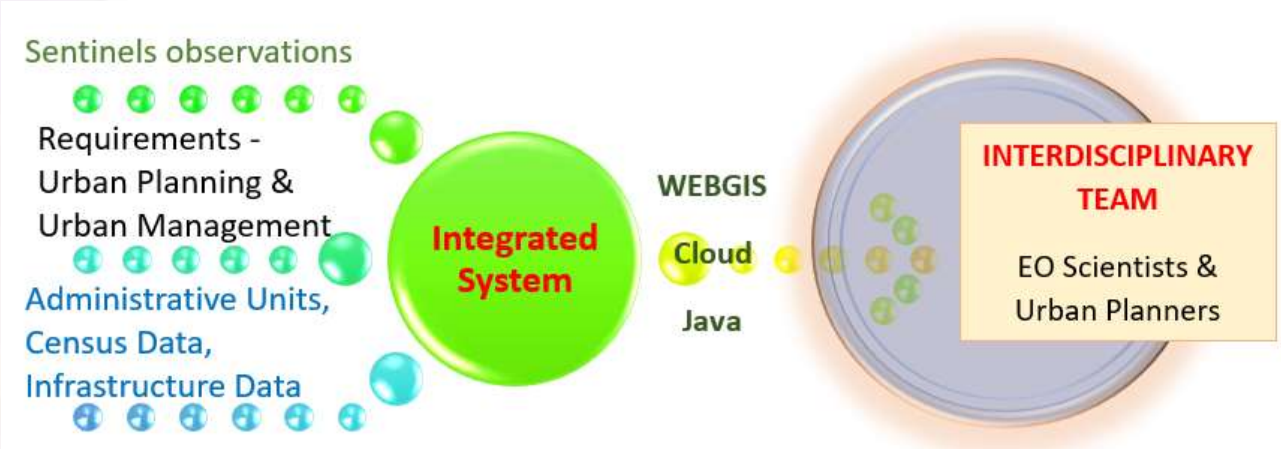
Case Study (7) - Results




ArcGIS Pro - ARTFIG2018 - Map
Map
KML Layer
Project
Map
Insert
Analysis
View
Edit
Imagery
Share
Animation
Appearance
Labeling
Catalog
Map

FUTURE WORK

- developing a system between earth observation (EO) scientists and Romanian urban planners
- identifying the derived geo-information products and services to support urban planning at city and regional scales
- fusion of multisource data



CONCLUSIONS – MAIN ADVANTAGES

- SAR's - capability to observe **during cloud cover**
- SENTINEL- 1's **frequent revisits**
- **monitoring resources -** a higher urbanization is the cause of environmental pollution, traffic congestion and the destruction of natural resources
- satellite imagery is **powerful** in demarcating **urban extents**
- satellite imagery can be used to provide **up-to-date geospatial information** on the spatial structure and boundaries of cities
- **timely information** on urban expansion provided by satellite imagery **is vital** in ensuring integrated spatial planning and land use management

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Thank you for your kind attention!

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