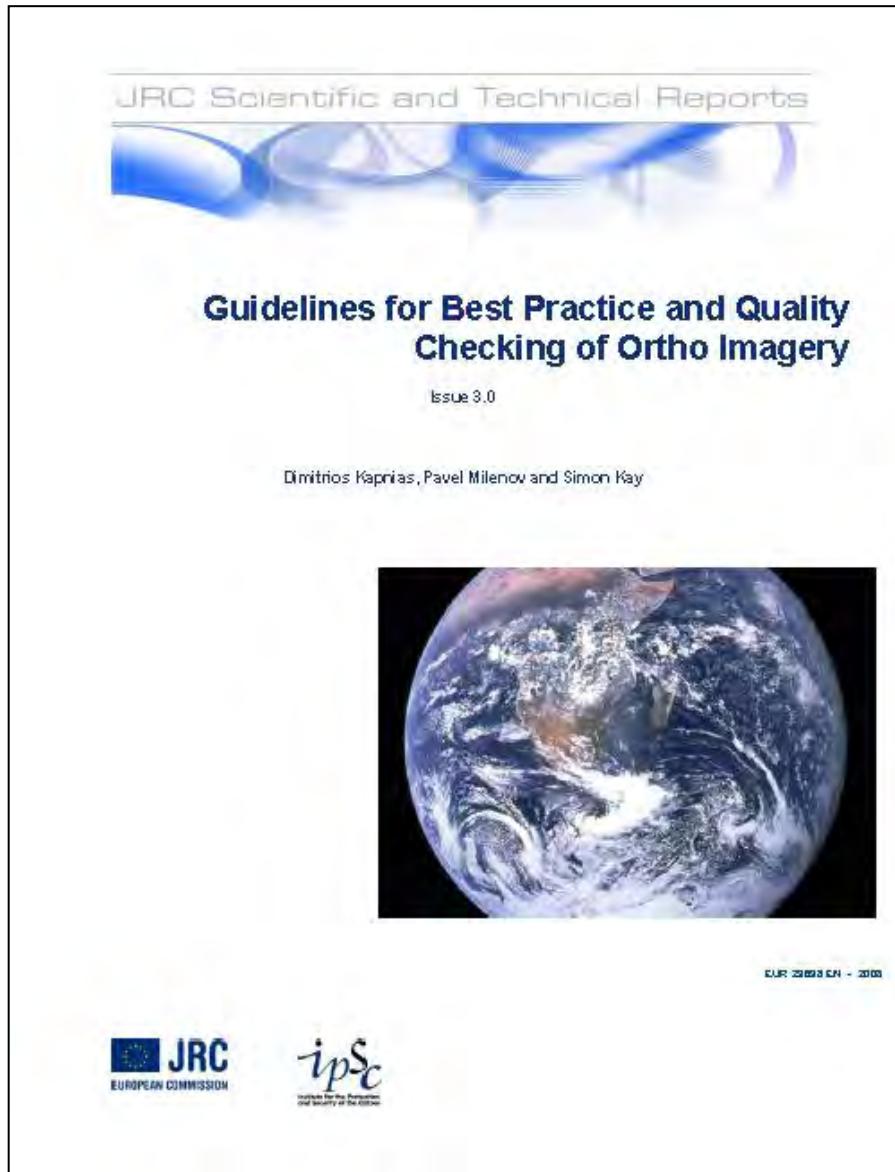


Sistema Informativo Agricolo Nazionale e la nuova PAC in HORIZON 2020

SIAN e le tecnologie per l'osservazione della terra

*Dottorato di ricerca in «Nuove tecnologie e informazione territorio-ambiente»
3 luglio 2013*



Land Parcel Identification System (LPIS)

The Land Parcel Identification System is a fundamental part of the Integrated Administration and Control System (IACS), aimed at technical implementation of the Common Agricultural Policy stipulated since the early 1990's.

Locating and measuring agricultural surfaces create wide-ranging difficulties for farmers who are not technically prepared for this task.

The LPIS allows the geographical identification of the agricultural parcels both by the administration and by the farmer.

Recently LPIS systems are no more strictly dedicated to support the aid declaration and subsequent control 's phase, but this data base is already broadly used by other external users.

In fact the reference parcels, together with the orthophotos and the attribute information on land use, make available the basic set of components, necessary for any land management decision

from: Wikicap - European Commission

Land Eligibility detection using updated and multitemporal ortho-imageries

Piano voli 2007 - 2009



Piano Voli 2010 - 2012



Annualità Ortofoto

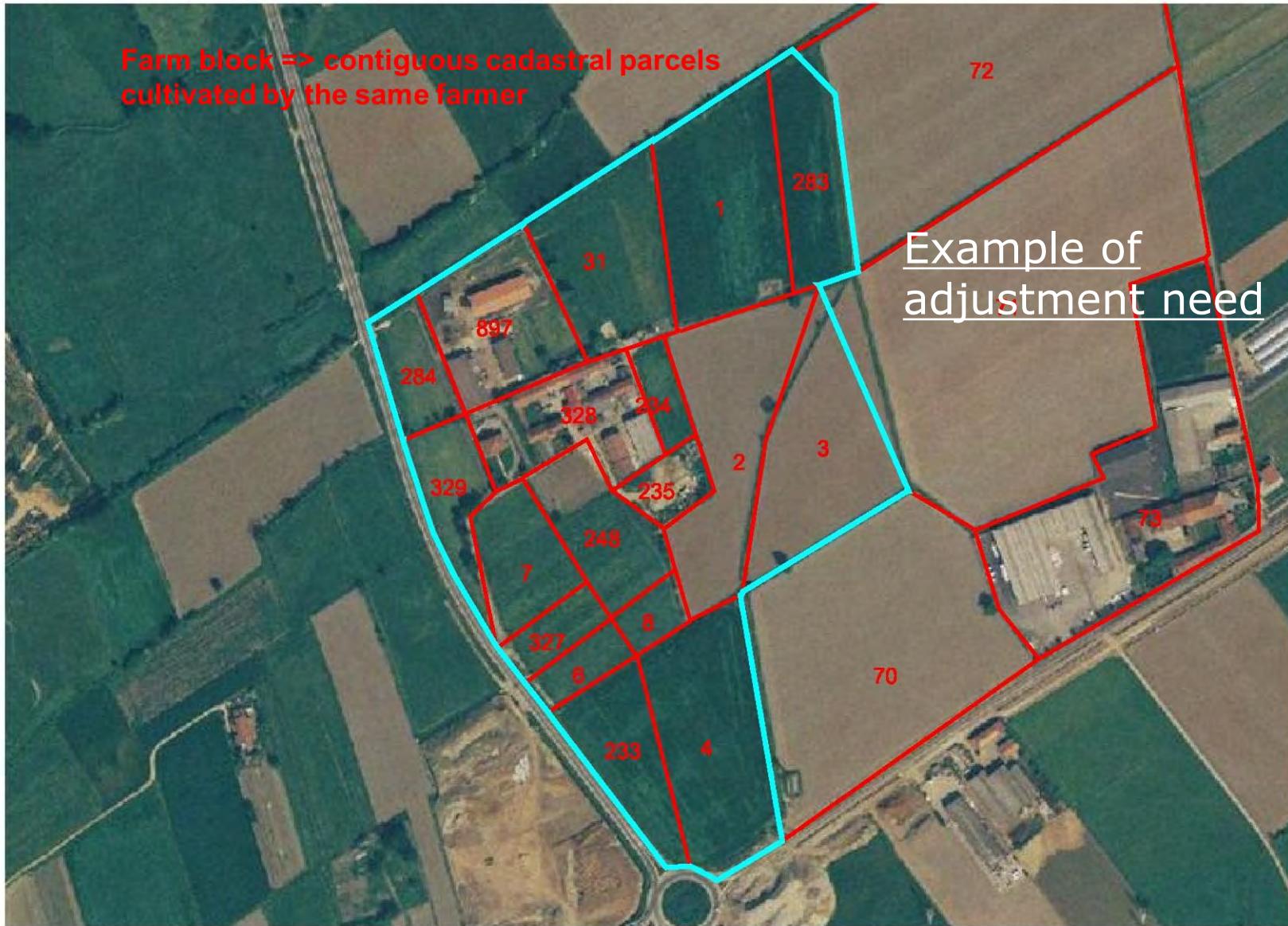
2007

2008

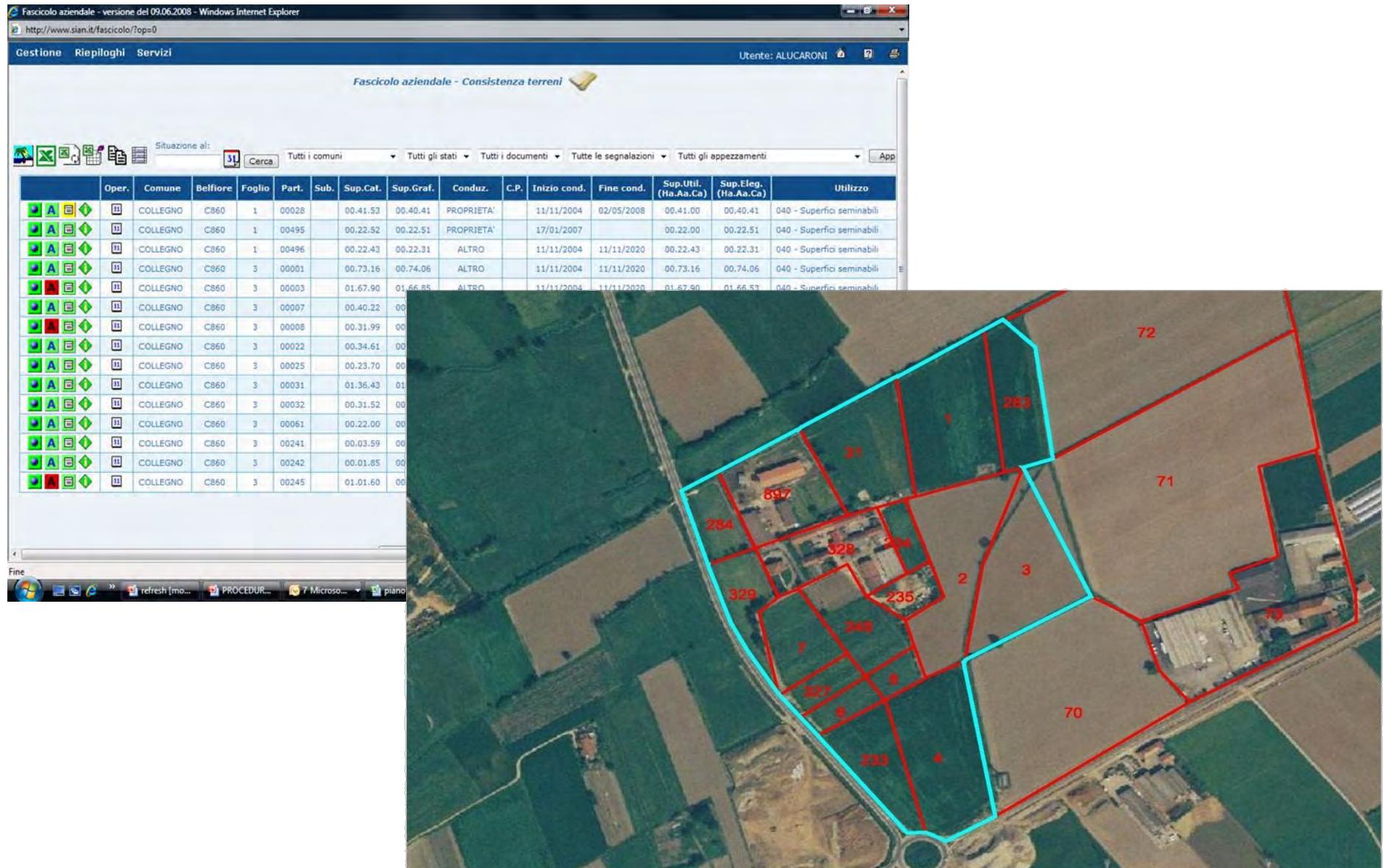
2009

2010

Eligible areas detection on single parcels



Farm Block consistency - Farm Register and LPIS



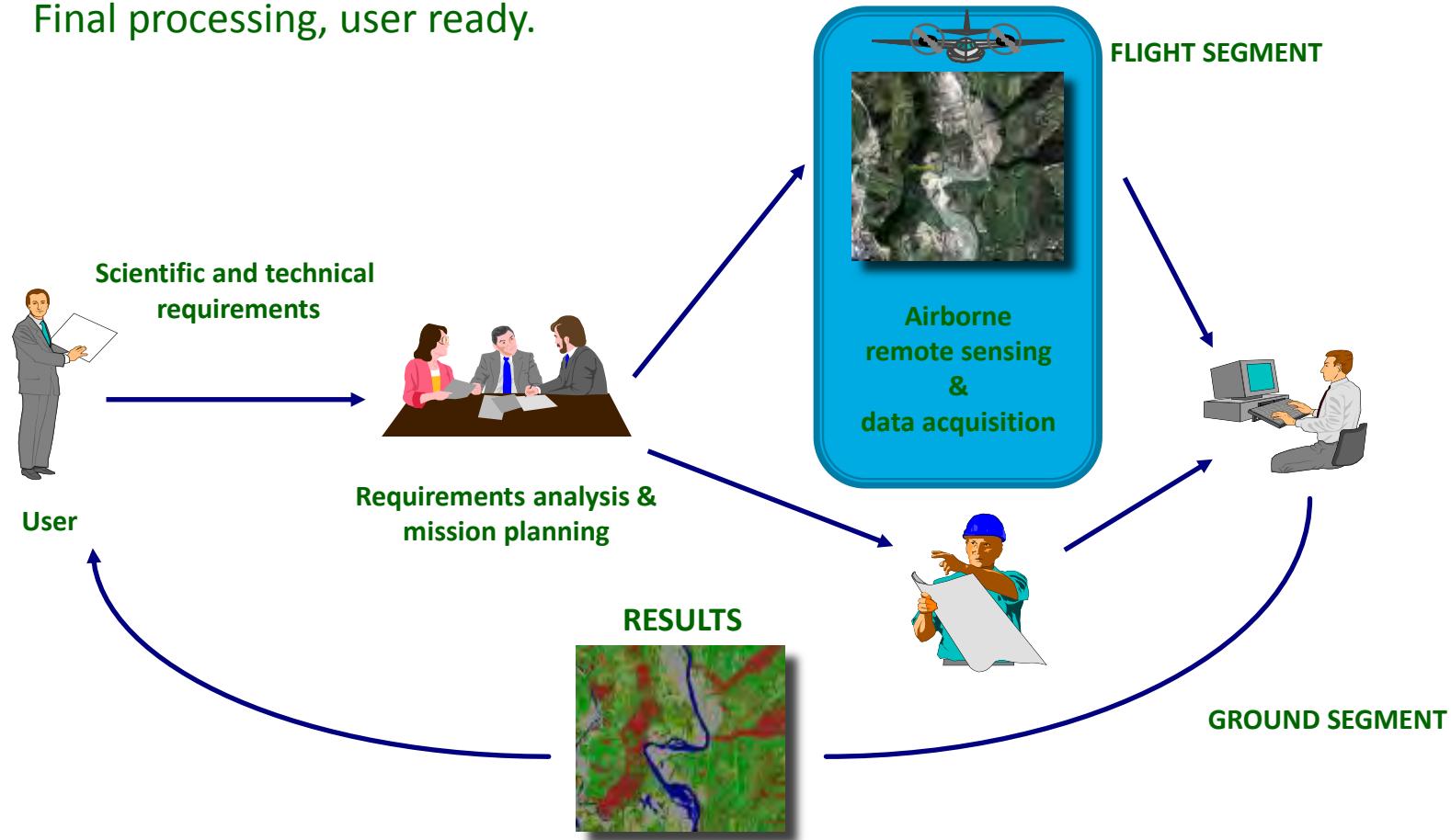
TELAER

Advanced remote sensing system

The Architecture System: flight and ground segment

Telaer is an integrated system able to manage entire production chains:

- Remote sensing mission planning,
- Data acquisition by a set of advanced sensors operating both in optical and radar mode,
- Final processing, user ready.



Flight segment

Partenavia AP 68TP600 "Viator"



- ❖ Engine type: turboprop aircraft
- ❖ Wingspan: 12 m
- ❖ Length: 11.27 m
- ❖ Height: 3.63 m
- ❖ Payload: 768 kg
- ❖ Maximum operating speed: 340 km/h
- ❖ Autonomy: 950 km

Learjet 35A



- ❖ Engine type : turbofan Garret T731
- ❖ Wingspan:: 12.03 m
- ❖ Length: 14.83 m
- ❖ Height: 3.73 m
- ❖ Payload: 1361 kg
- ❖ Maximum take-off mass : 8310 kg
- ❖ Maximum operating speed: ~800 km/h
- ❖ Autonomy: ~4000 km

The flight segment - Qualified configurations

Partnenavia AP 68TP600 "Viator"



Learjet 35A



❖ Optical configuration:

Multispectral (Daedalus) o Hyperspectral (Sim.Ga Selex Galileo) o Lidar o Zeiss / UltraCam X photogrammetric camera

Multispettrale (Daedalus) Iperspettrale (Sim.Ga Selex Galileo)

❖ Optical configuration :

Multispectral (Daedalus) o Hyperspectral (Selex Galileo) Zeiss o UltraCam X photogrammetric camera

Trimble AIC cameras

❖ SAR configuration:

X SAR

❖ Combined configurations:

X SAR

Zeiss o UltraCam X photogrammetric camera

Trimble AIC cameras

Optical sensors

Photogrammetric camera (analog) Zeiss RMK-TOP 15 e TOP 30

- ❖ Forward Motion Compensation (FMC)
- ❖ Focali 153 and 300 mm
- ❖ Formato 23 x 23 cm
- ❖ Esposizione manuale e automatica
- ❖ Magazzino per 200 foto
- ❖ Supporto girostabilizzato



AC Trimble Dual oblique

Caratteristiche tecniche:

- | | |
|---------------------------|-----------------|
| ❖ Immagini Pancromatriche | 8984*6730 pixel |
| ❖ Pixel size | 6 µm |
| ❖ Focale | 100mm |
| ❖ Dimensione immagine | 53.90mm*40.39mm |
| ❖ Bit immagine output | 8 / 16 |
| ❖ Risoluzione | RGB |



Photogrammetric camera (digital) Ultracam Vexcel Xp

Caratteristiche tecniche:

- | | |
|---------------------------|-------------------|
| ❖ Immagini Pancromatriche | 17310*11310 pixel |
| ❖ Pixel size | 6 µm |
| ❖ Focale | 100mm |
| ❖ Dimensione immagine | 103.9mm*68.4mm |
| ❖ Bit immagine output | 8/16 |
| ❖ Risoluzione | RGB / Near IR |



SAR (Synthetic Aperture Radar) sensor

Telaer System – X band SAR up to 0,5m resolution

- ❖ Antenna with horizontal polarization to 45° direction and double function of transmission and reception
- ❖ Operating frequency: 9.35 – 9.75 GHz (X band)
- ❖ Effective band-width: 50 – 400 MHz
 - ❖ off nadir angle range: 20° – 70°
 - ❖ peak sidelobe ratio: -26 dB
 - ❖ integrated sidelobe ratio: -16 dB
- ❖ Repetition frequency (PRF): fino a 16 kHz
- ❖ Dynamic range: 120 dB
- ❖ Operating height to 8400 m
- ❖ Operating airplane speed 110 – 210 m/s



Daedalus multispectral sensor

Data system enhancements:

- * 16 - 128 Channels, 16 bit A/D per channel.
- * Removable disk recording.
- * Ortho-Rectified output: GIS compatible imagery.
- * Advanced software processing tools.
- * Color touch screen GUI interface or remote control.
- * Significant reductions in size, weight and power.
- * Ethernet port.

Band	Band Edges
1	0.43 - 0.45 μm
2	0.48 - 0.50 μm
3	0.50 - 0.52 μm
4	0.52 - 0.54 μm
5	0.54 - 0.56 μm
6	0.56 - 0.58 μm
7	0.58 - 0.61 μm
8	0.61 - 0.64 μm
9	0.65 - 0.68 μm
10	0.68 - 0.72 μm
11	0.72 - 0.78 μm
12	0.78 - 0.84 μm
13	0.84 - 0.92 μm
14 SWIR	1.55 - 1.75 μm
15 SWIR	2.08 - 2.35 μm
16 LWIR	8.5 - 12.5 μm

Visible

Near Infrared

Thermal Infrared



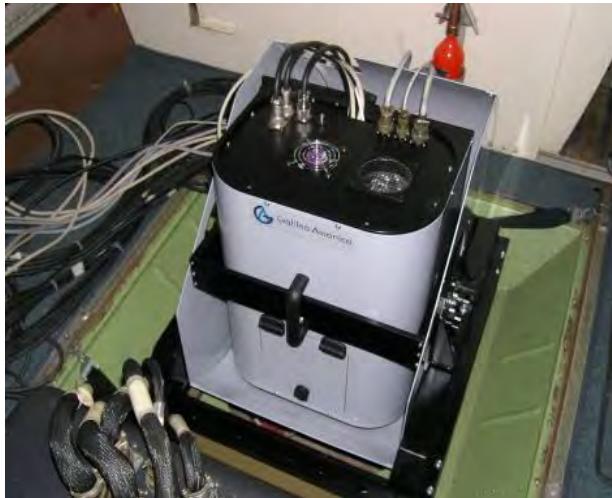
Data Digitization / Recording

ArgonST Inc Proprietary Information



Scan Head & Spectrometer

SIM-GA hyperspectral sensor



	VNIR Spectrometer	SWIR Spectrometer
Spectral Range	400-1000nm	1000 –2450nm
Spectral Sampling	1.2nm	5.8nm
Spectral bands	512	256
Spatial pixels	1024	320
IFOV per pixel	0.7mrad	1.3mrad
FOV	±19.8°	±12.04°
GSD@H=1000m	0.7m	1.3m
SWATH@H=1000m	700m	425m
Digital resolution	12 bit	14 bit
Operating Frame Rate	54 Hz	27 Hz
Operating Data Rate	54MB/s	4.2MB/s
Storage Capacity	600GB	
Autonomy	3h	
H/v	>26s	

LIDAR (Light Detection Ranging) Sensor



Parametri	Caratteristiche
• Operatività	tra 100 m e 3.000 m di quota di volo relativa
• Accuratezza orizzontale (1 sigma)	migliore di 12.000 della quota di volo relativa
• Accuratezza verticale (1 sigma)	±15 cm a 1.200 m circa di quota relativa ±25 cm a 2.000 m circa di quota relativa ±35 cm a 3.000 m circa di quota relativa
• Acquisizioni all'impulso	2 milioni per ciascun impulso (Flight & Look pulse)
• Acquisizioni dell'intensità	12 bit dinamici per ciascuna misura
• Angolo di scansione	variabile da 0° a ±30° con incrementi di 1°
• Alimentamento	variabile da 0 a 0.70 x la quota relativa (m)
• Sistema GPS integrato	Applanix POS AV 510 ed antenna GPS Novatel M1000 a 12 canali con acquisizione dei segnali ogni 0.5 secondi
• Frequenza di scansione	33.000 Hz (33.000 punti al secondo)
• Data storage	Hard drive 100 MHz rimovibile (10 ore di registrazione)

Remote Sensing Services and Applications

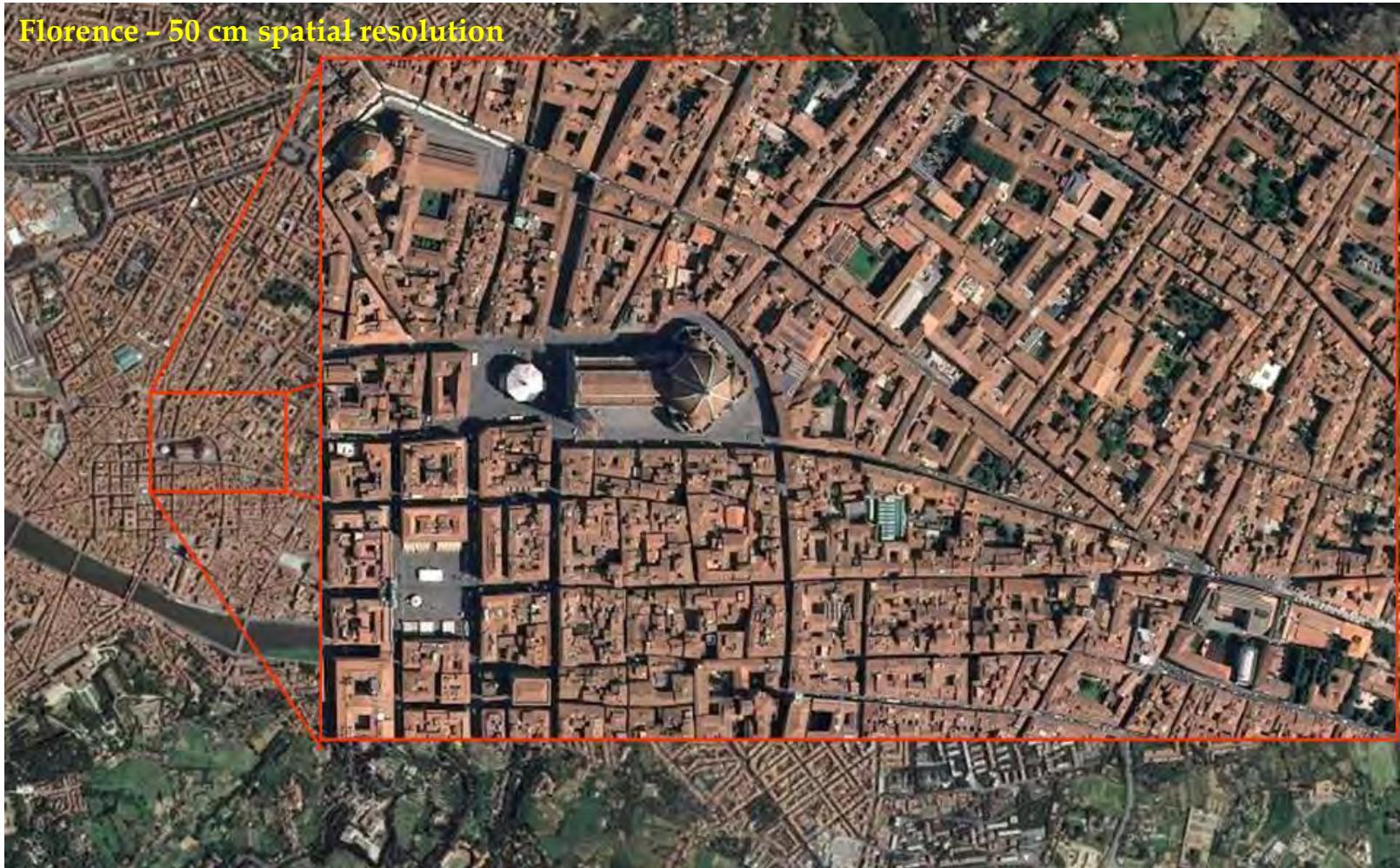
Services and geo-applications

Used Sensors and systems

Services and Applications		Laser Scanner	X-SAR	Sims. Ga.	Hyperspectral	Multispectral	Dedalus	Oblique Camera	Digital Camera
Digital orthophoto production, scale range 1:10.000 – 1:2.000									
Digital elevation model									
Cartographic elements extraction									
Land use / Land cover map									
Urban monitoring and applications									
Agriculture and precision farming									
Landfill and quarry monitoring									
Oil spill detection and mapping									
Water quality observations									
Thermal maps									
Thematic maps									
Forest inventory									
Fire detection and mapping									
Landslide risk monitoring									
Geothermal and volcanic applications									
Geologic mapping									
Rapid Mapping									
Fishing and aquaculture									



Digital basic orthophoto



Digital basic orthophoto

PRODUCT DESCRIPTION	
Spectral bands	Visible (RGB) + NIR
Geometric resolution and pixel dimension (gsd)	cm 50
Radiometric resolution	8 bit for pixel (every band)
Cartographic reference scale	1:10.000
Overlap	60% - 70%
Sidelap	10% - 20%
Residual cloudiness	Standard for agricultural purposes ≤ 5% (block of acquisition) ≤ 15% (single orthophoto)
Georeferencing	UTM/WGS84 [<i>in the prevailing fused one in the area</i>]
Format image	Compressed format ECW
Run-time flights	From April to August
License	Classified to the subjects included in Regulations AGEA for the supply of orthophoto

Digital enhanced orthophoto



Digital enhanced orthophoto

PRODUCT DESCRIPTION	
Spectral bands	Visible (RGB) + NIR
Geometric resolution and pixel dimension (gsd)	cm 20
Radiometric resolution	8 bit for pixel (every band)
Cartographic reference scale	1:5.000
Overlap	65% - 75%
Sidelap	35% - 45%
Residual cloudiness	Standard for agricultural purposes ≤ 5% (block of acquisition) ≤ 15% (single orthophoto)
Georeferencing	UTM/WGS84 [<i>in the prevailing fused one in the area</i>]
Format image	Compressed format ECW
Run-time flights	From April to August
License	Classified to the subjects included in Regulations AGEA for the supply of orthophoto

Multi-purpose products

The Vexcel Ultracam X digital camera (0.4 - 0.9 microns) makes it possible to have medium and very high resolution survey both in panchromatic and multispectral mode (from blue to near-infrared).

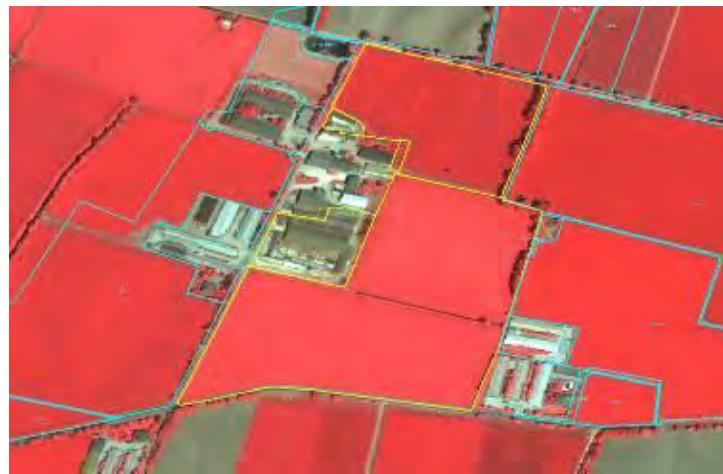
Digital acquisitions makes it possible to optimize the orthophotos production times and to return a multi-purpose product (color and false colour infrared for agriculture and vegetation in general). Consolidated functions of "pansharpening" create natural colour and infrared false color images



Digital Image in false colour with infrared band at 0,5 m spatial resolution – farming area mixed sown-pasture-forest

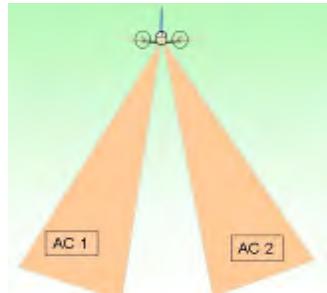


Photo-interpretation for the identification of agricultural parcels



Digital Image in false colour with infrared band – parcel geo-definition

Rollei Camera ortophoto



ROLLEI OBLIQUE CAMERA



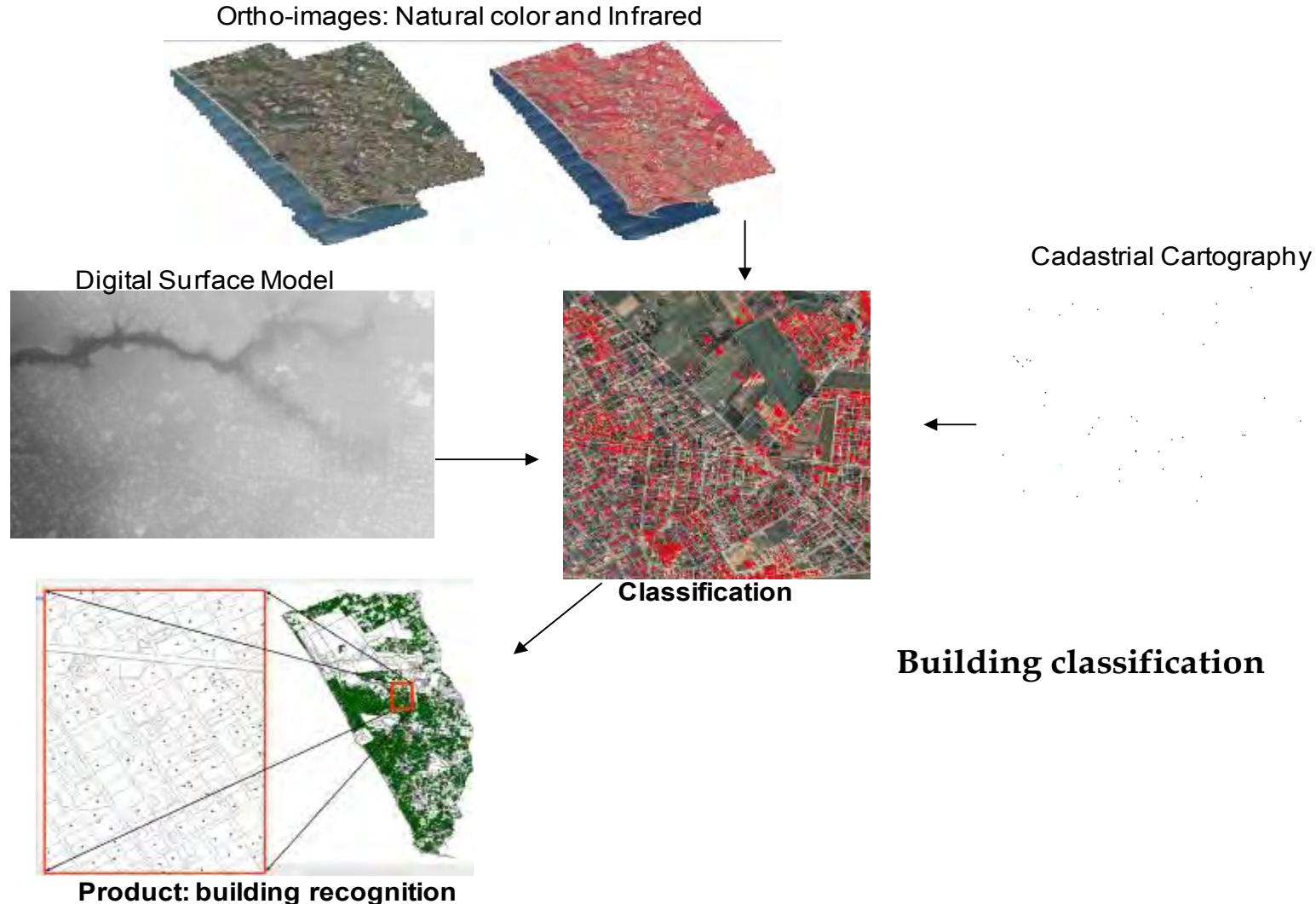
VEXCEL PHOTO-CAMERA

Terni Urban Area

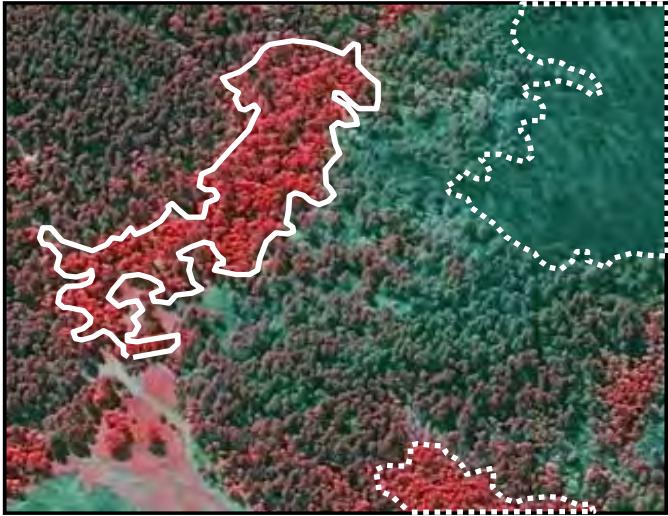
Rollei Camera ortophoto



Cartography and urban monitoring



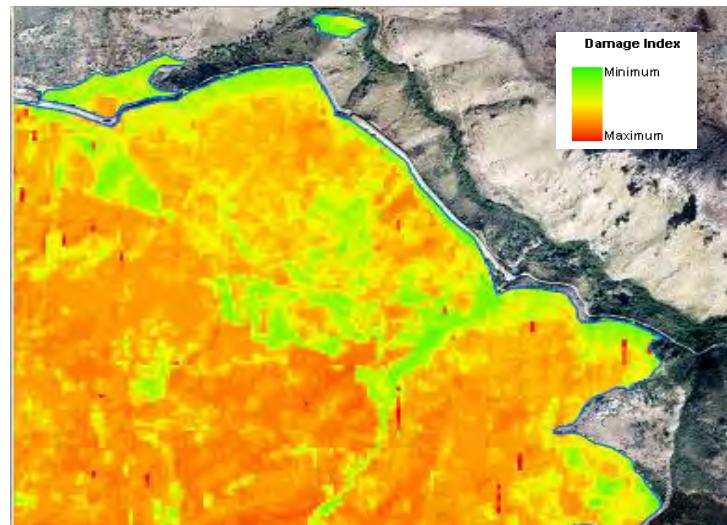
Fire detection and mapping



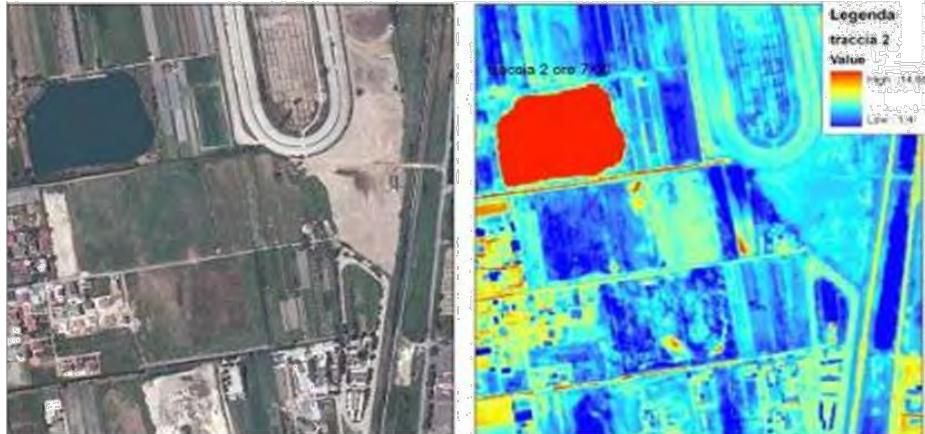
Determination of the damage on cadastral basis, estimation of the event entity and natural environmental heritage loss. Identification and mapping of the different types of damage inside of the areas affected by fire, using techniques based on photo interpretation and semi-automatic classification.

Geographic identification of burned areas and their typology for assessing the damages.

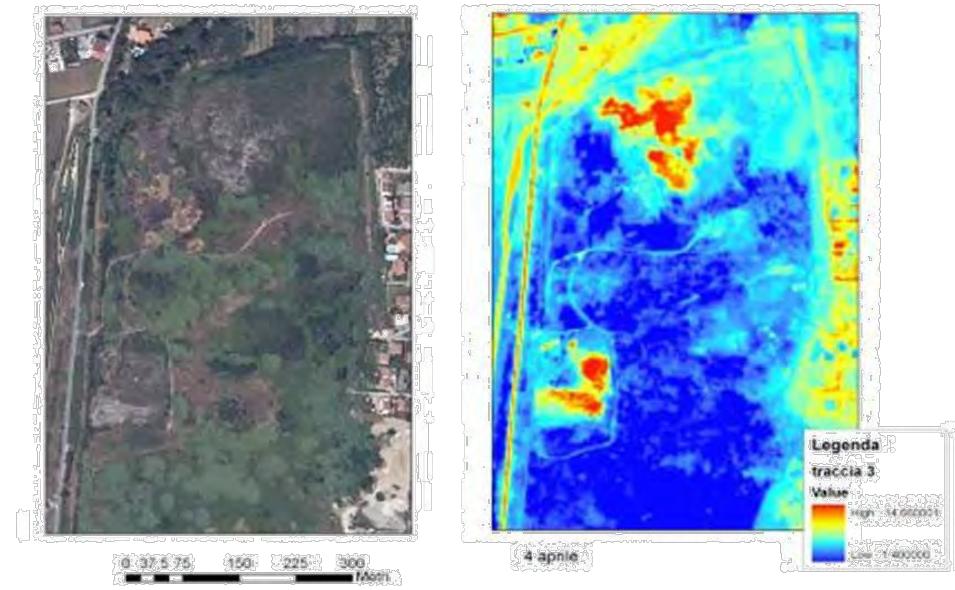
Mapping of the vegetation damage and the vegetative regrowth using high-definition spectral sensors. Identification of the type of woodland and forest, in order to evaluate the actual wood surface, in association with damage index: the actual loss of heritage and natural landscape could be determined.



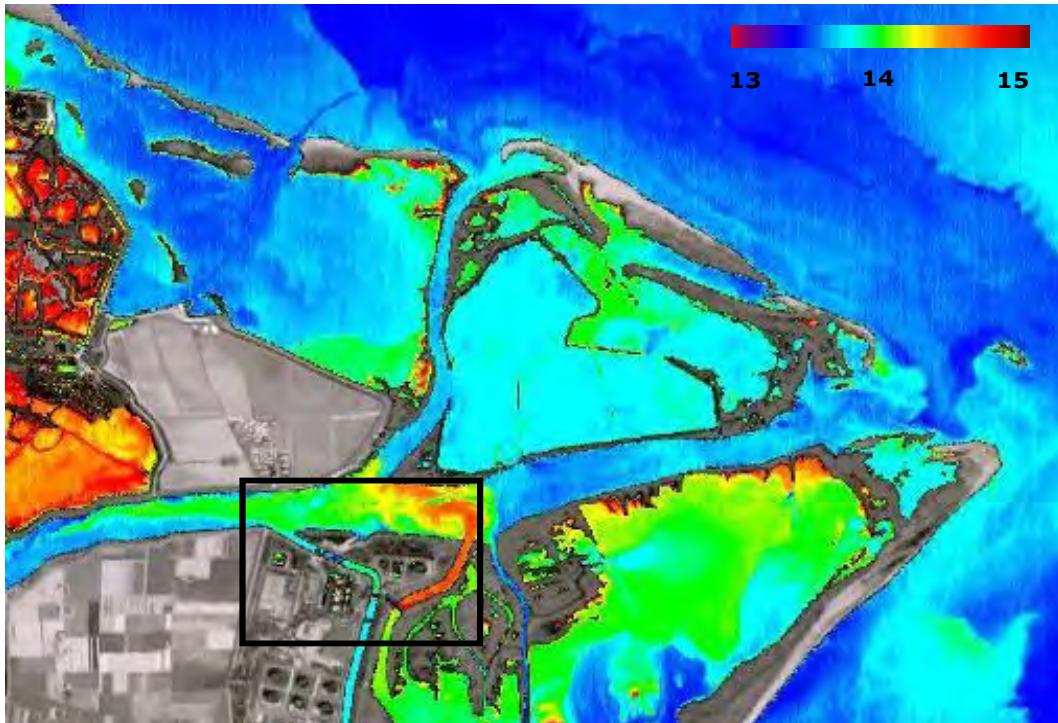
Landfill identification and monitoring



Active and inactive quarries are often transformed in landfills (authorized and not). Identification of suspicious areas through thermal anomalies by multispectral data with thermal band.
Identification and classification of areas that are often not visible and not accessible.



Thermal maps



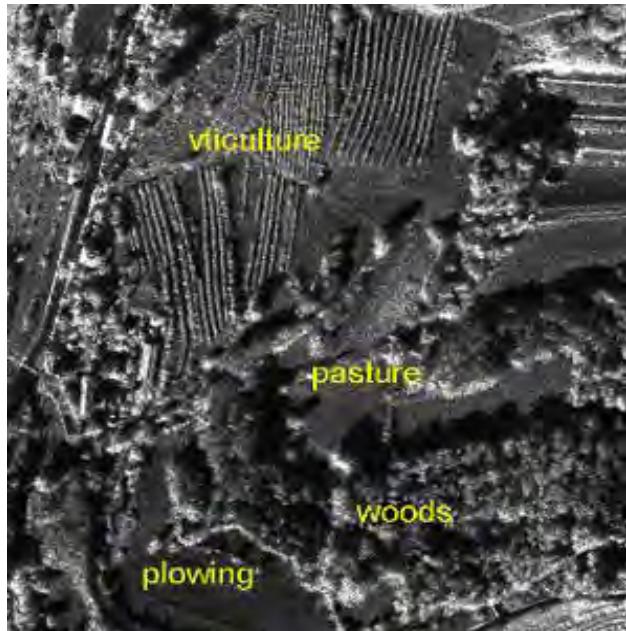
Sea Surface Temperature map from Daedalus sensor thermal band
Power plant of Porto Tolle (Po River Delta)

Hot water discharge



Thermal maps make it possible immediate detection of anomalous discharge into sea and rivers, that can be controlled in order to identify the nature and quality of discharge, by restricting the number of inspections.

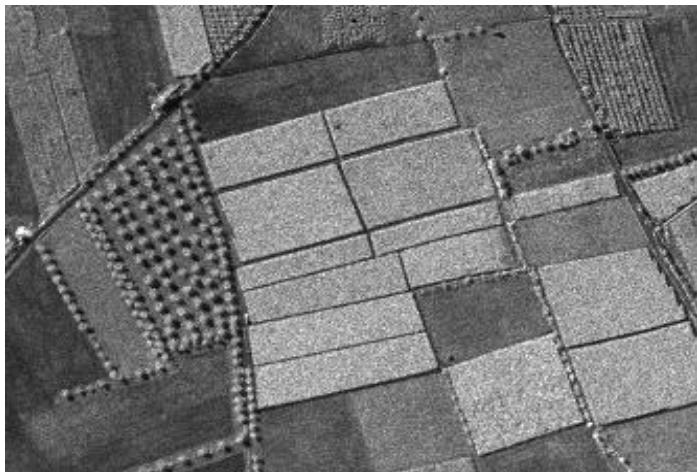
SAR applications - Land and risk management



Agricultural land use



Flooded area detection

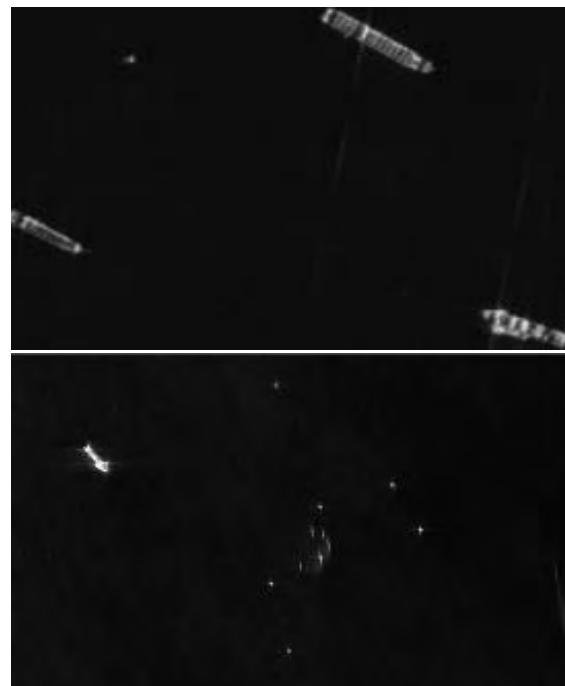
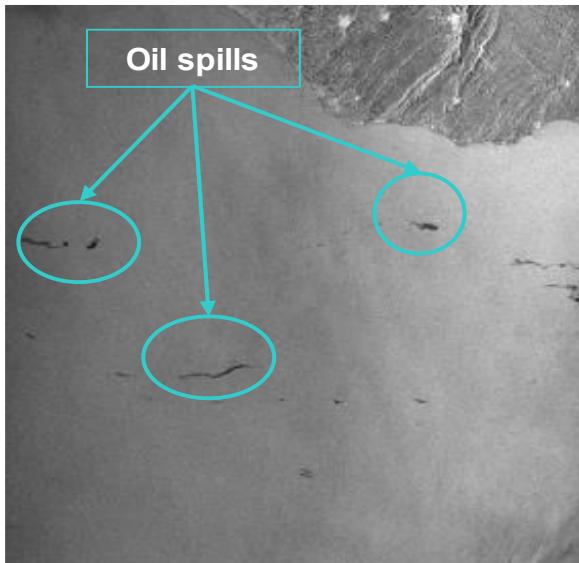


Geometric identification of fields and crops features (trees, vines).
Identification of 3D structures and environmental conditions (fields, stone walls, soil moisture).

SAR applications - Maritime surveillance and pollution monitoring



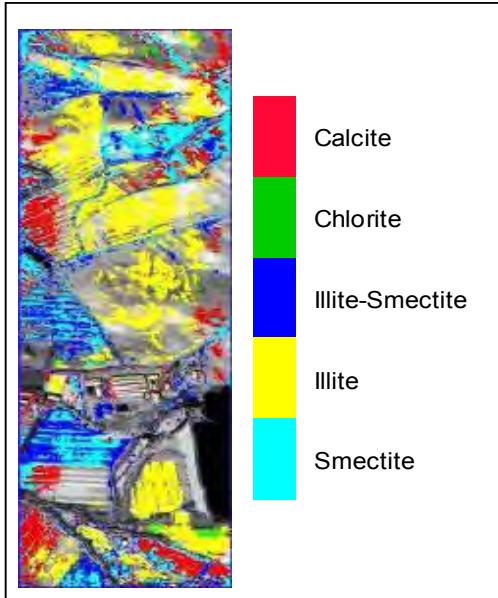
Oil spill and ship detection



Identification of oil spill and polluting materials from boats in coastal waters and open sea.
The oil spills on SAR image appear as black spots, with contours outlined with great precision.

SAR instrument provides an efficient way of detecting ships in the open sea and measuring, through wake and Doppler displacement, their speed and direction.
Repeated observation can contribute to a maritime surveillance system, complementing information on routes from coastal radars.

Hyperspectral applications



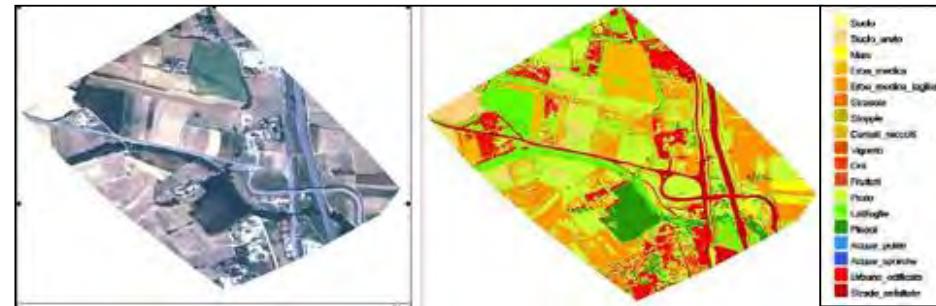
Soil Composition: clay and carbonates



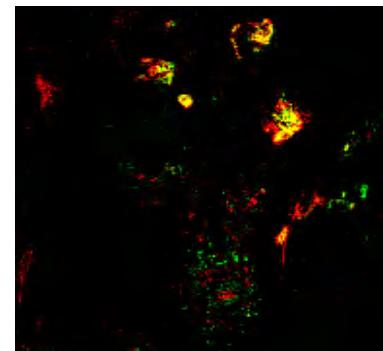
True color map



Mapping of asbestos cover (Eternit)



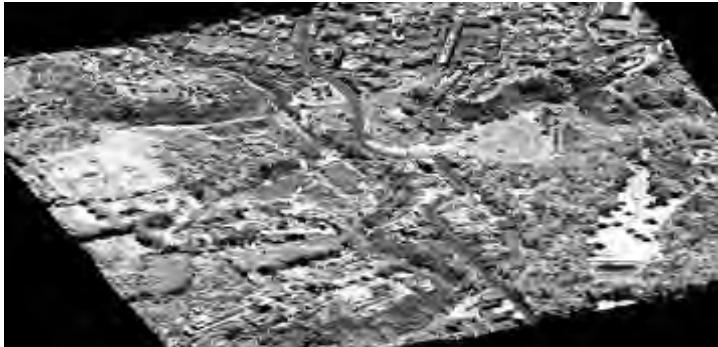
Classification of agricultural areas (precision farming)



Map of abundance of jarosite and pyrite

Mapping of landfill mining.
Mineralogical characterization
of surface (pollutant phases).
Assessment of soil-contamination and
surface water

LIDAR applications



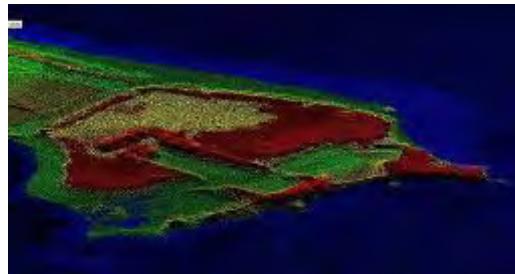
urban 3D mapping



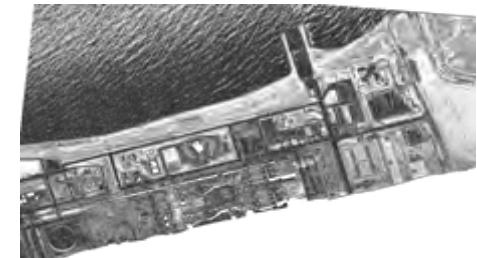
Landslide mapping



Quarry 3D mapping



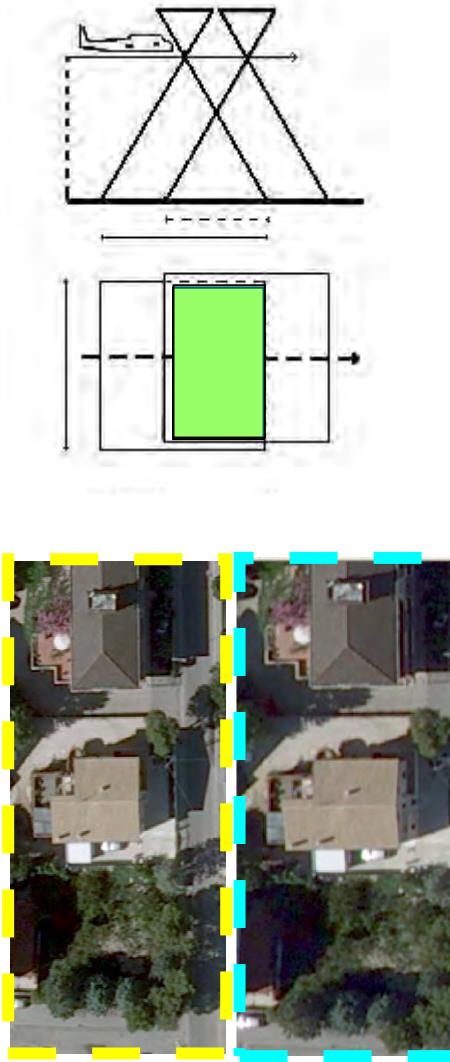
Coastal 3D monitoring



Advanced Services and Applications

Building Automated Identification and Classification

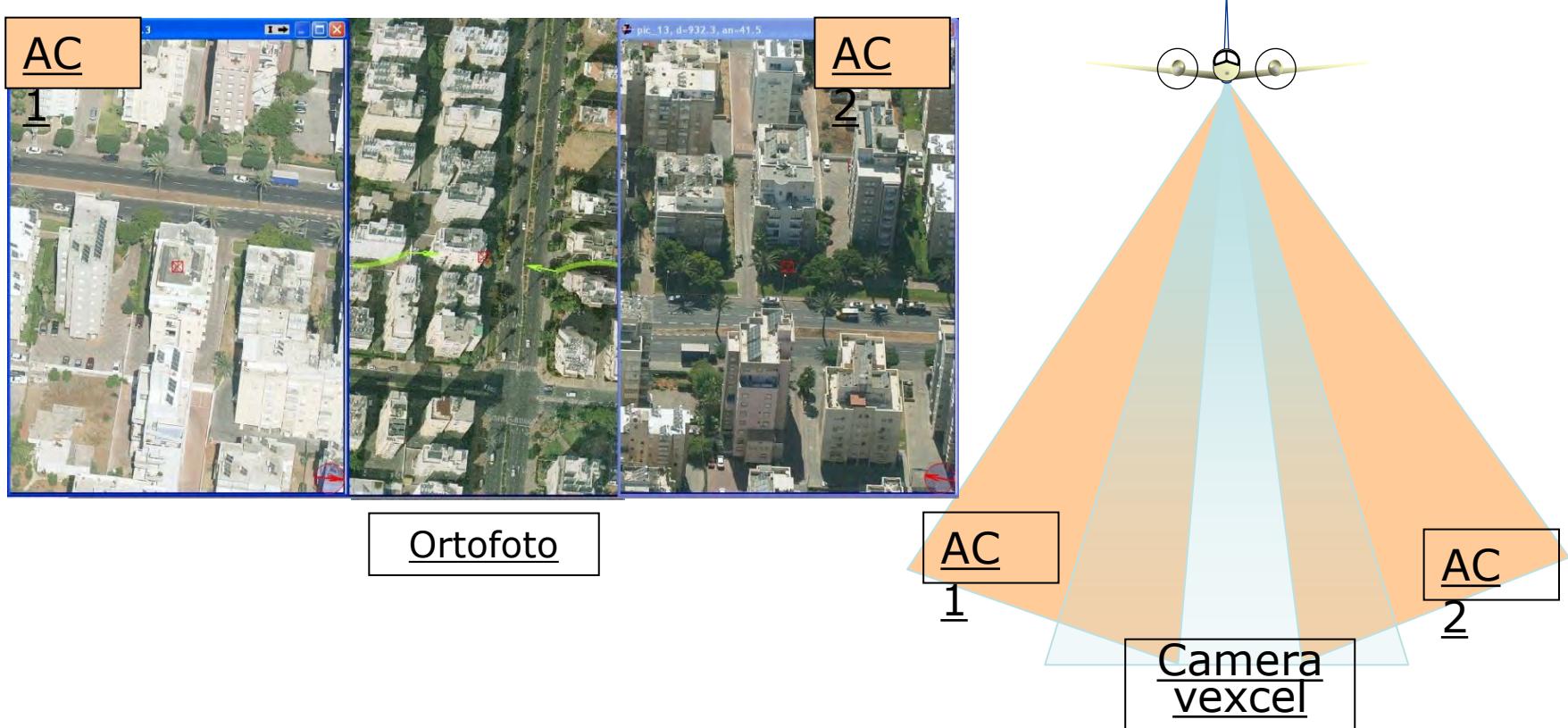
Building Automated Identification and Classification



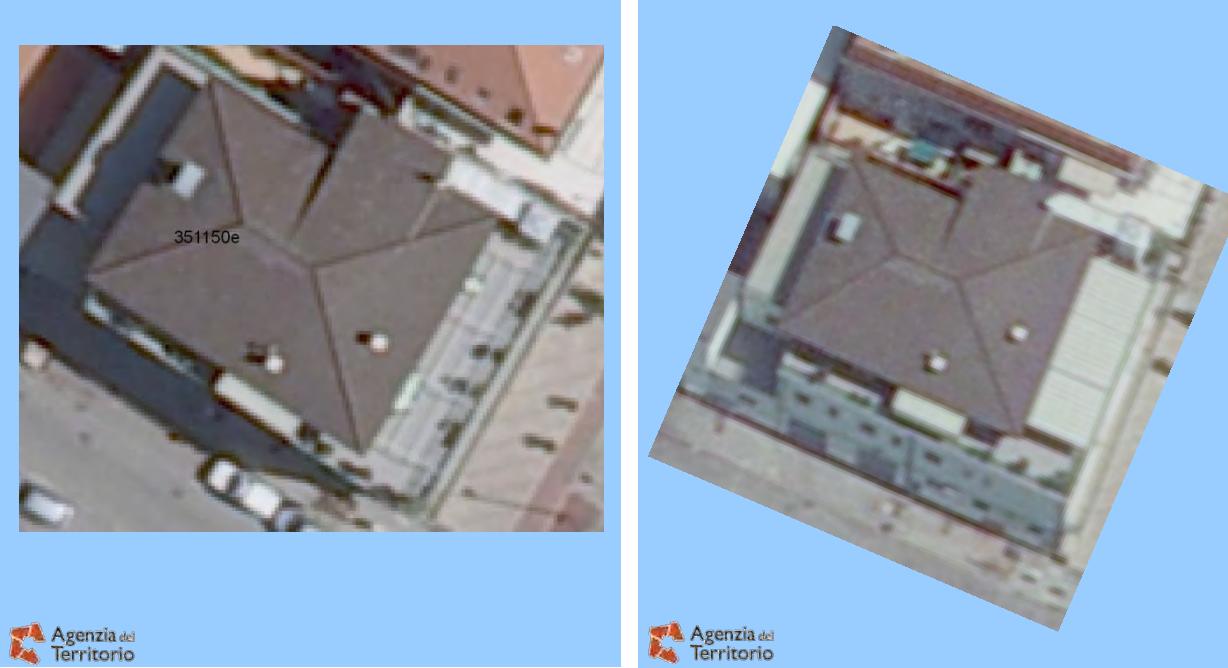
Building Automated Identification and Classification



Building Automated Identification and Classification



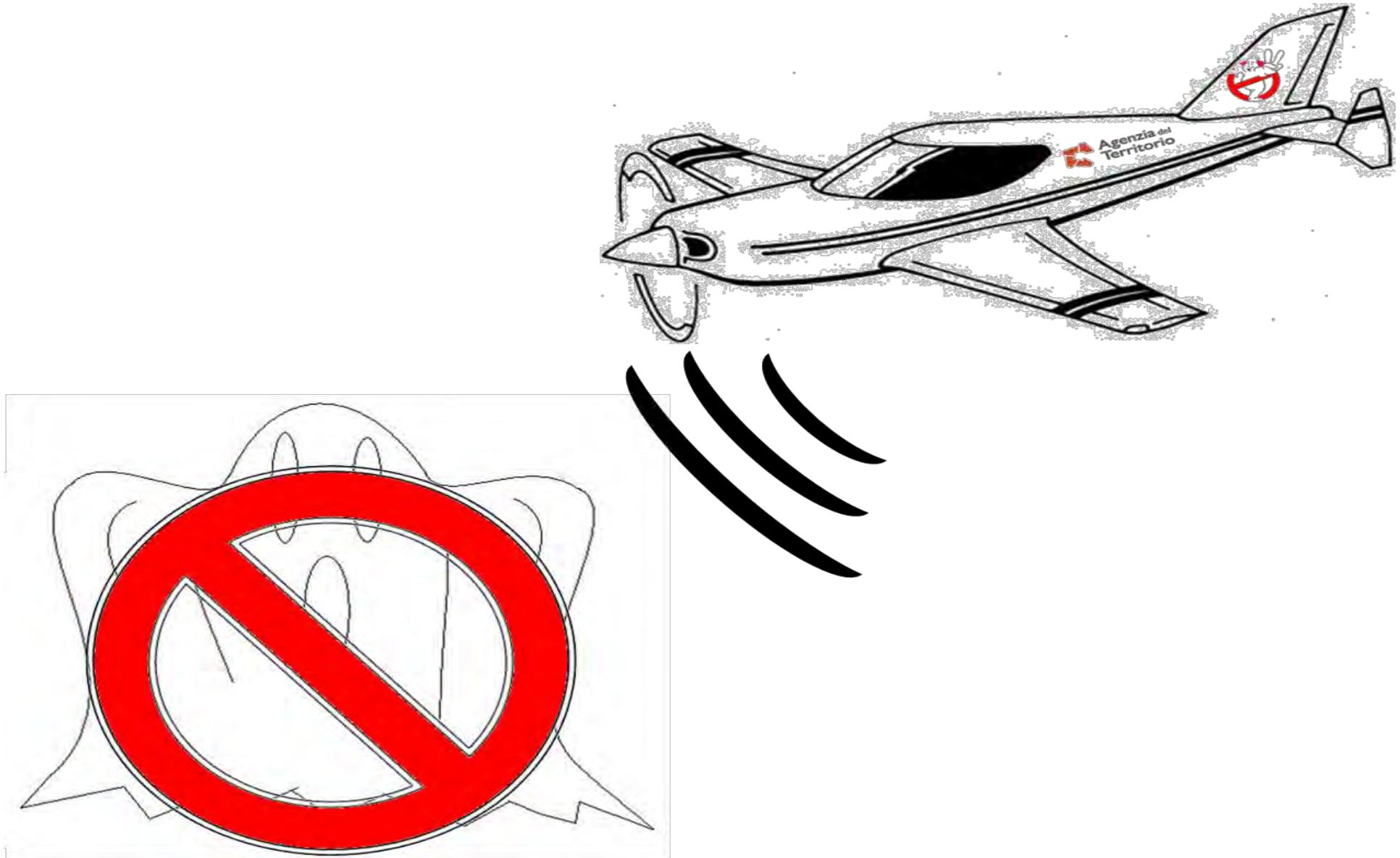
Building Automated Identification and Classification



IDC	Descrizione	Valore
Codice Comune	Codice del Comune	G482
Foglio	Numero foglio Catastale	41
Particella	Numero della particella in cui cade l'edificio	3079
Tipo Edificio	Identificazione della tipologia di edificio	Edificio residenziale
Altre Info	Ulteriori Informazioni richieste da AdT	

Note

Building Automated Identification and Classification



Advanced Services and Applications

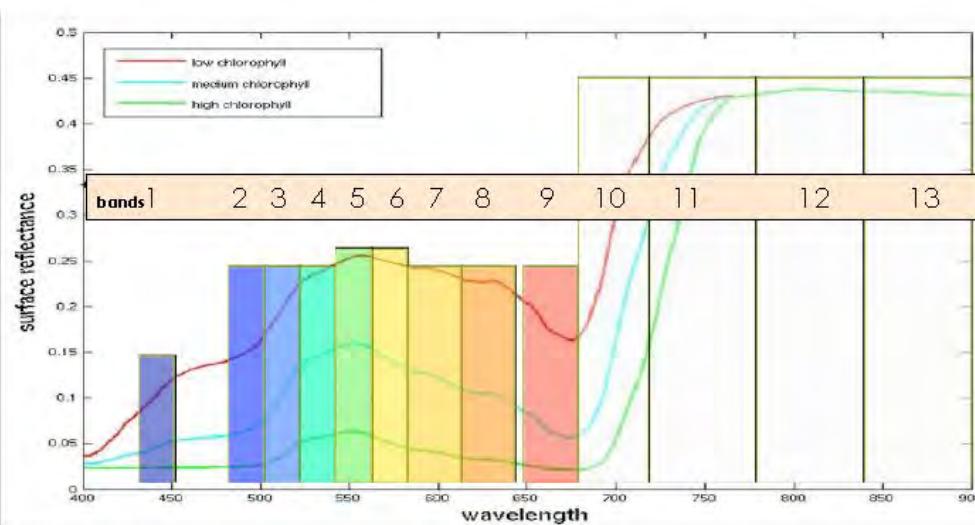
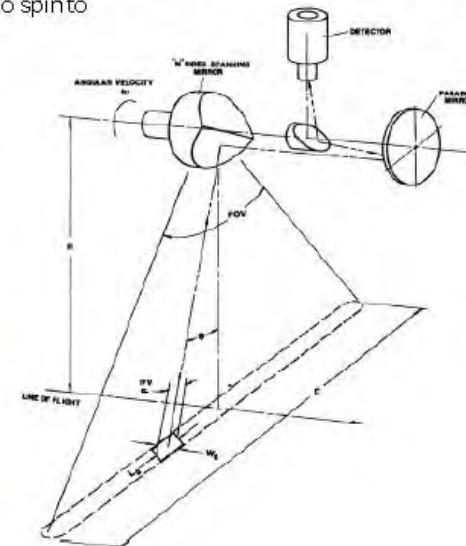
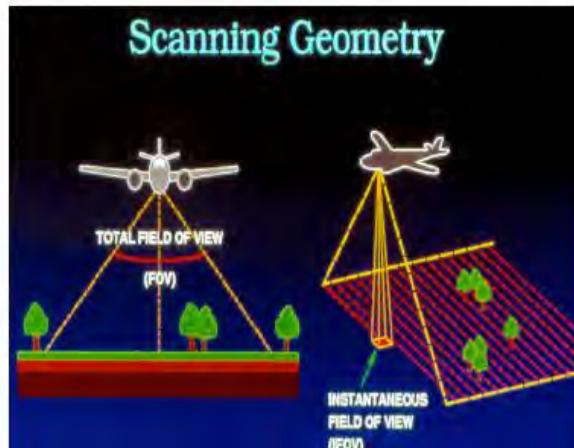
Asbestos Mapping

Asbestos Mapping

- FOV = 90°
- IFOV = 1.25 mrad
- Swath = 2H
- GSD ≈ 70 cm @ H of 600 m



La particolare geometria dello specchio unito alla sua velocità di rotazione permette un GSD molto spinto



Daedalus ATM
Passive multispectral
scanner



ATM PLUS ENHANCED VNIR BANDS	
Band	Band Edges
1 VIS	0.43 – 0.45 um
2 * VIS	0.48 – 0.50 um
3 * VIS	0.50 – 0.52 um
4 VIS	0.52 – 0.54 um
5 * VIS	0.54 – 0.56 um
6 VIS	0.56 – 0.58 um
7 * VIS	0.58 – 0.61 um
8 VIS	0.61 – 0.64 um
9 * VIS	0.65 – 0.68 um
10 * NIR	0.68 – 0.72 um
11 NIR	0.72 – 0.78 um
12 NIR	0.78 – 0.84 um
13 NIR	0.84 – 0.92 um
14 SWIR	1.55 – 1.75 um
15 SWIR	2.08 – 2.35 um
16 LWIR	8.5 – 12.5 um

9 VISIBLE
BANDS

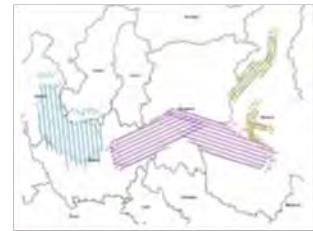
4 NEAR
INFRARED
BANDS

2 SHORT WAVE
INFRARED BANDS
1 LONG WAVE
INFRARED BAND

Asbestos Mapping

- Acquisition

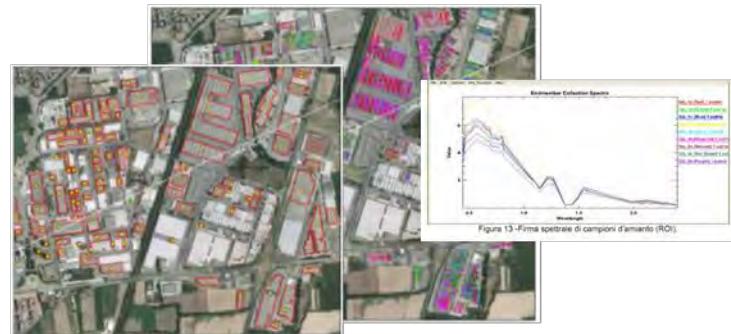
Flight



- Georeferencing

- Classification

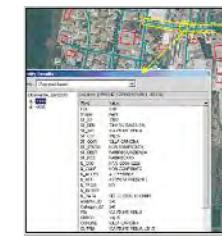
Thematic layer generation



- Vectorization

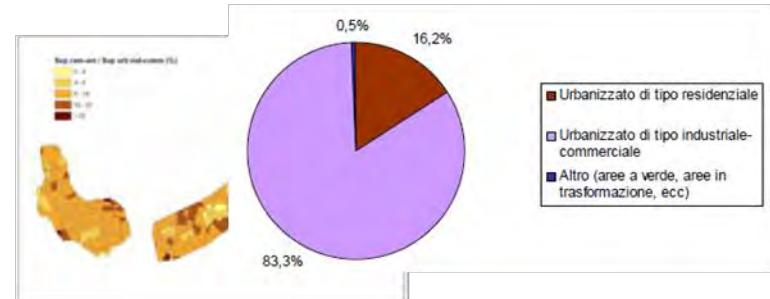
- Accuracy reliefs analysis

Inspection



- GeoDatabase
- Statistics
- Publication

Reporting



Asbestos Mapping

Firme spettrali MIVIS
CNR IIA Basile, Allegrini

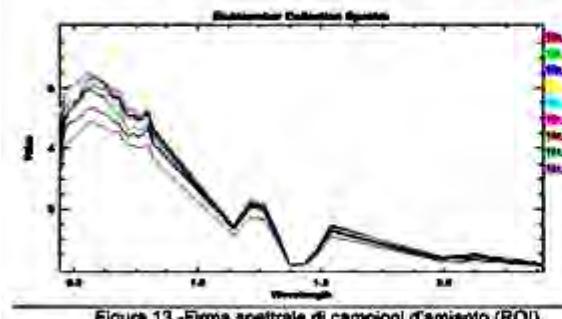
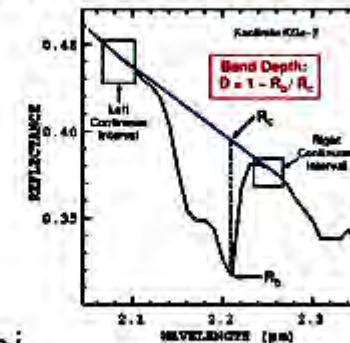
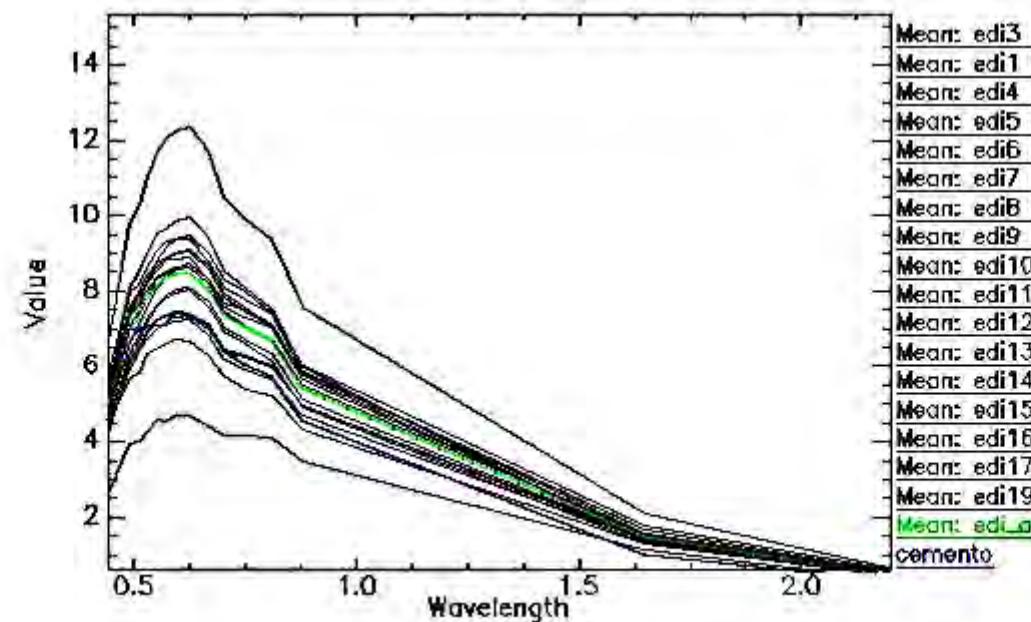


Figura 13 -Firma spettrale di campioni d'amianto (ROI).

Approccio singole bande
MIVIS CNR LARA Pignatti

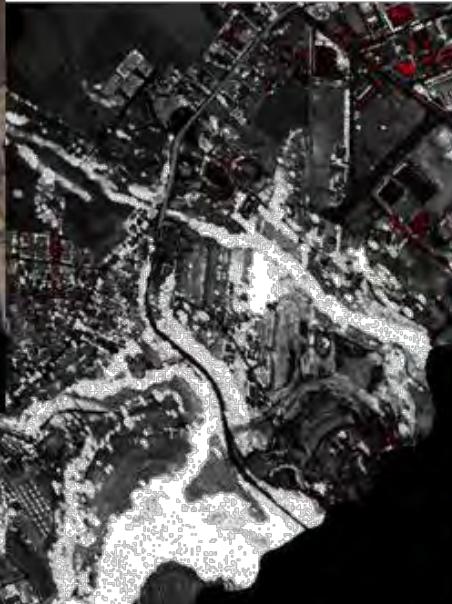


Firme spettrali Telaer, Biscontini

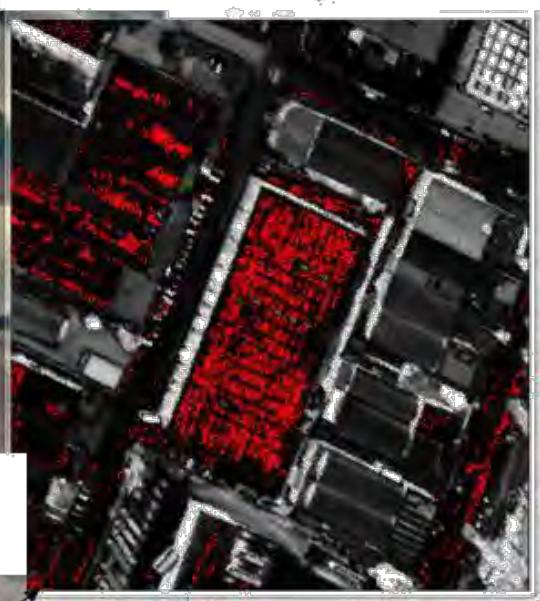


Asbestos Mapping

Ortofoto Daedalus



Classificato su mappa
della divergenza



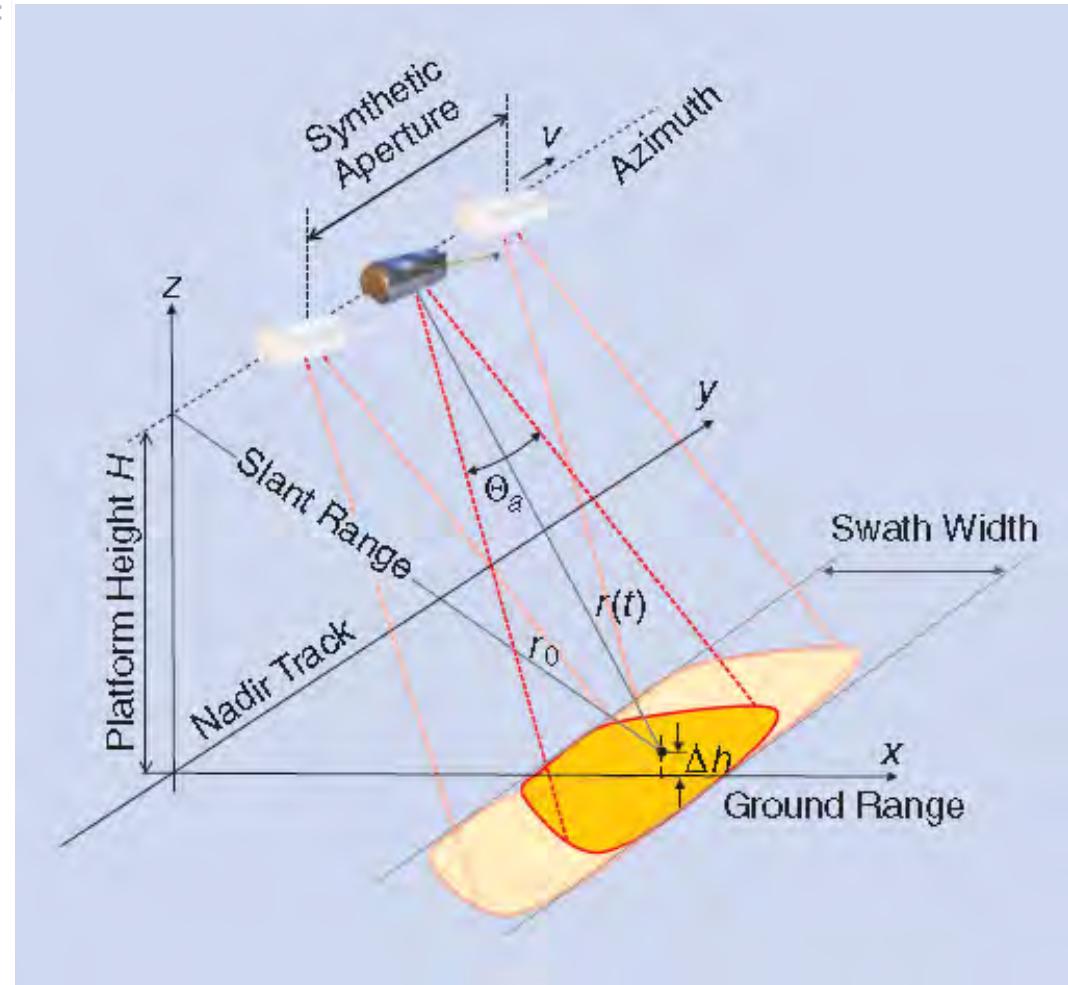
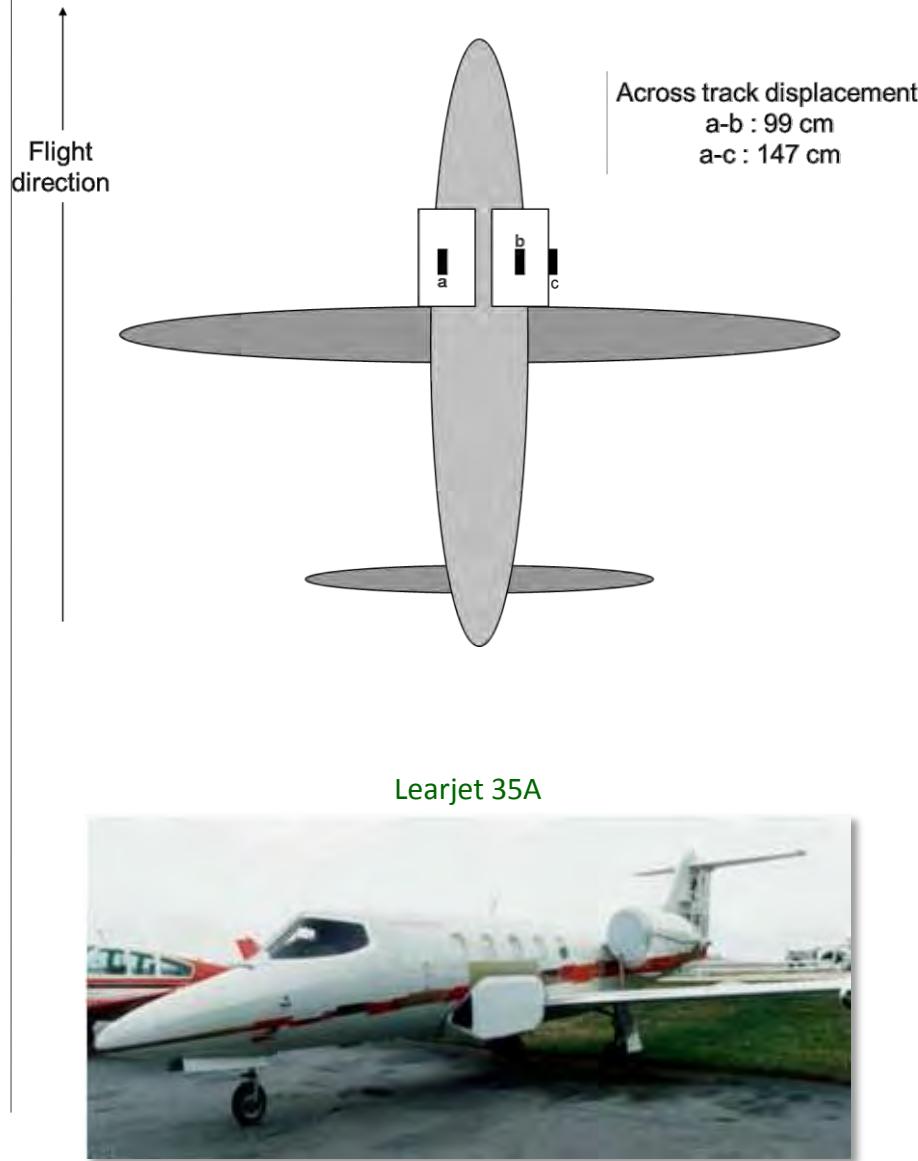
Advanced Services and Applications

Synthetic Aperture Radar SAR

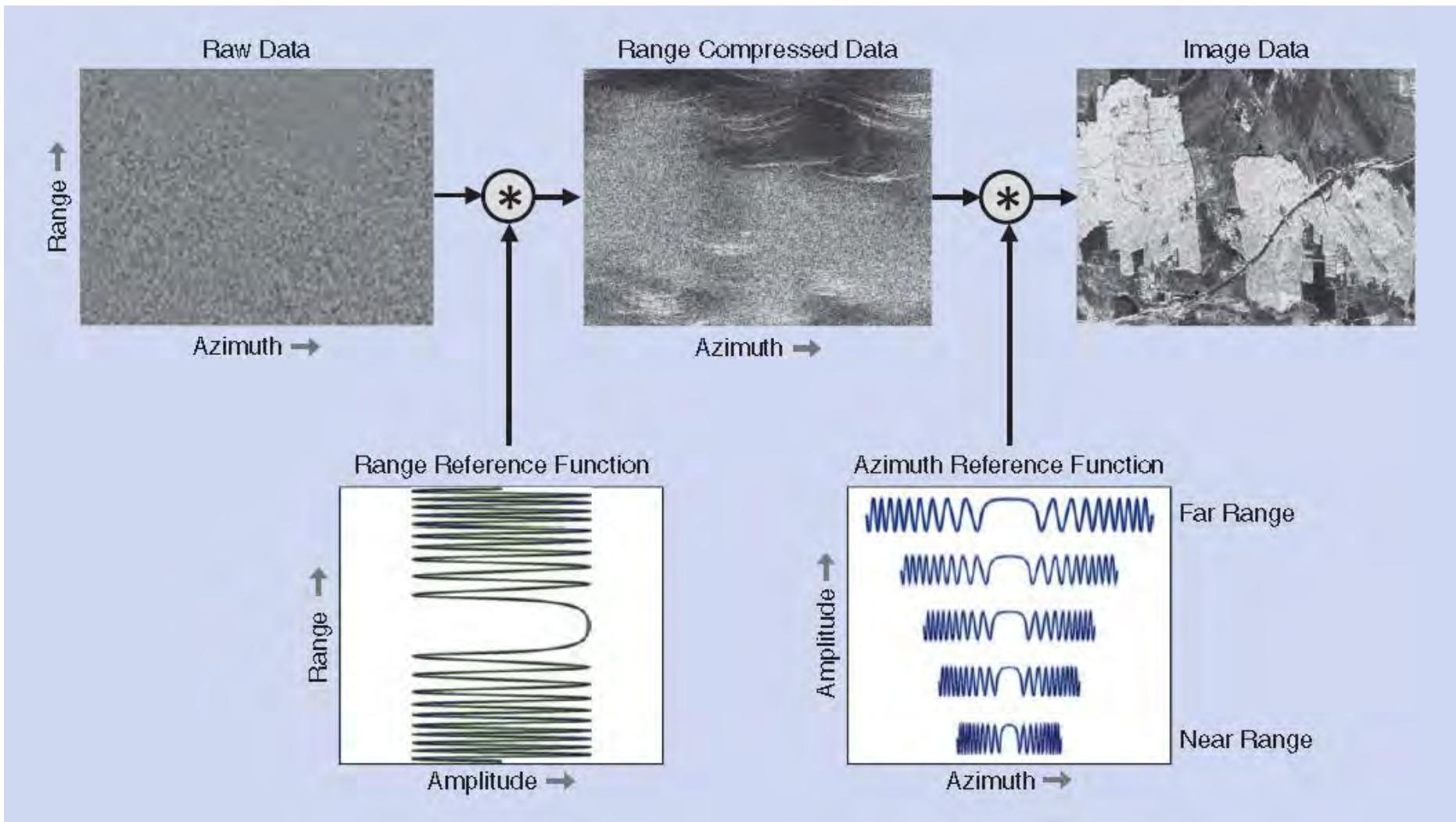
vs

Interferometric Synthetic Aperture Radar
InSAR

Synthetic Aperture Radar - SAR



Synthetic Aperture Radar - SAR



Synthetic Aperture Radar - SAR

THE ORIGINAL TELAER SYSTEM

Airplane Parameters	
Model	Learjet 35A
Propulsion	2 Turbofan Garret T731
Velocity	up to 800 Km/h
Autonomy	4000 km
Flight Altitude	up to 8400 m



Parameters of the Original TELAER SAR System	
Operating frequency	9.55 Ghz
Transmitted Bandwidth	100 – 400 Mhz
PRF	200 – 16000 Hz
Standard Swath width	2-15 km
Resolution	1-5 m
# of receiving antennas	1



Roma Area ML SAR image (Geocoded)

Synthetic Aperture Radar - SAR

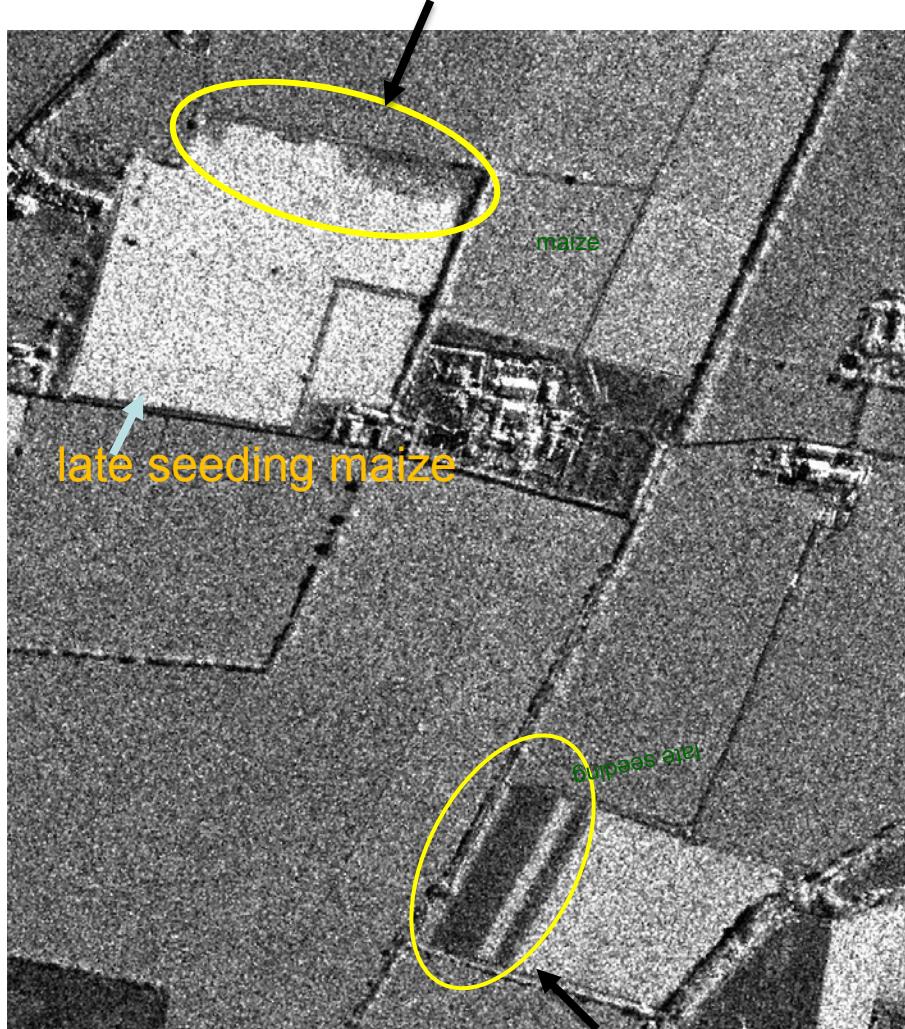
..assured data around the agronomic year, the illumination (day/night), the weather....



Synthetic Aperture Radar – SAR 0,5m

GAEC Standard 3.1- Water stagnation, without evident ditches

Airborne
0,4m Aug 08

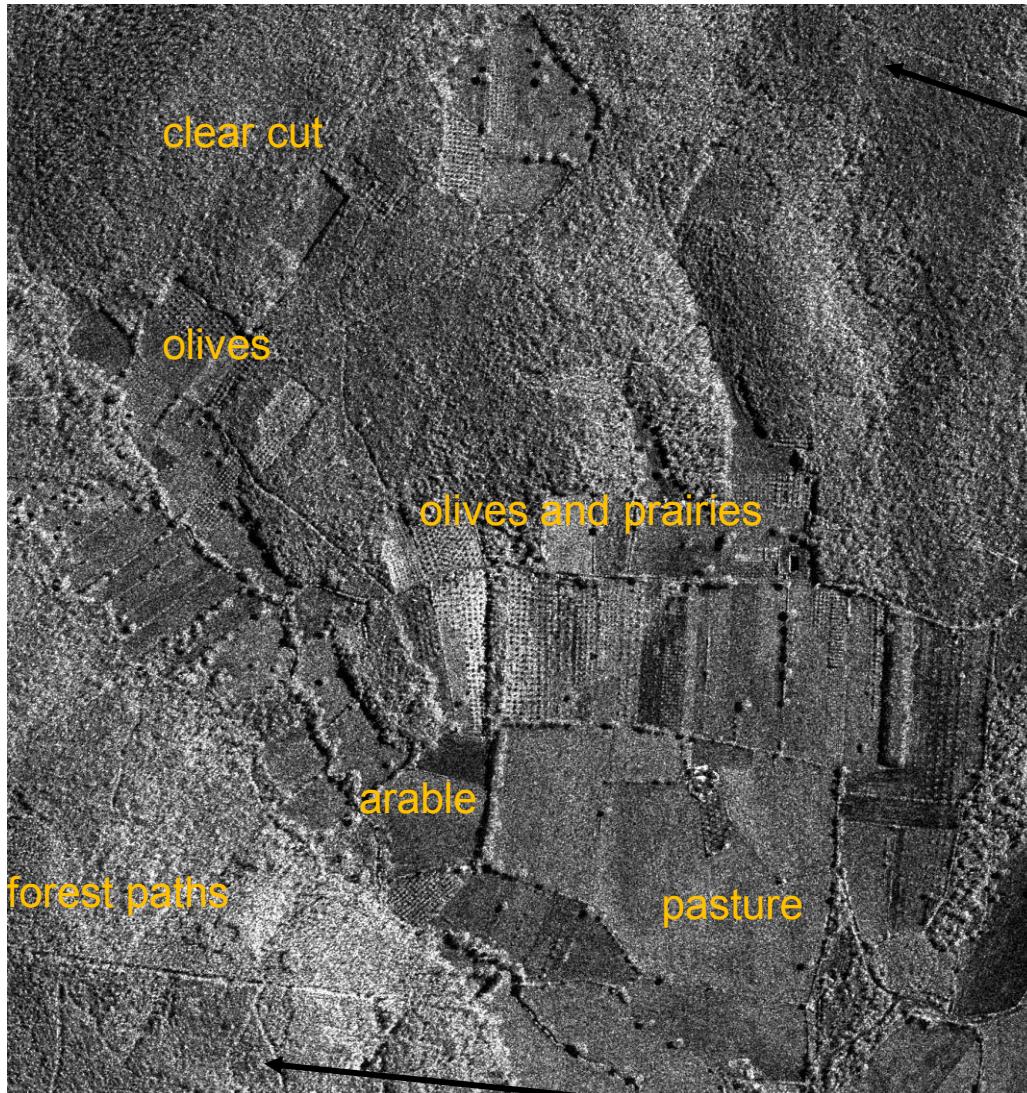


6 Sept. 08

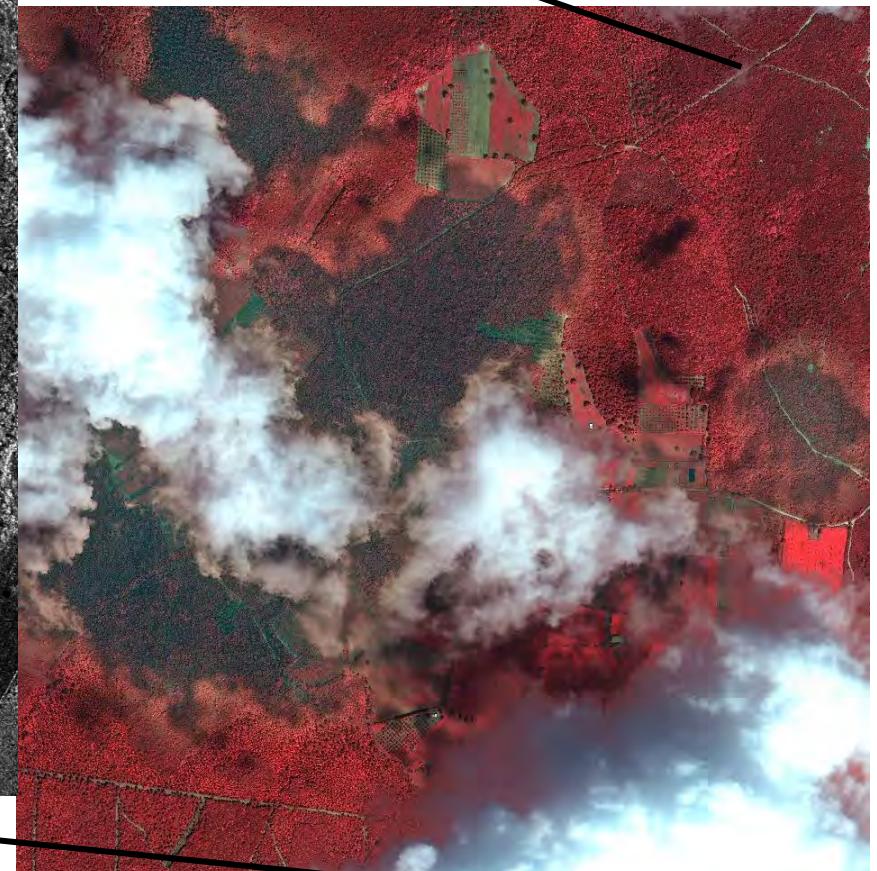
partial harvesting



Synthetic aperture radar - SAR



Optical cloud cover:
SAR Detection capability



Synthetic Aperture Radar - SAR

**Woodland typologies
detection capability
North Italy**



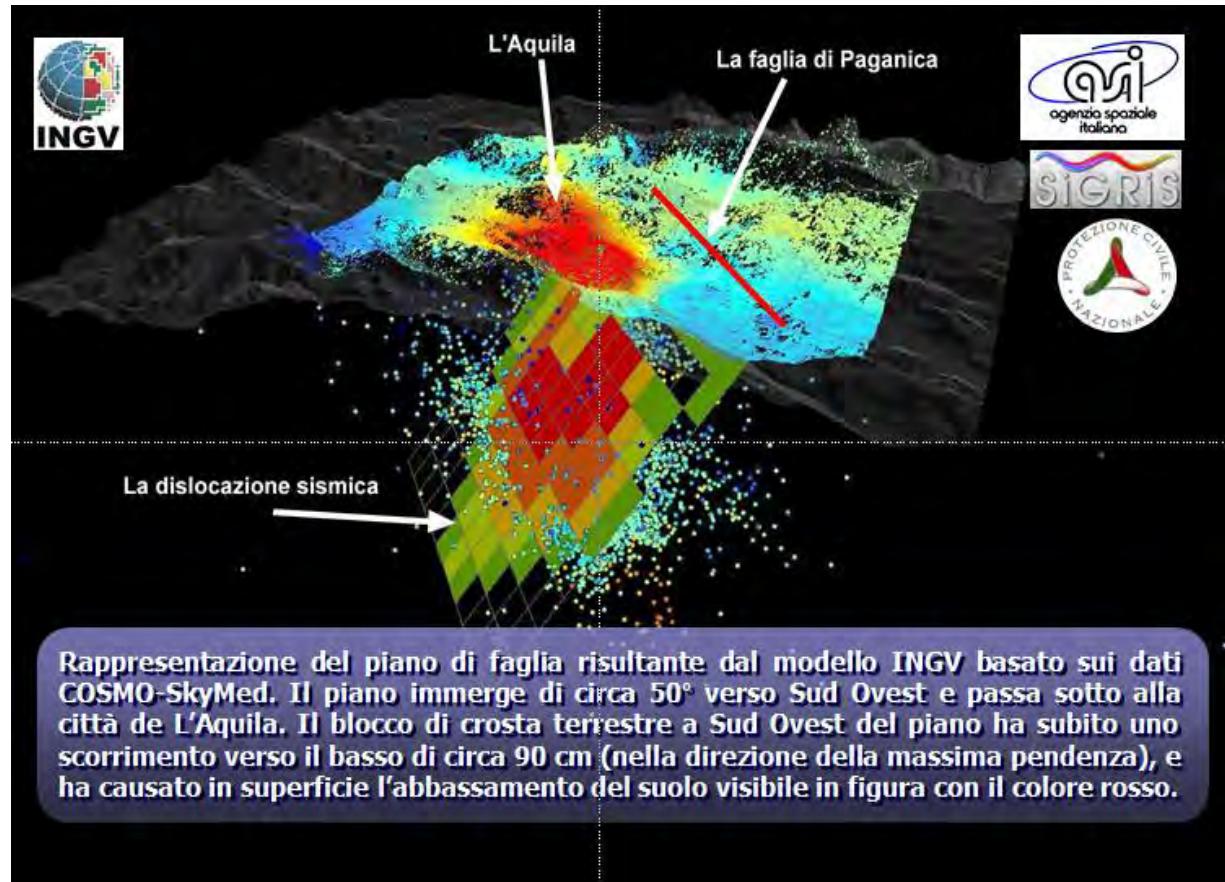
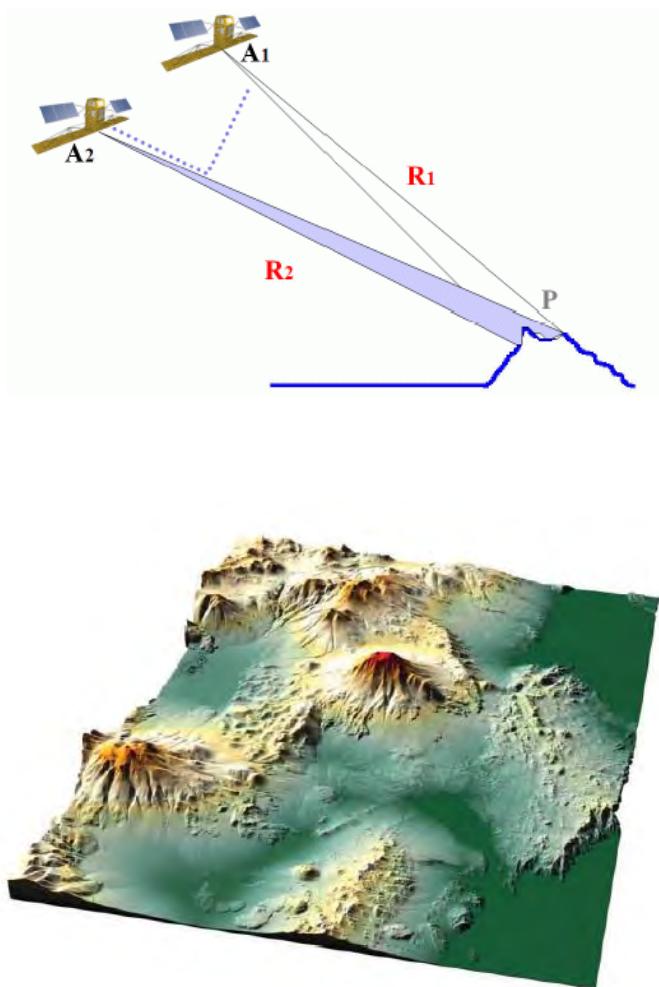
Poplar groves at different density and age: experimental timber farm (biomass production test)



SIN

Sistema Informativo
Nazionale per lo sviluppo
dell'agricoltura

Interferometric Synthetic Aperture Radar - InSAR



Interferometric Synthetic Aperture Radar - InSAR

UPGRADING TO THE INTERFEROMETRIC MODE

TECHNICAL DETAILS



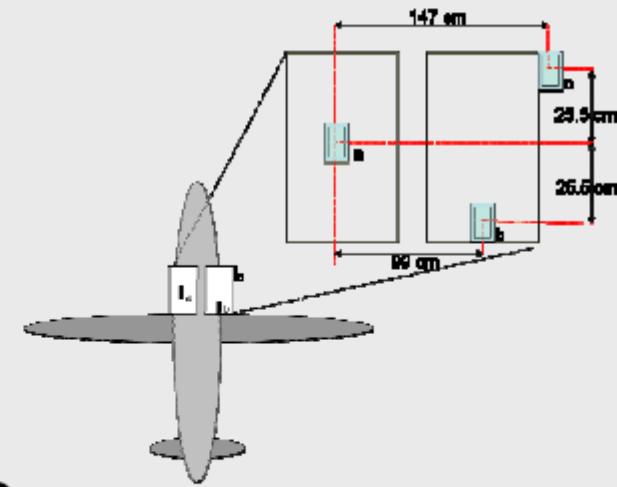
Acquiring an accurate embedded GNSS-IMU system

High accuracy in real-time track measurement

- to reduce motion errors
- to allow repeatability of the same track (for repeat pass applications)

High accuracy in post-flight track measurement (to reduce the impact of motion errors)

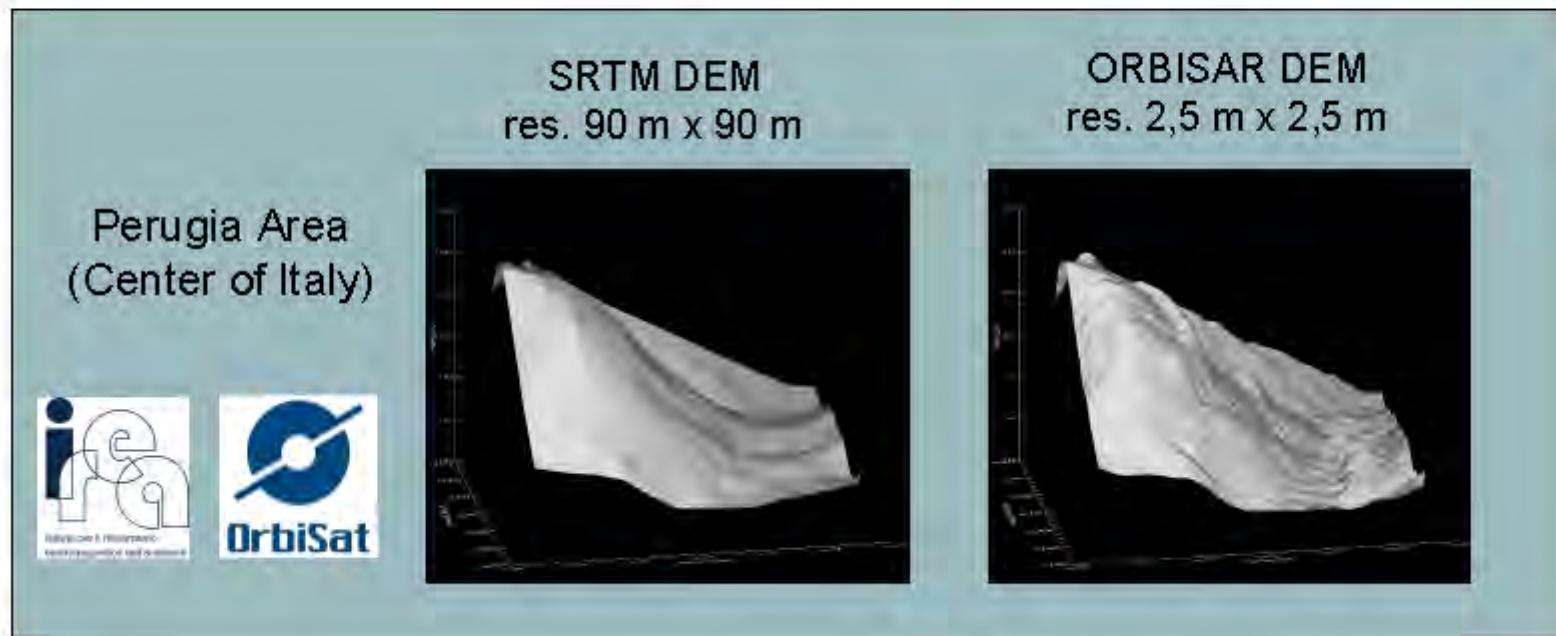
Acquiring single-pass interferometric capabilities



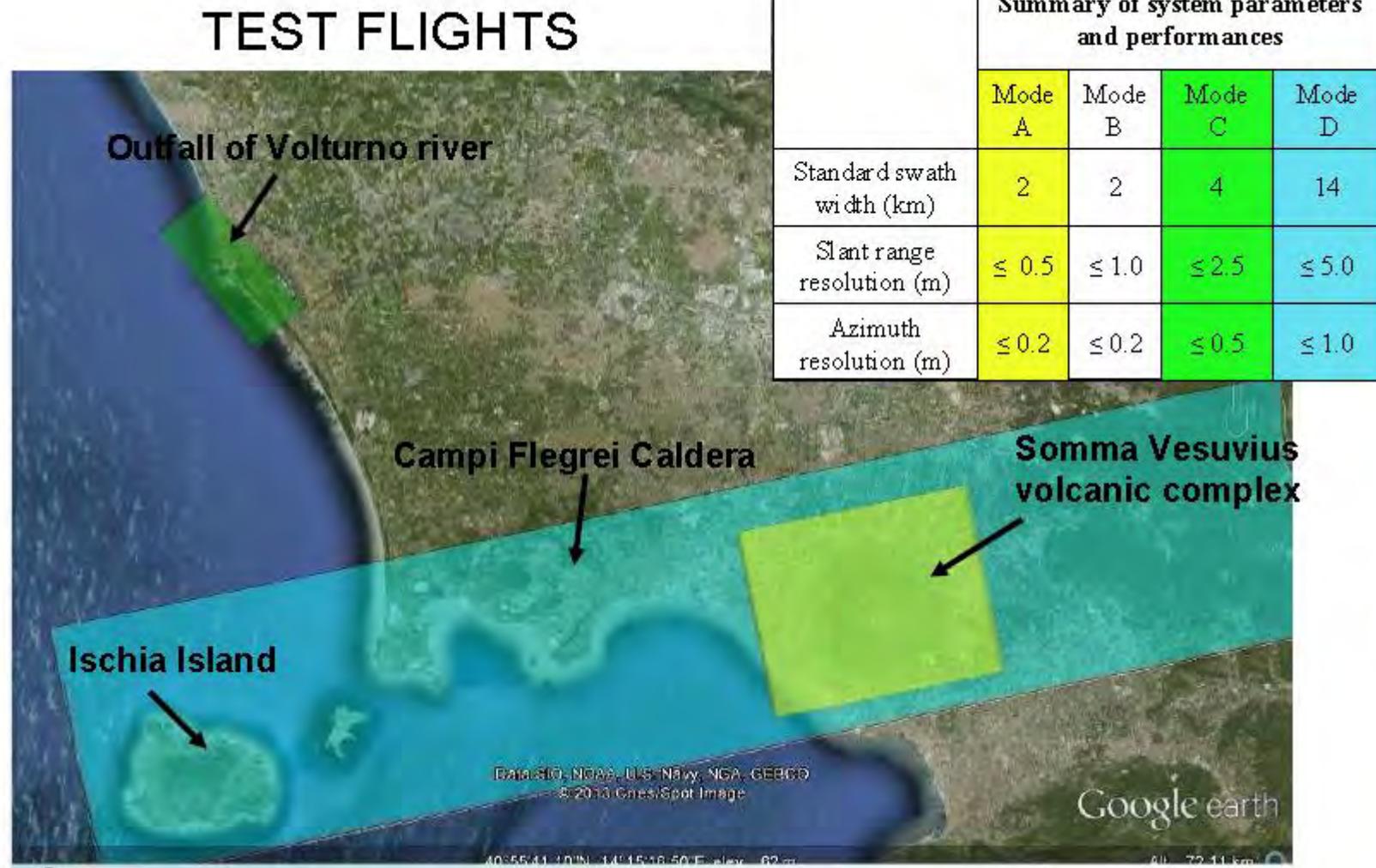
- Three different across-track baselines
- Two different along-track baselines

Interferometric Synthetic Aperture Radar - InSAR

UPGRADING TO THE INTERFEROMETRIC MODE MOTIVATIONS



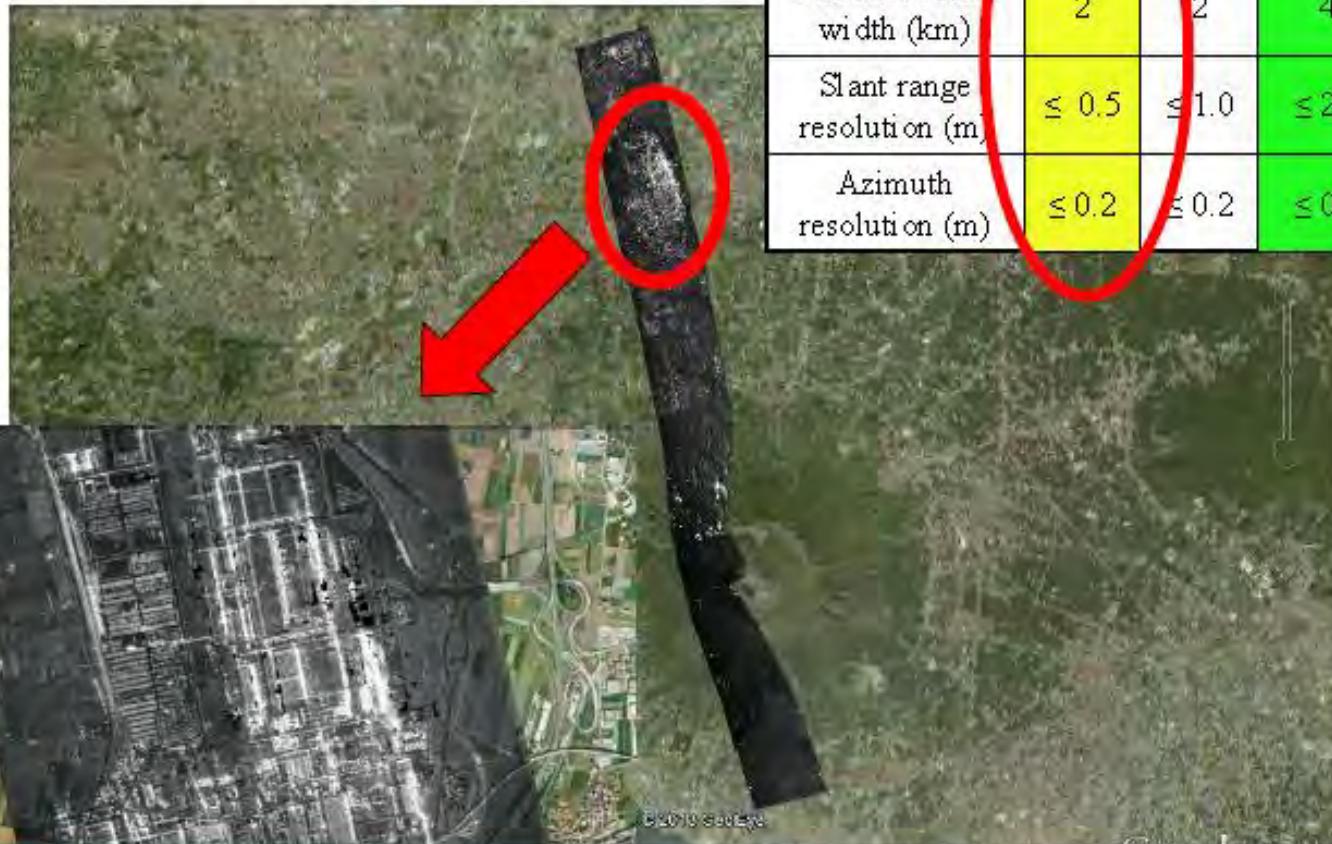
Interferometric Synthetic Aperture Radar - InSAR



Interferometric Synthetic Aperture Radar - InSAR

MODE A (400 MHz)

Amplitude SAR Image



	Summary of system parameters and performances			
	Mode A	Mode B	Mode C	Mode D
Standard swath width (km)	2	2	4	14
Slant range resolution (m)	≤ 0.5	≤ 1.0	≤ 2.5	≤ 5.0
Azimuth resolution (m)	≤ 0.2	≥ 0.2	≤ 0.5	≤ 1.0

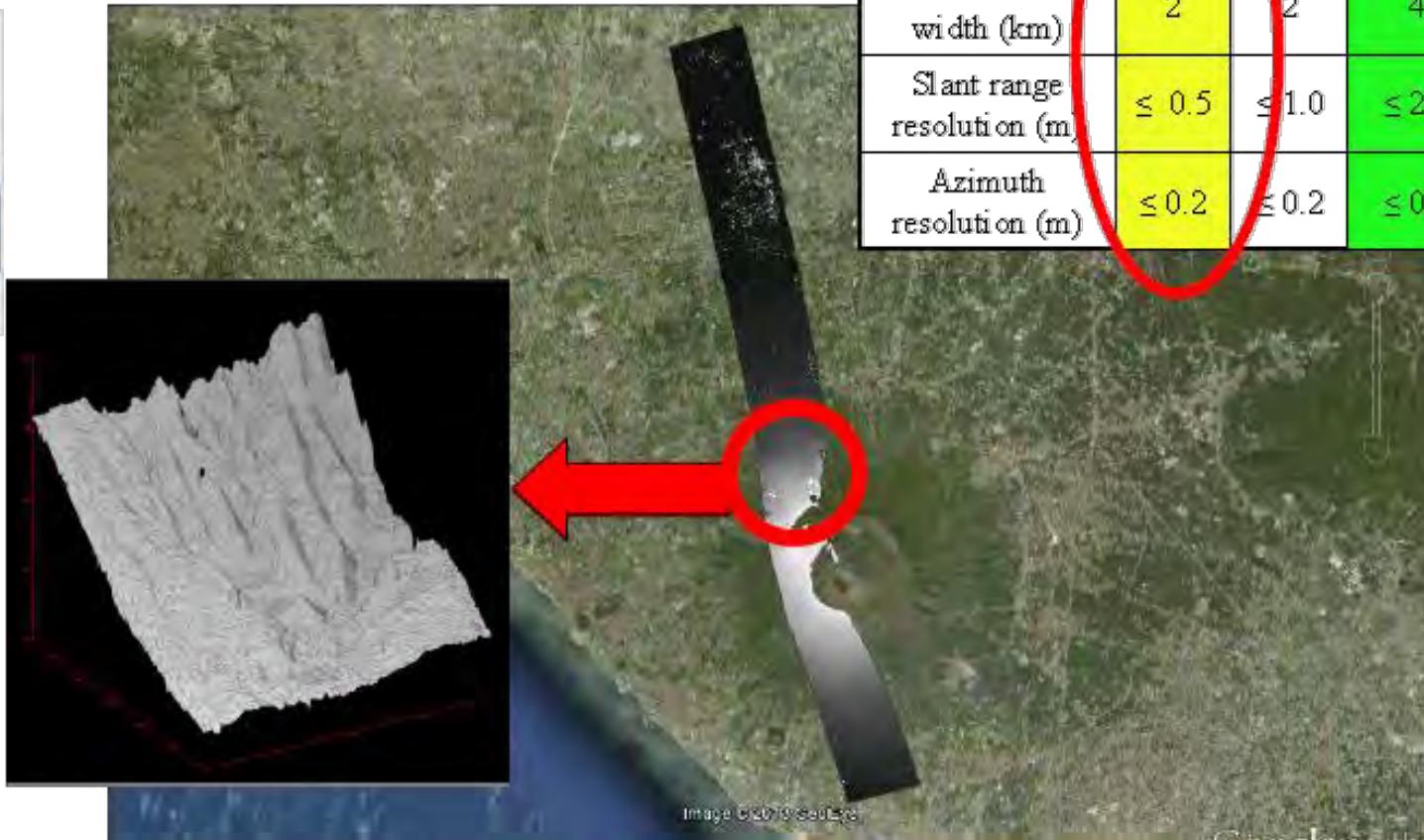
Interferometric Synthetic Aperture Radar - InSAR

MODE A (400 MHz)

Interferometric DEM

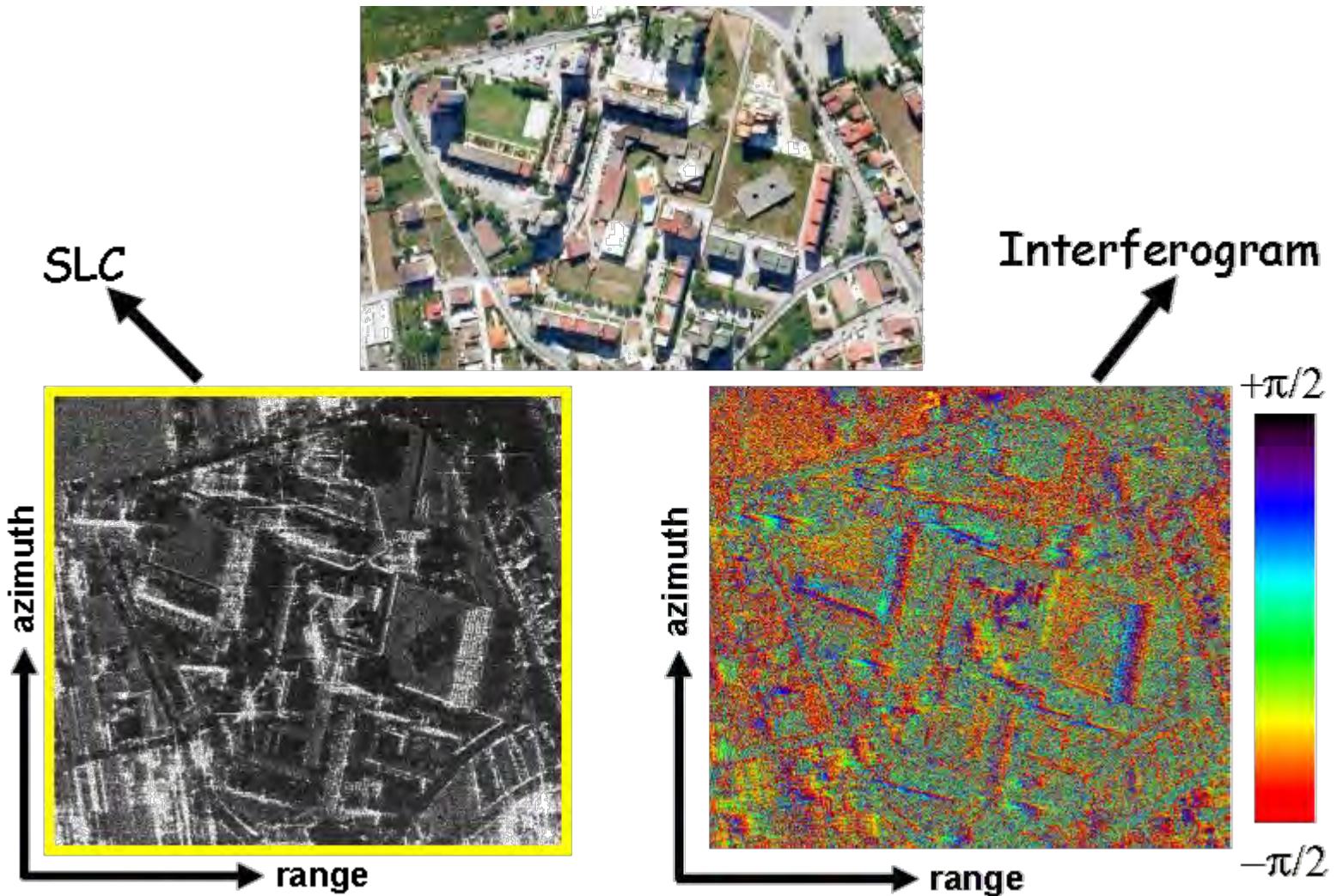


istituto per il rilevamento
elettromagnetico dell'ambiente



Interferometric Synthetic Aperture Radar - InSAR

High resolution ($0.5\text{ m} \times 0.5\text{ m}$)



Interferometric Synthetic Aperture Radar - InSAR

MODE D (50 MHz)

Amplitude SAR Image



	Summary of system parameters and performances			
	Mode A	Mode B	Mode C	Mode D
Standard swath width (km)	2	2	4	14
Slant range resolution (m)	≤ 0.5	≤ 1.0	≤ 2.5	≤ 5.0
Azimuth resolution (m)	≤ 0.2	≤ 0.2	≤ 0.5	≤ 1.0

Interferometric synthetic aperture radar - InSAR

MODE D (50 MHz)

Interferometric DEM



	Summary of system parameters and performances			
	Mode A	Mode B	Mode C	Mode D
Standard swath width (km)	2	2	4	10
Slant range resolution (m)	≤ 0.5	≤ 1.0	≤ 2.5	≤ 5.0
Azimuth resolution (m)	≤ 0.2	≤ 0.2	≤ 0.5	≤ 1.0

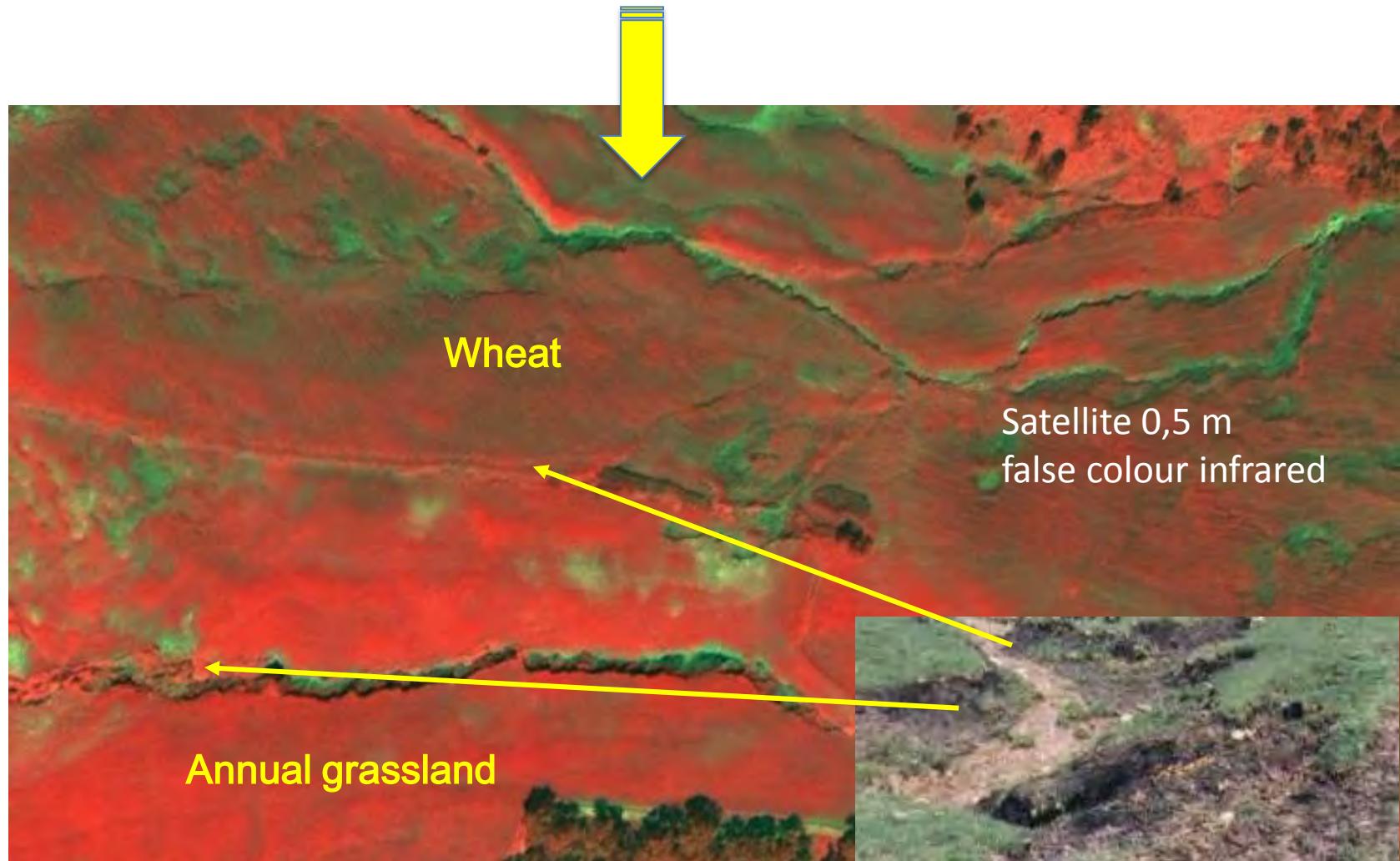
Advanced Services and Applications

Hydrogeological risk

Mitigation actions in agriculture and forestry

Hydrogeological risk: Mitigation actions

Soil erosion and landslides



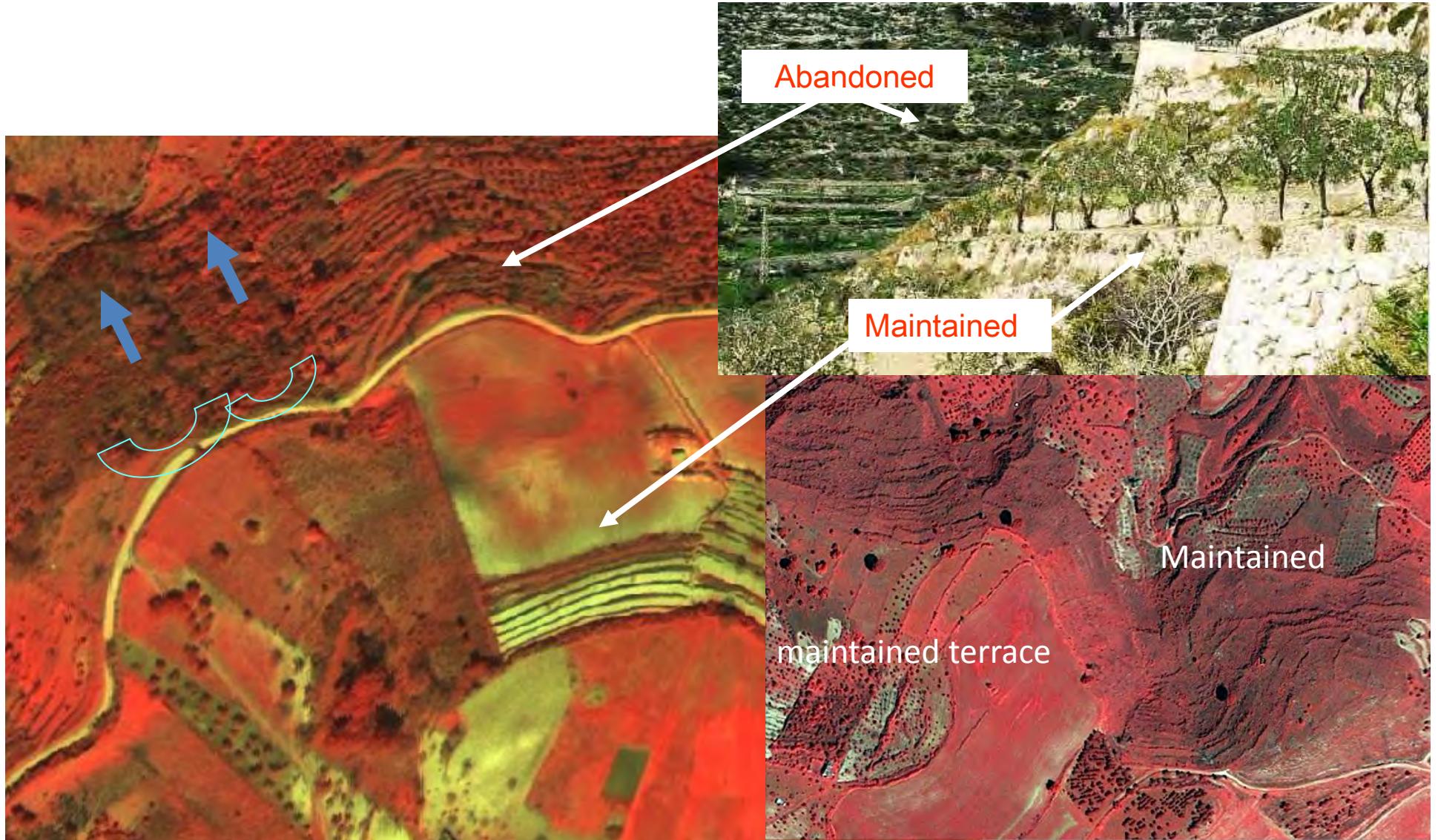
Hydrogeological risk: Mitigation actions

Soil erosion and landslides



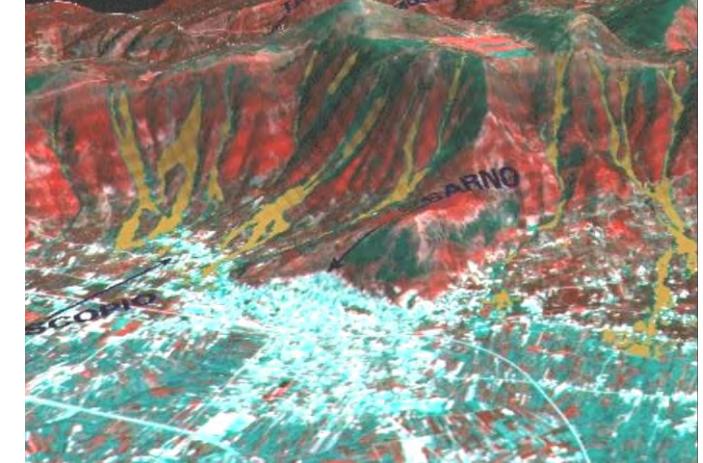
Hydrogeological risk: Mitigation actions

Soil erosion and landslides



Hydrogeological risk: Mitigation actions

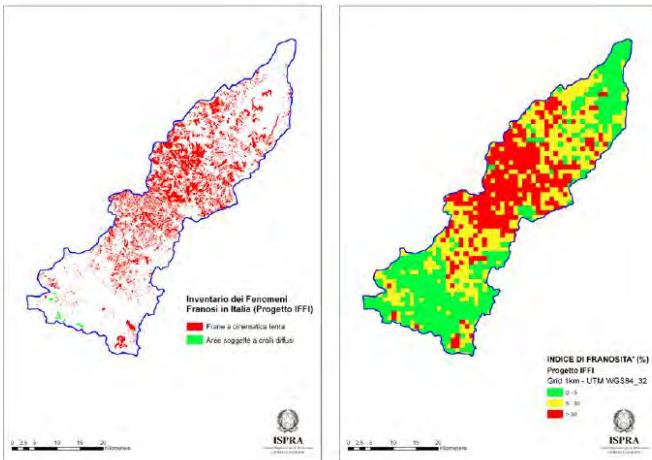
Wrong or inadequate management of forest areas



Hydrogeological risk: Mitigation actions

Integration of agriculture and environment sectors and their databases

Carte franosità, erosione, interventi difesa suolo, ...



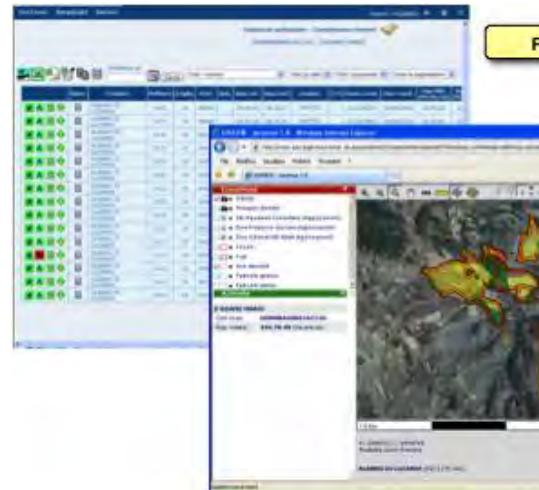
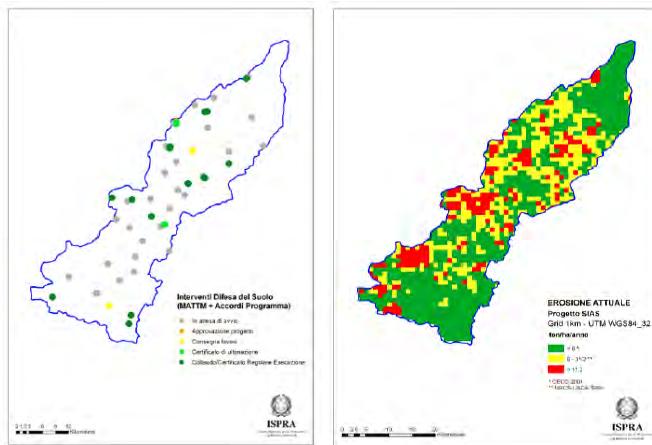
Statistiche agricole e forestali
(AGRIT, INFС, Populus)



Land Parcel Identification System



Fascicolo aziendale

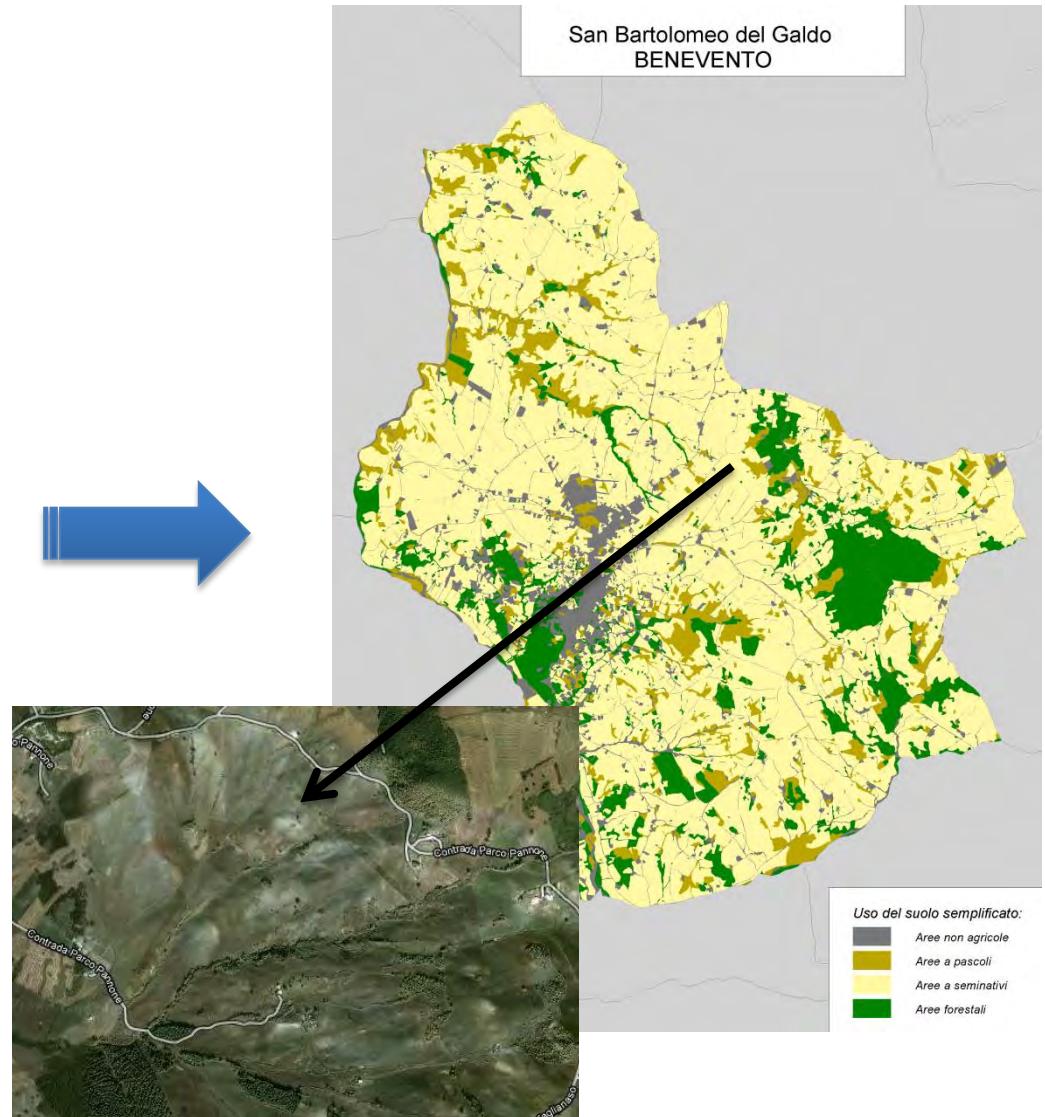
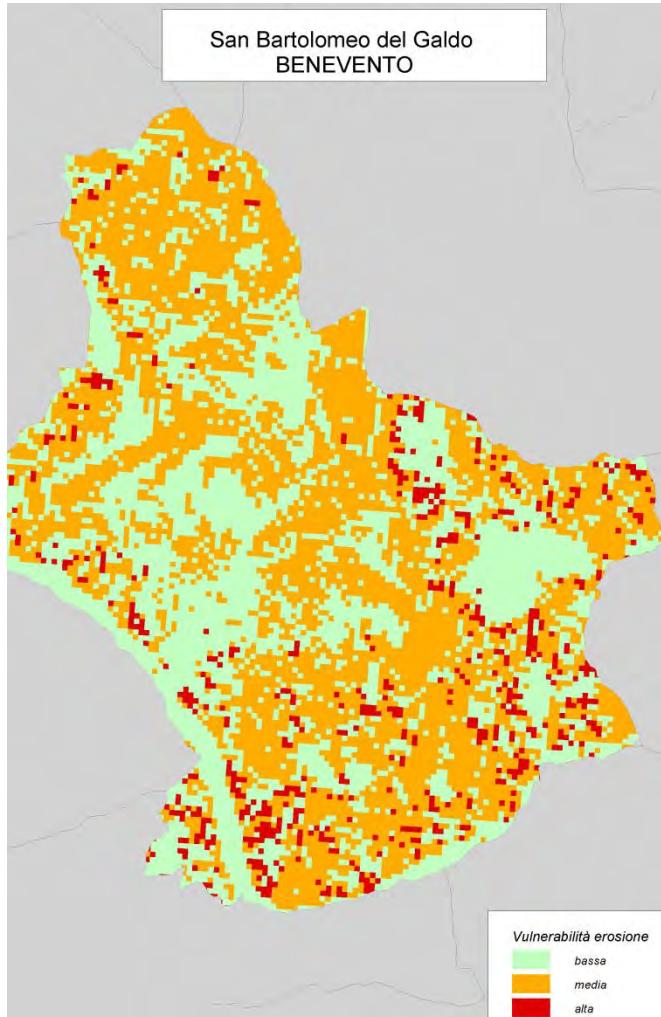


Fascicolo Aziendale

- Sezione anagrafica
- Sezione zootecnica
- Sezione territoriale
- Sezione fabbricati
- Sezione mezzi di produzione
- Sezione manodopera
- Sezione titoli all'aiuto
- Sezione ittica

Hydrogeological risk: Mitigation actions

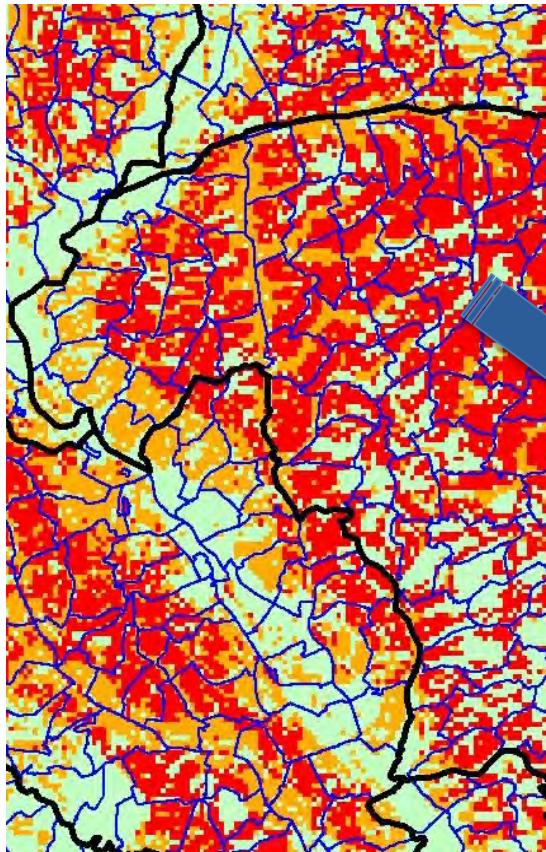
Soil erosion vs agricultural land use



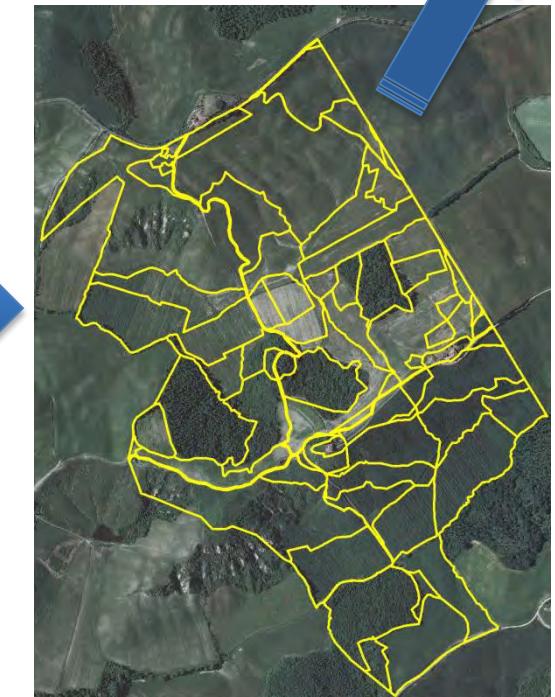
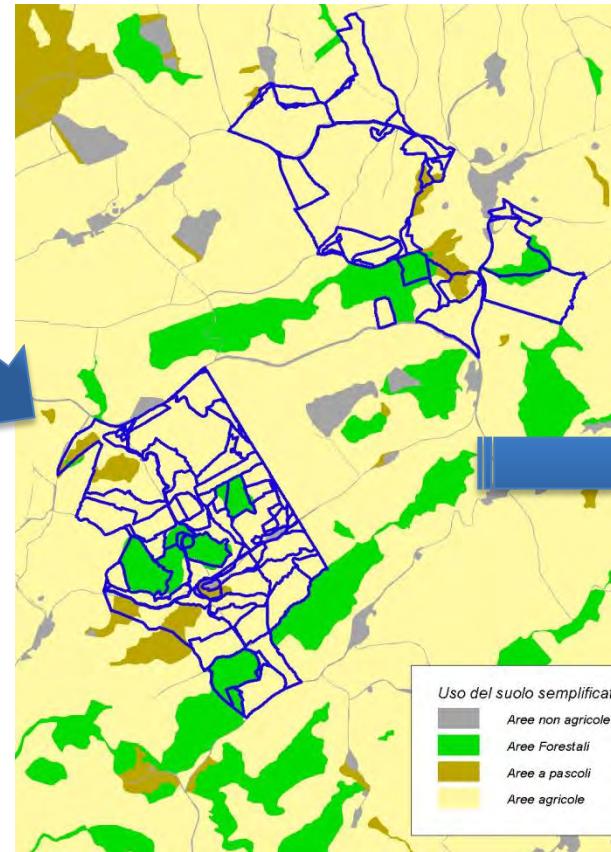
Hydrogeological risk: Mitigation actions

Soil erosion vs agricultural land use

Hazard maps
Vs
cadastral maps

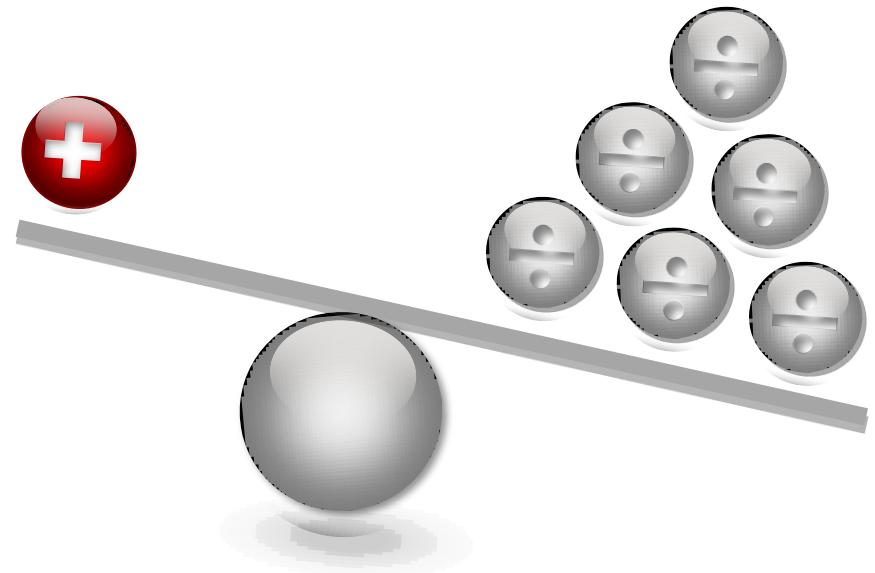


Farm register



Agricultural subsidies

Hydrogeological risk: Mitigation actions in agro-environment



**Land conservation in Italy:
A priority for the correct
development**