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Advanced Instruments in UAS: Drones and Thermography for Risk Management and Emergency Response

Dott. Massimo BELLONI

Senior Pilot and Trainer, LARES Italia
massimobelloni@uniprotezionecivile.it

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Massimo BELLONI

Senior Pilot and Trainer, LARES Italia

Advanced Instruments in UAS: Drones and Thermography for Risk Management and Emergency Response

My aeronautical background began in 1998, when I started my training in recreational and sport aviation at Volarte66 flight school. In1999, I obtained my ultralight aircraft pilot qualification for three-axis fixed-wing aircraft, followed in 2000 by the passenger-carrying qualification. In 2004, I completed the training course for ultralight flight instructors and obtained the related instructor qualification. My experience with UAS, Unmanned Aircraft Systems, started in the professional field in 2018. In 2020, I obtained the Flight Instructor qualification for UAS, and in 2023 I obtained the qualification for the European Standard Scenarios. I currently operate as a UAS professional pilot and instructor, with a particular interest in the integration of advanced instruments, sensors and operational procedures in drone missions. I am also active in civil protection as a volunteer with Lares Lazio, part of Lares Italia, where I serve with a specialization as a drone pilot. This operational context has given me direct experience in the use of UAS for practical missions, where reliability, situational awareness, safety and data interpretation are essential.

Why UAS in emergency management?

UAS = Unmanned Aircraft System

In emergencies, the first need is not flying.
The first need is understanding what is happening.

- Reduce uncertainty in the first minutes
- Reach areas that are dangerous or inaccessible
- Support coordination between command room and field teams
- Transform images into operational information

From model aircraft to UAS

A short history of drones

- Radio control
- Military UAVs
- GPS / autopilot
- Digital cameras
- Civil protection
- Sensor missions

A UAS is a system

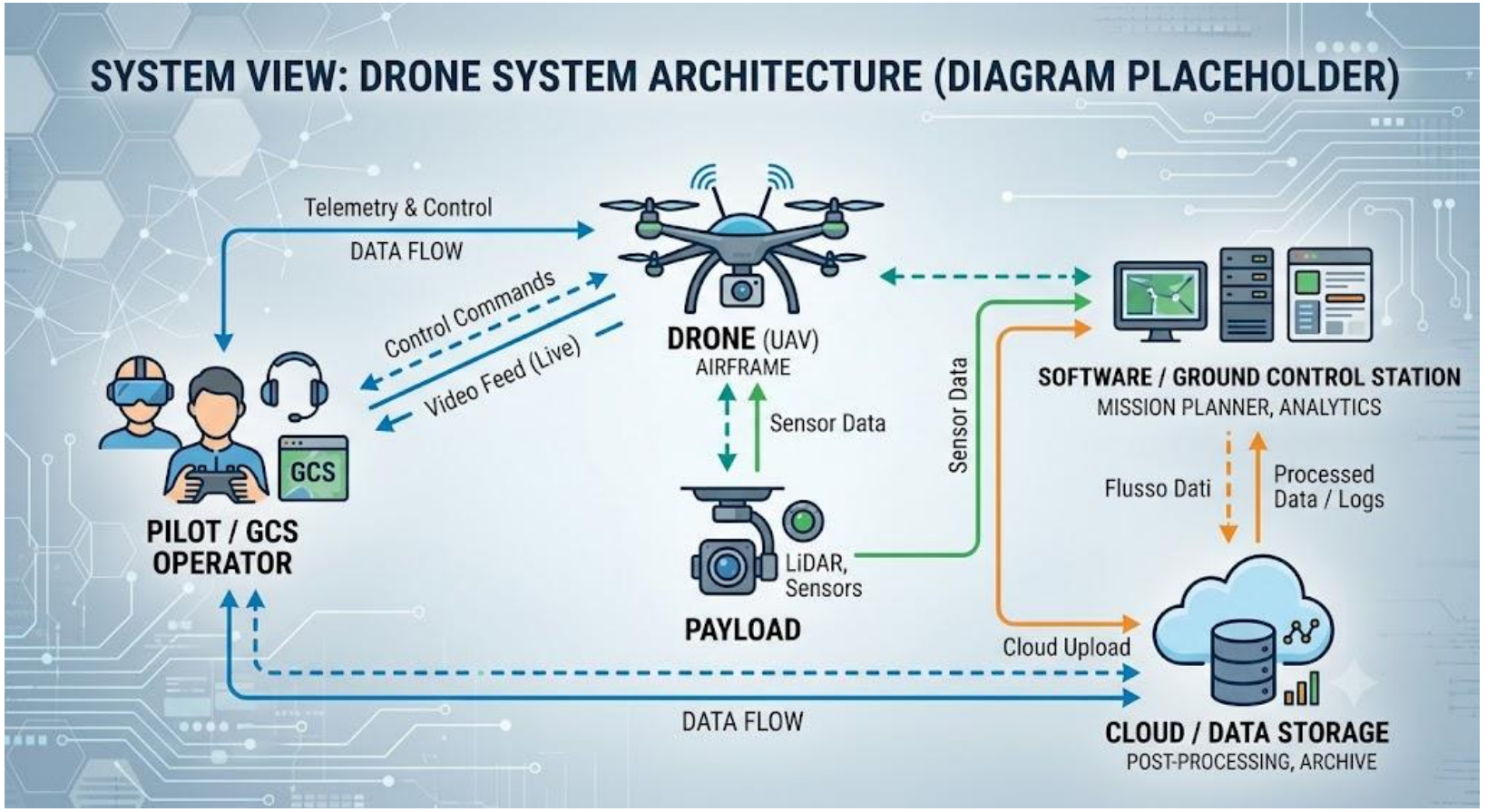
Not just an aircraft, not just a camera

Aircraft	**Payload**	**Pilot & crew**
Software	**Data**	**Decision makers**

The value is created when all parts work together.

A UAS is a system

Not just an aircraft, not just a camera



The value is created when all parts work together.

LARES UAS fleet

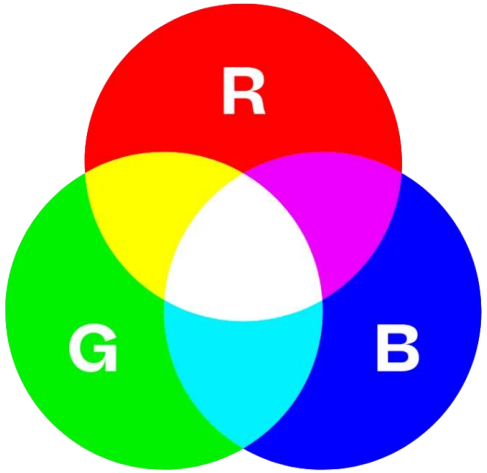
Different drones, different missions

Drone	At demo	Operational role
Matrice 300	Reference platform	Complex missions, advanced payloads, inspection and SAR
Matrice 30	Demo unit	Compact professional emergency drone, RGB/thermal
Mavic 4T	Demo unit	Portable tactical drone, RGB/thermal rapid deployment
Mini 3	Demo unit	Lightweight reconnaissance and training
Agras	Reference platform	Agricultural and specialist scenarios
Phantom 4 v1.2	Demo unit	Historical platform, training and photogrammetry

Sensors: RGB, thermal and handheld thermography

Seeing, measuring and explaining the scene

Same scene, different information.



RGB: visual details, context and documentation

Thermal: heat patterns and anomalies

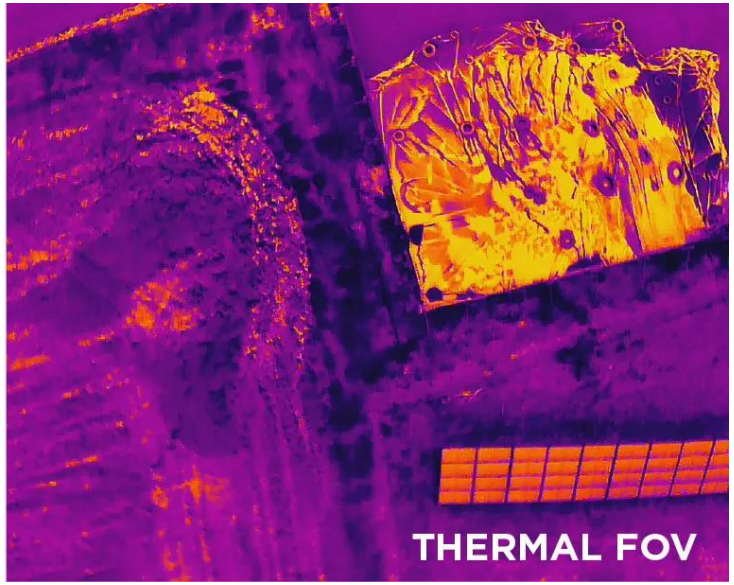
Handheld thermal camera: simple live demonstration before flight

RGB = Red-Green-Blue

Thermography: seeing the invisible

A simple principle with complex interpretation

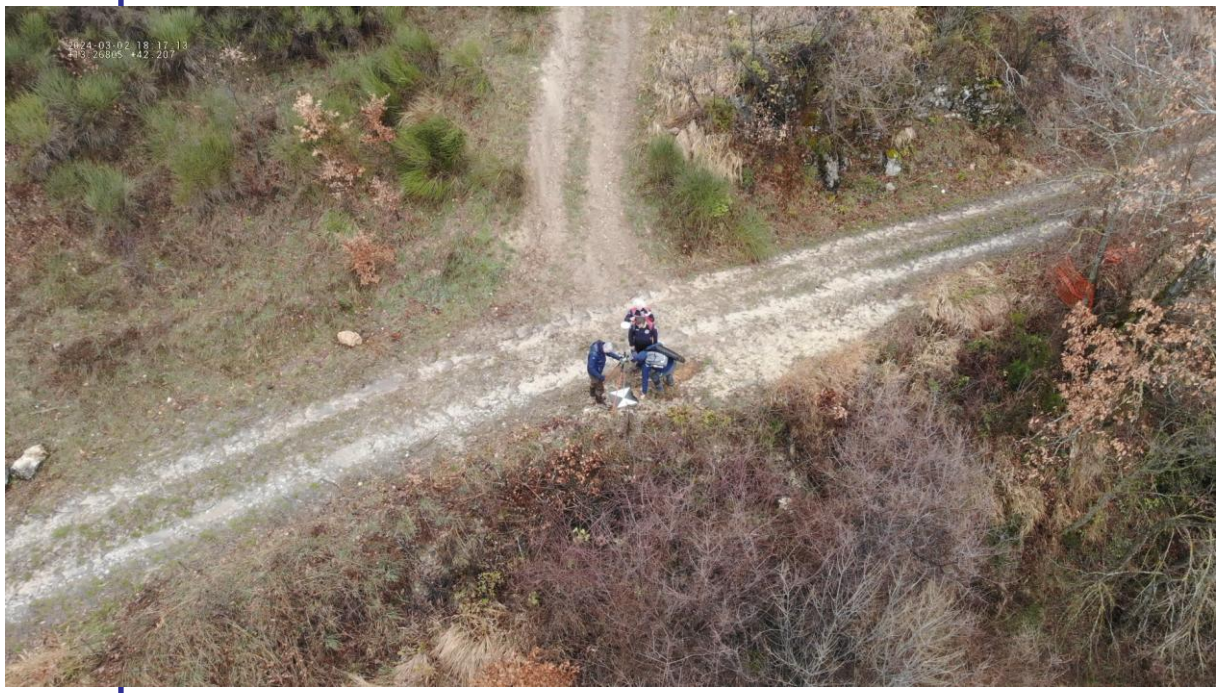
Thermography does not show what things look like.
It shows how they radiate heat.

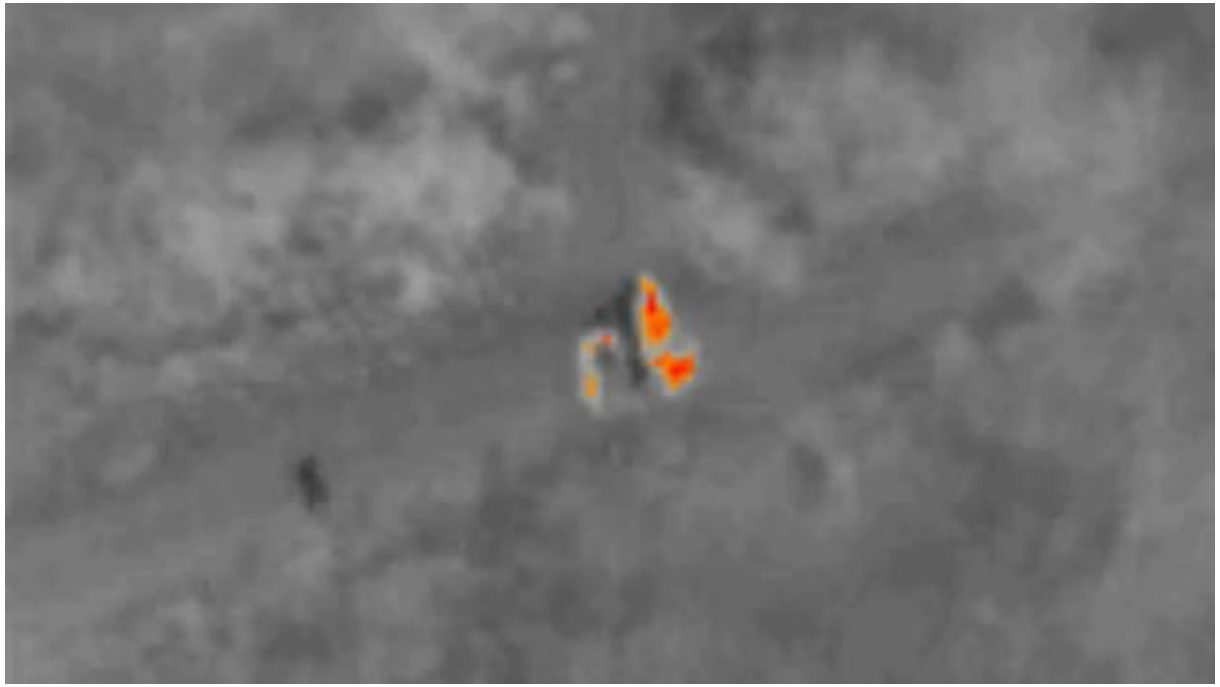


Infrared radiation is converted into an image.
The image represents thermal patterns, not ordinary colour.
Useful for people search, hotspots, inspections and anomaly detection.

Thermography: seeing the invisible

A simple principle with complex interpretation





From industrial tool to drone payload

The evolution of thermal cameras

Industrial cameras

Building inspection

Handheld tools

Radiometric sensors

Drone payloads

Thermal mapping

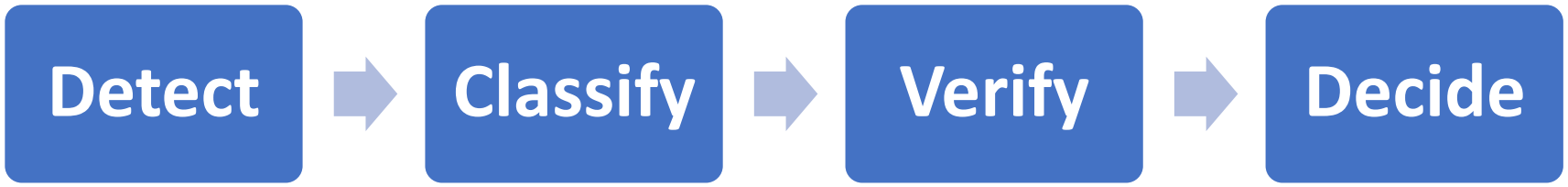
False positives are part of the job

Why interpretation matters

A hot spot is not automatically a person.

Temperature is influenced by material, sun, wind, distance and angle.

Thermal data must be verified with RGB, context and ground teams.



Thermal image is data, not proof

Managing uncertainty is a professional skill

A false positive is not a failure if the procedure identifies it before it becomes a wrong decision.

- Initial thermal target detected
- Compare RGB and thermal views
- Evaluate terrain and environmental context
- Request ground verification if needed
- Classify the target and update the search plan

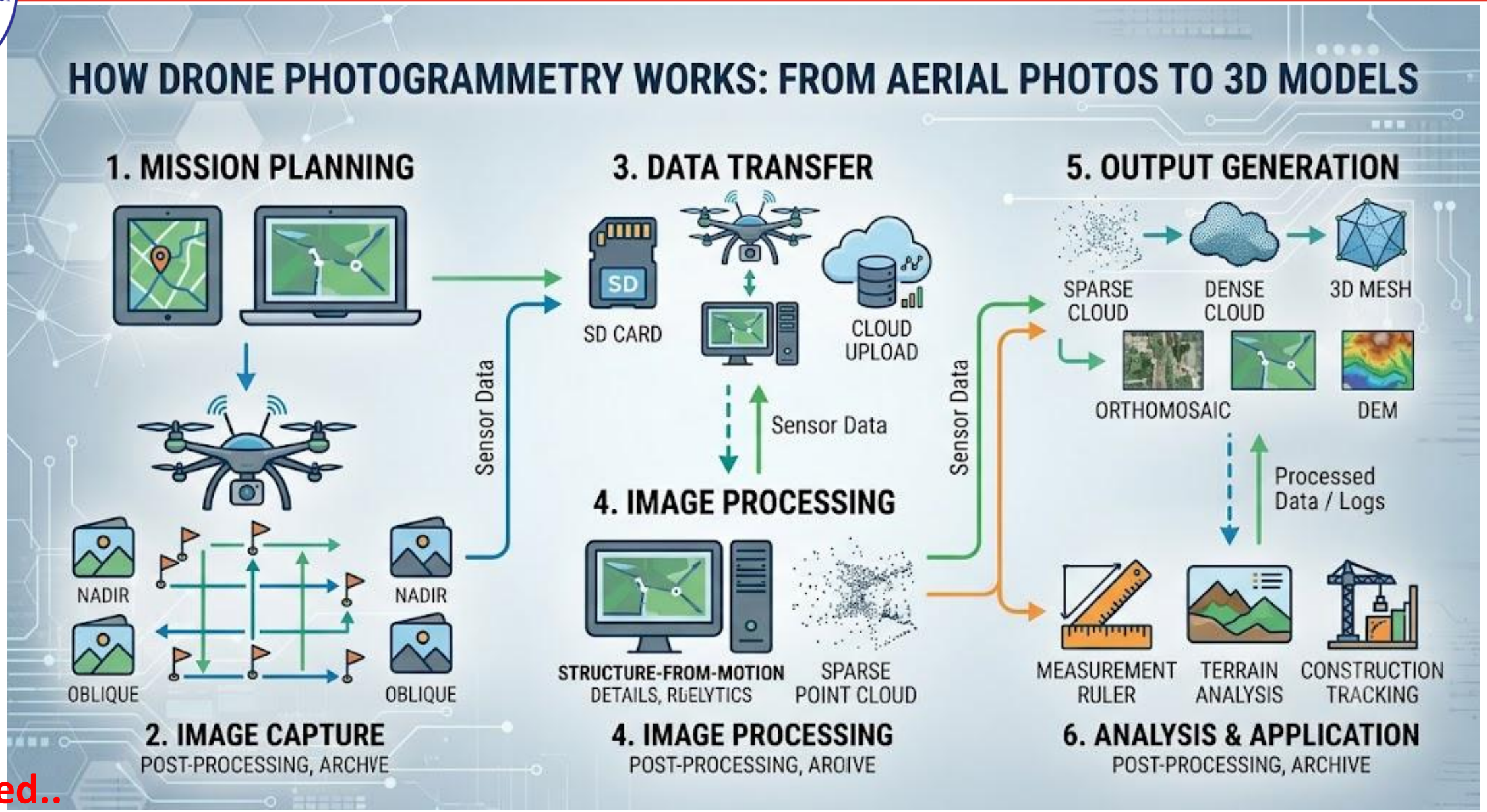
Team building is exactly the key!

Photogrammetry: from photos to measurable models

Many overlapping photos can become maps, 3D models and measurements.

- **Flight grid with overlap**
- **Image alignment and reconstruction**
- **Orthophoto and 3D model generation**
- **Measurements and comparison over time**

Photogrammetry: from photos to measurable models

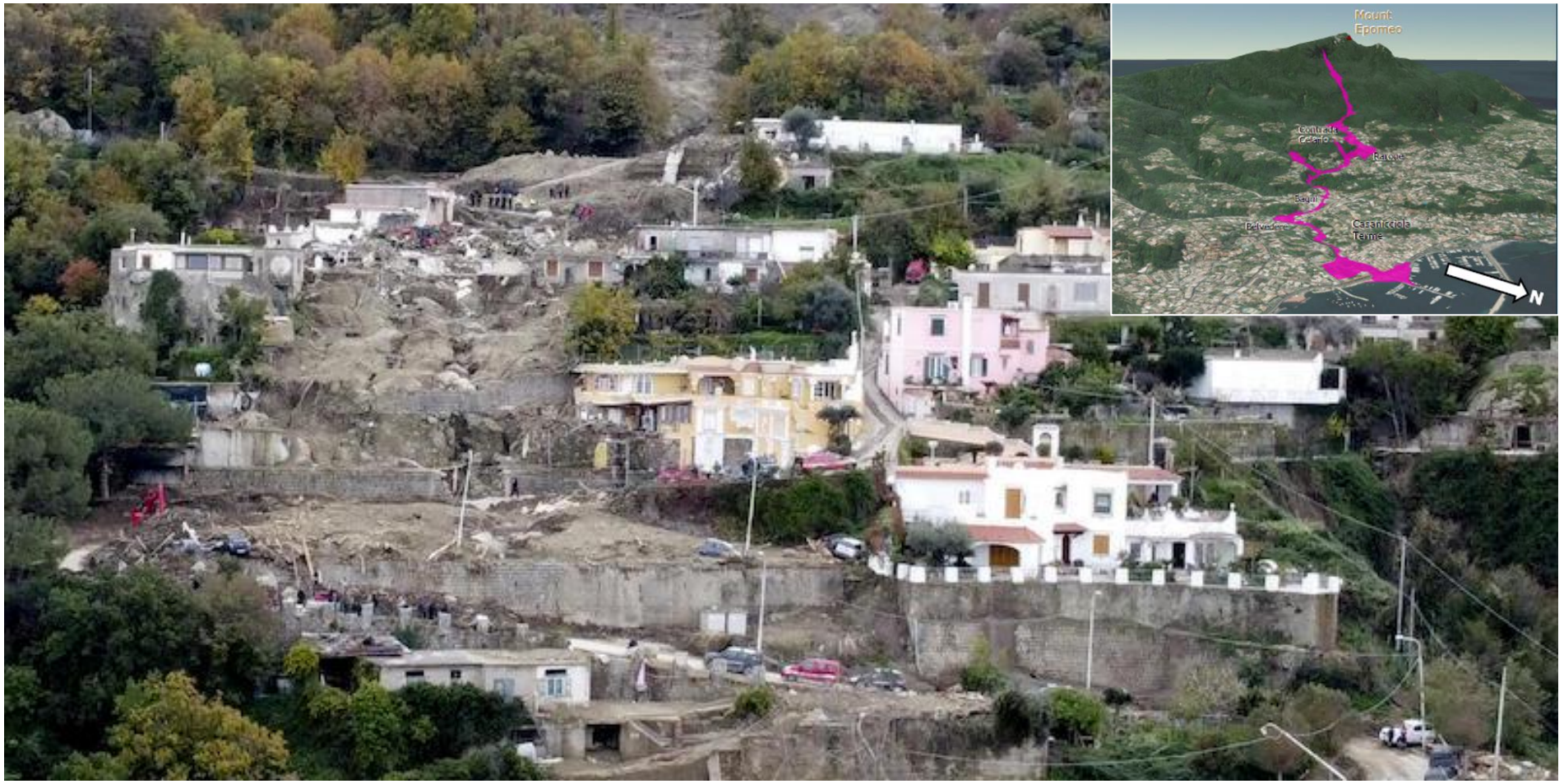


IA generated..

Photogrammetry: from photos to measurable models

Photogrammetry: Some examples…

Preliminary assessment of the Casamicciola landslide



Source: ISPRA

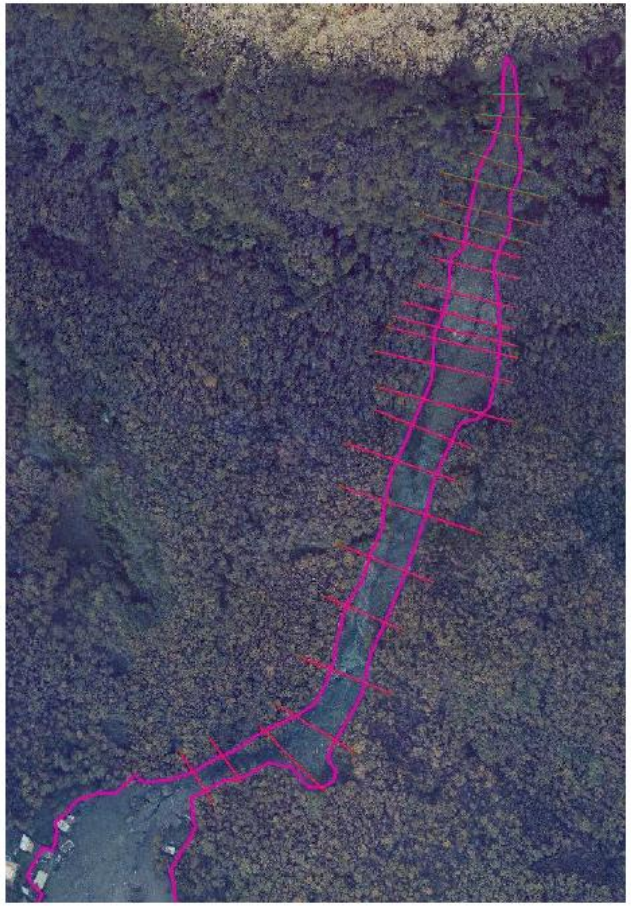
Photogrammetry: Some examples…

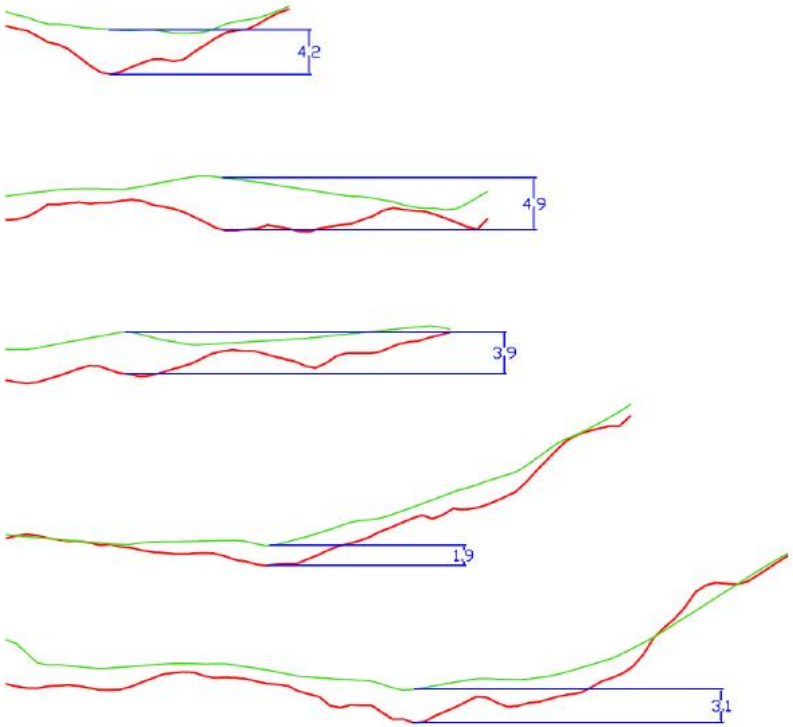
Preliminary assessment of the Casamicciola landslide

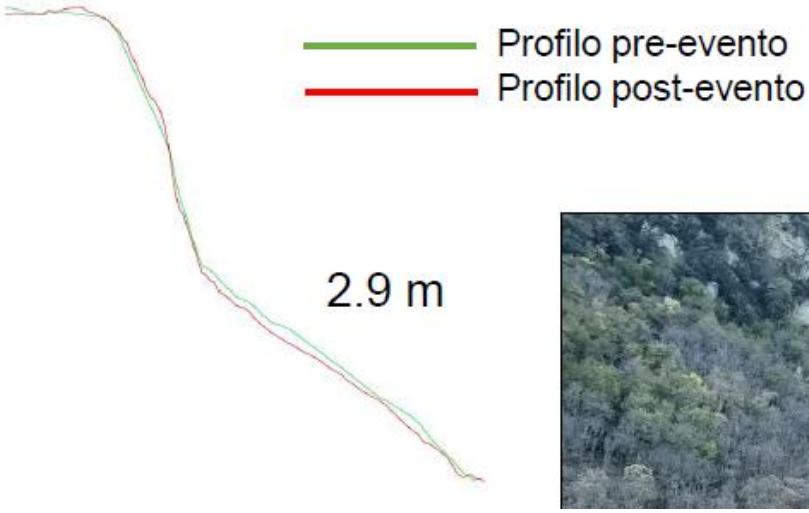
Source: ISPRA

Photogrammetry: Some examples…

Preliminary assessment of the Casamicciola landslide







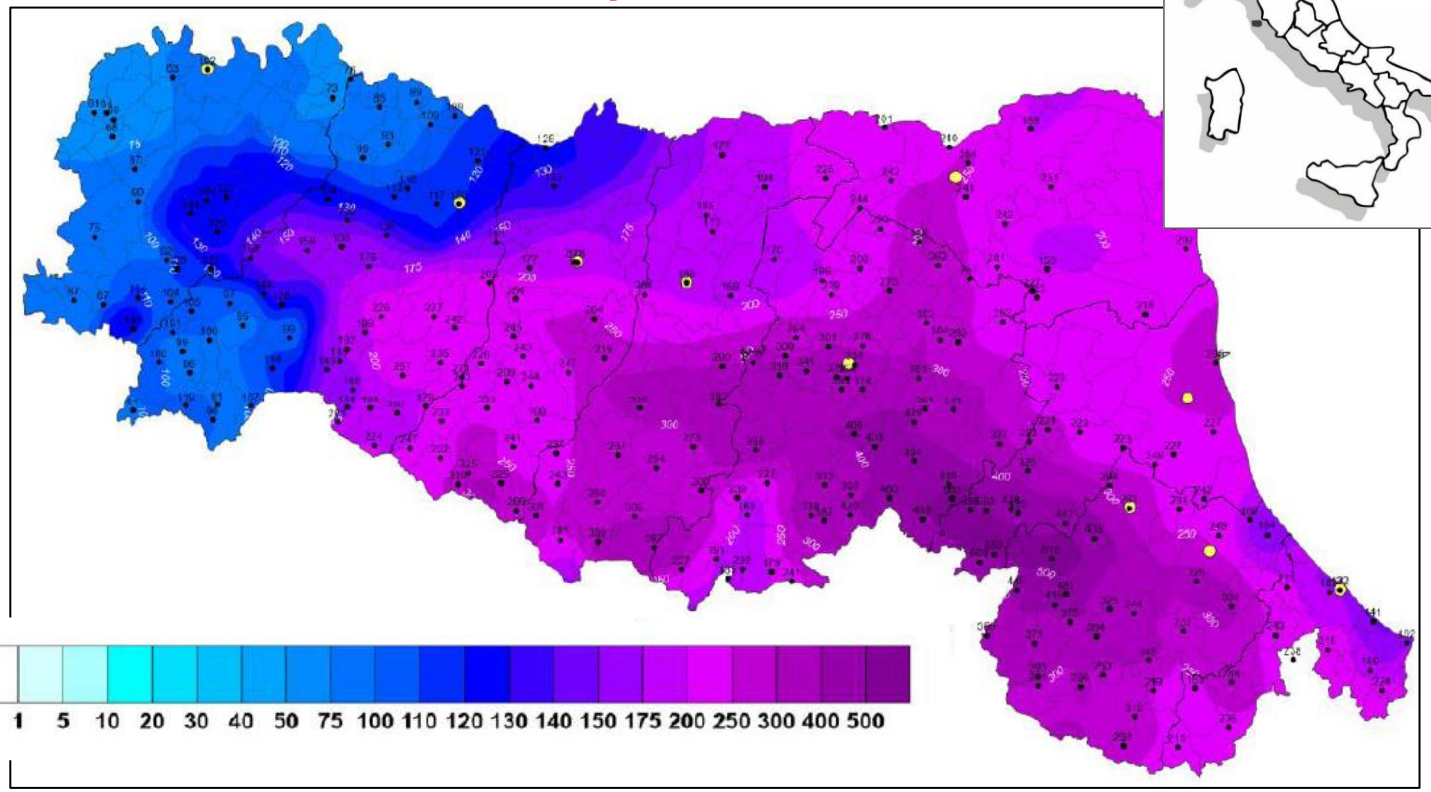
Source: ISPRA

Photogrammetry: Some examples…

Emergency landslide assessment after extreme rainfall

May 1-3. 2023

May 16-17. 2023



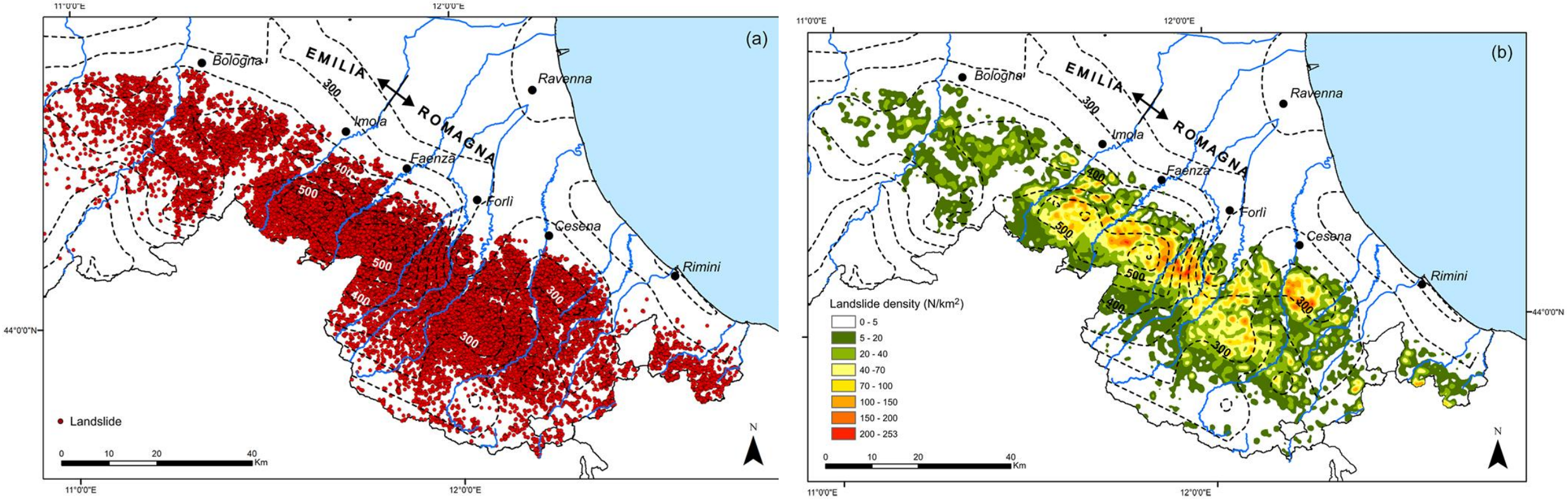
Total precipitation observed across the Emilia-Romagna region from May 1 to May 17. 2023.

Higher cumulative rainfall value registered: 553 mm / 17 days

Source: ISPRA

Photogrammetry: Some examples…

Emergency landslide assessment after extreme rainfall



Landslide density triggered by the May 2023 events: **200-253 landslides/km²**.

Total events: **80.997 landslides** (Berti et al.. 2025)

Source: ISPRA

Photogrammetry: Some examples…

Emergency landslide assessment after extreme rainfall

3 technicians
1 DJI M300 RTK with LiDAR
1 RTK-GNSS Antenna&Controller
1 Pickup truck
5 days (12h per day)
10 field surveys

Derived orthomosaic


UAS flight


GNSS Survey on Ground Control Point (GCP)

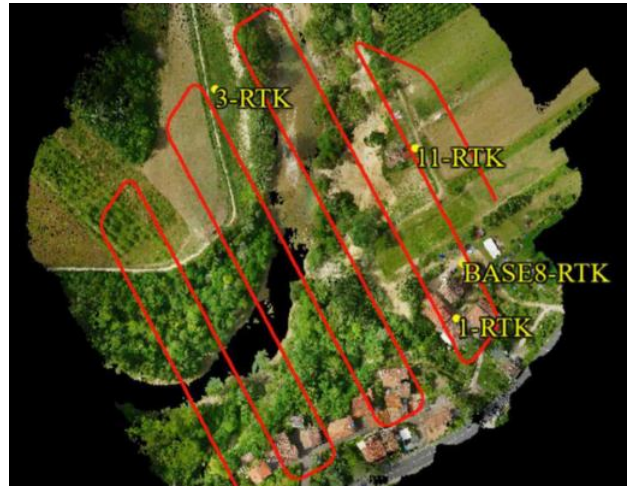

Technicians at work

Source: ISPRA

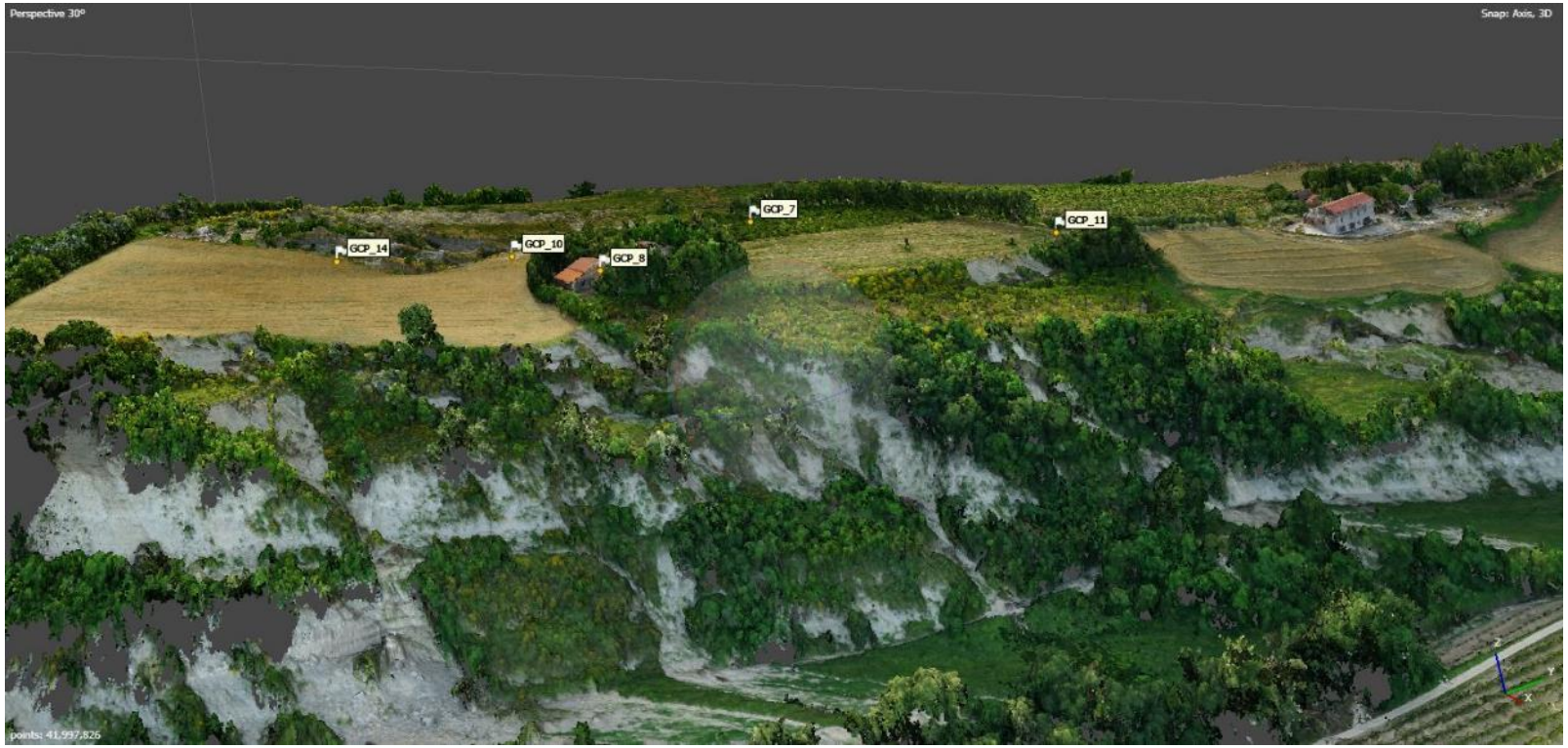
Photogrammetry: Some examples…

Emergency landslide assessment after extreme rainfall

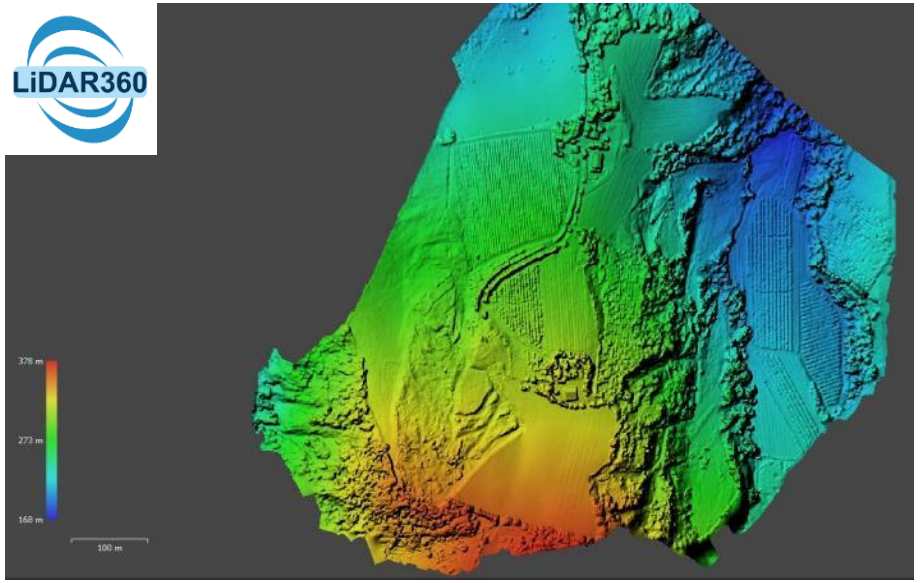
Cloud: 88.804.029 points
Point cloud average density: 271 points/m^2
Ground Sampling Distance (GSD) Orthomosaic: 5cm/px
Check Point RMSE: 0,0132m



flight plan



derived point cloud



derived DSM

Source: ISPRA

Photogrammetry: Some examples…

Emergency landslide assessment after extreme rainfall

GNSS survey on translational slide at Fontanelice (BO)

logistical challenges: unpaved and unusable roads

Source: ISPRA

How we choose the right drone

The mission defines the aircraft, not the opposite.

Mission objective	**Area size**	**Weather**	**Required sensor**
Flight time	**Safety constraints**	**Data output**	**Team available**

Operational limits

Procedures turn technology into a safe operation.

- **Battery endurance**
- **Wind and weather**
- **Visibility and terrain**
- **Airspace and regulation**
- **Privacy and data protection**
- **Loss of link or interference**
- **False positives and wrong interpretation**
- **Too much data, too little time**

Final takeaways

Three ideas to remember

1. **Drones are operational data platforms, not flying toys.**

2. **Thermography helps us see the invisible, but it must be interpreted correctly.**

3. **In emergency response, technology is useful only when it improves safety, coordination and decisions.**

Thank you for your attention…
…and now let's give it a try!!

www.uniprotezionecivile.it

lares@uniprotezionecivile.it

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