Pilot verification of the use of unmanned aircraft systems in cadastral mapping – case study

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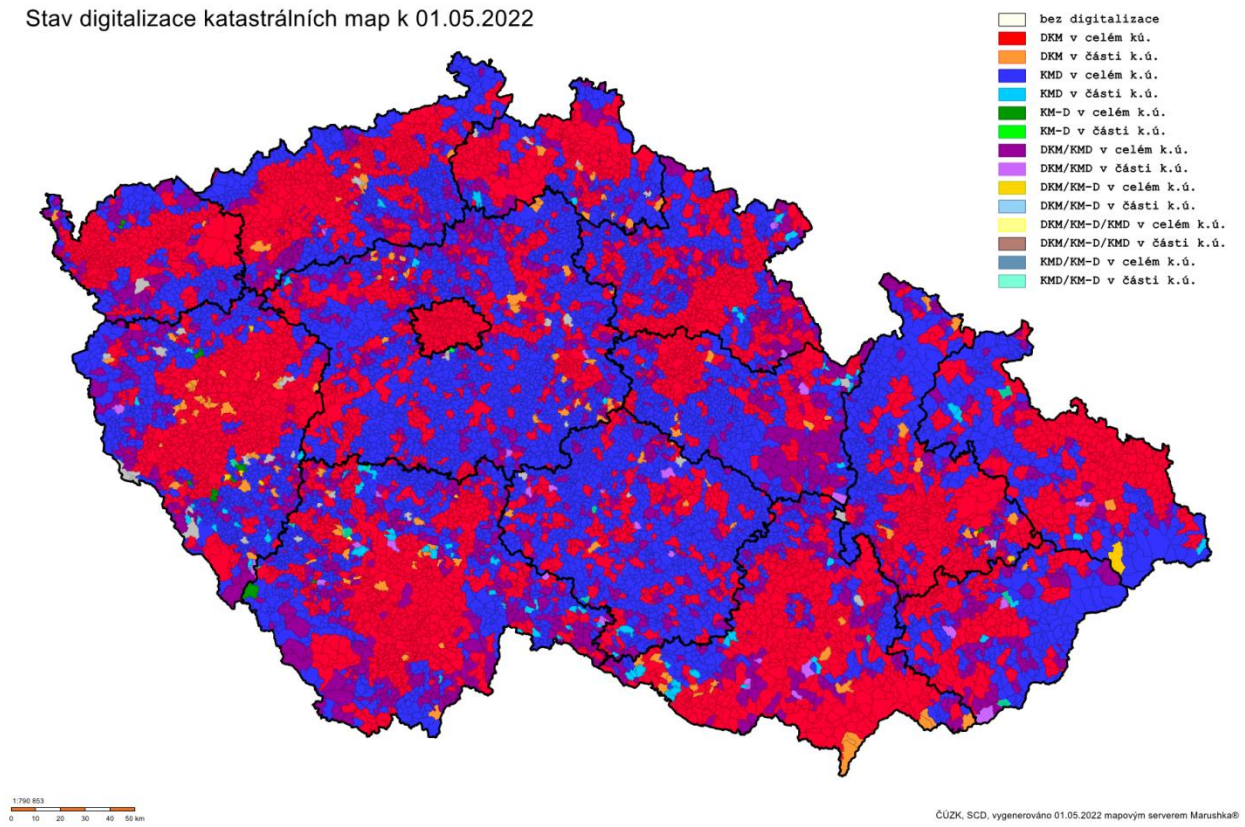


Cooperation between public and private bodies in cadastral mapping projects

Public sector

Responsibility according to the law

Administrative work

Determined boundary plan - owners may come to an agreement about the boundary between their properties

Land survey measurements – in most territories

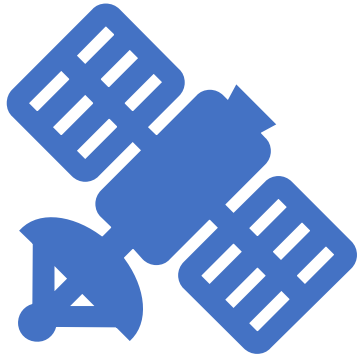
Cooperation between public and private bodies in cadastral mapping projects

Private sector

Submitting survey sketches - maintenance of cadastral maps

Land survey measurements – in some mapping projects

Case study - objectives



Can data taken by unmanned aerial systems be used for cadastral mapping?

Is data precise enough for accuracy class of boundary points stipulated by cadastral law?

Case study

Pilot verification of the use of unmanned aerial systems in cadastral mapping

- Two territories chosen – Žlunice and Klášter nad Dědinou

Involved parties:

An agreement between Cadastral office and **private company** on provision of data – orthophotos and a point cloud

Land survey measurements – carried out by **Cadastral office** (Ground control points, additional fieldwork)

Owners may come to an agreement about the boundary between their properties

Cooperation with the **municipality**

Drone

Trimble UX5 Unmanned Aircraft System

- Fast and safe aerial data collection
- Camera - 24 MP mirrorless APSC with custom 15 mm lens
- Short setup time with automated procedures in Trimble Access field software
- Flights were conducted in a fully automated manner
- Height above take-off location (AGL) - 75 m to 750 m
- Very sharp, colour rich images, even in dark or cloudy conditions
- Raw image file

Obtained data - **Orthophotos**

Scaled photographs positioned on a grid of ground control points	Tilted images	Side lap 77 % (± 10 %) and end lap 77 % (± 10 %)	Orthophotos processed by Space Intersection Photogrammetry of multiple images
Adjusted files in TIFF and JPEG format	Optimal image quality - Ground sample distance (GSD) 2 cm (± 20 %) and GSD 10 cm	6000 x 4000 pixels	Precision analysis

Obtained data – **Point cloud**

DTM
Digital Terrain Model

DSM
Digital Surface Model

Geo-referenced

Point cloud density

Precision analysis

Ground control points

The area has a planimetric extent of about: 1219 x 1343 [m].

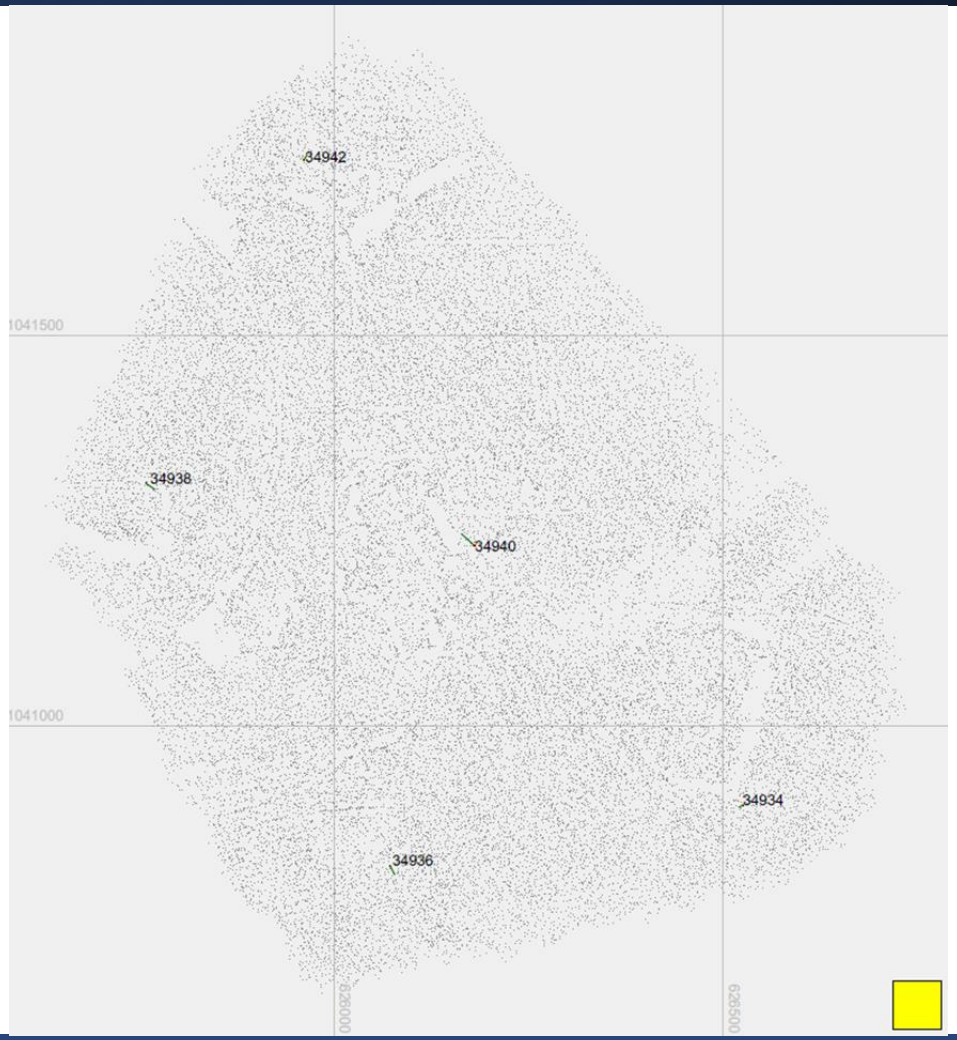
Rectification of images is generally achieved by "fitting“ the projected images of each photograph to a set of ground control points whose positions have been derived from ground measurements.

: Scale for the symbols. Symbol in the graphic is correlated to 0.008 [m] in the object.

: Residual XY (5) for ground control points (min=0.001, avg=0.001, max=0.003 [m]).

: Residual Z (pos.:2/neg.:3) for ground control points (min=-0.000, avg=0.000, max=0.000 [m]).

: Tie point location for 39993 points.



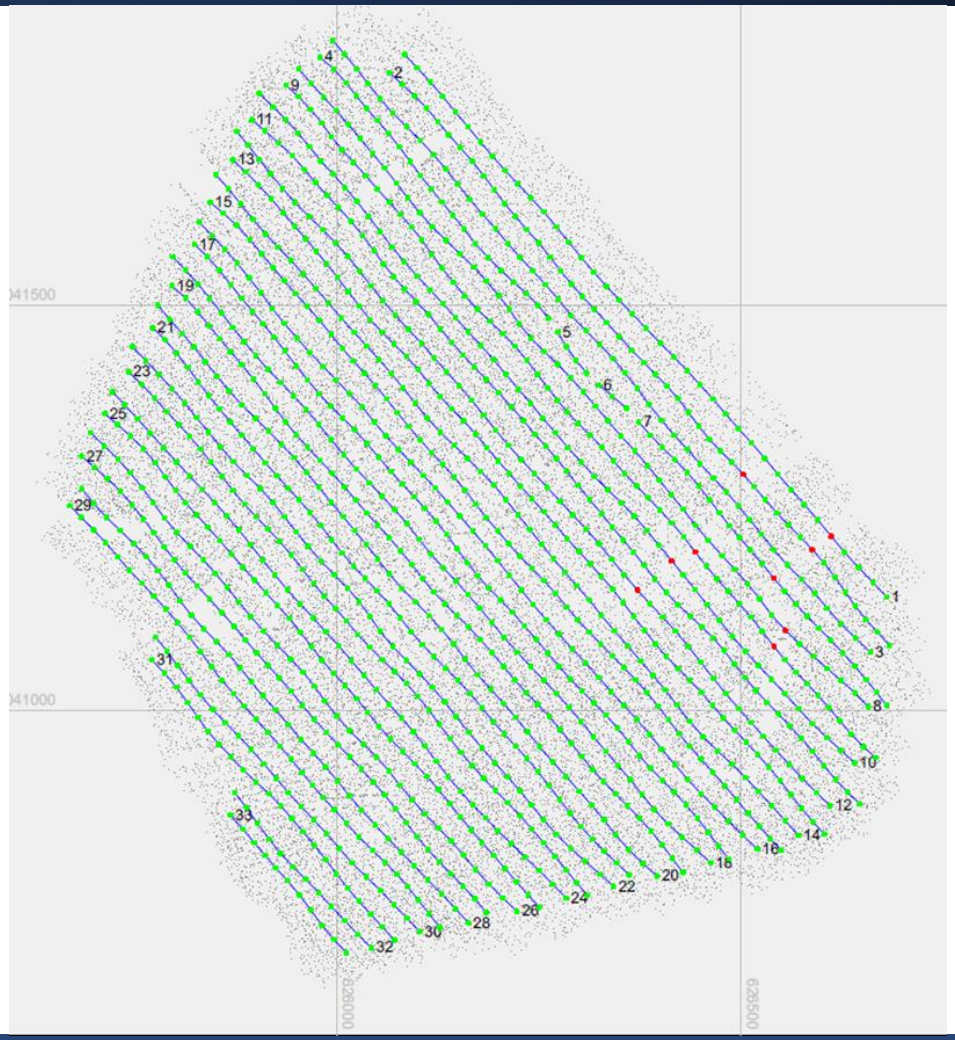
Flight overview

Graphic with 33 strip definitions for the arial triangulation.

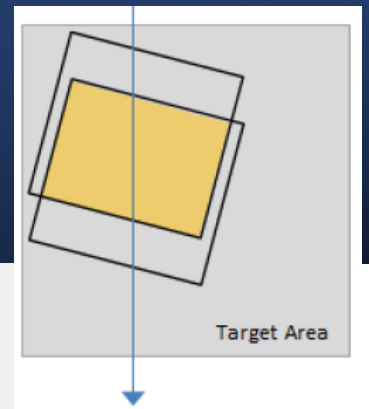
1194 adjusted photos

9 eliminated photos

Flight time/duration 2 days

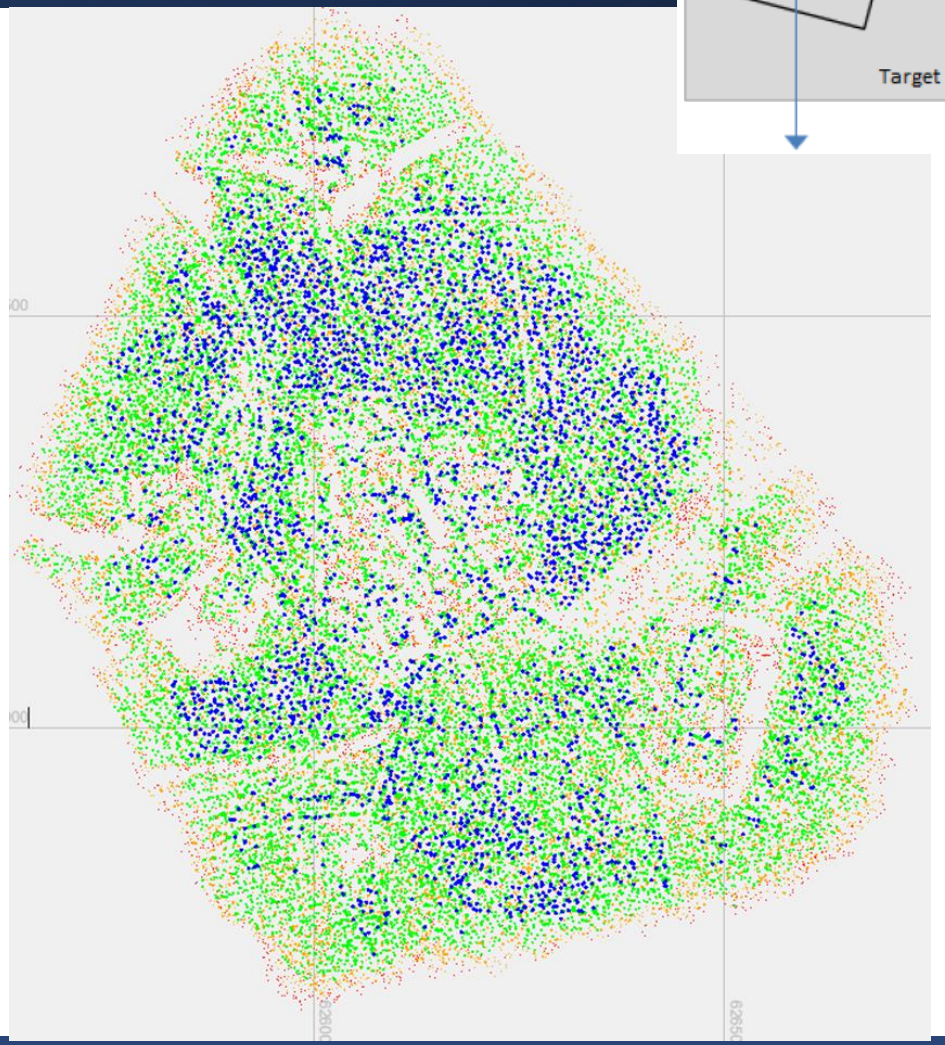


Tie point distribution



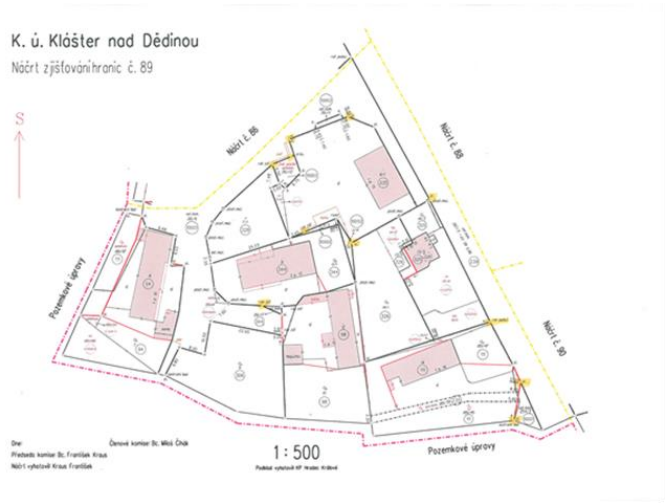
Tie point distribution of 39993 points in the project

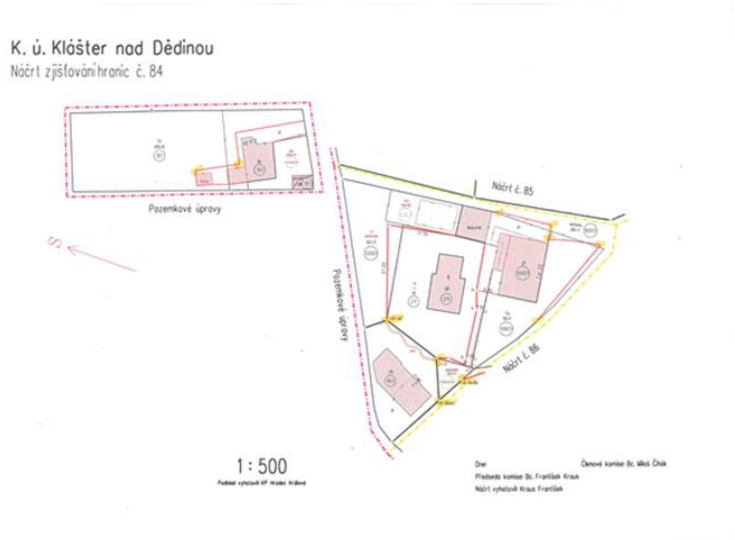
The point size and colour reflects the number of images containing the point



: Point found in (0-2) images.
: Point found in (3-4) images.
: Point found in (5-10) images.
: Point found in (>10) images.

Determined boundary plan

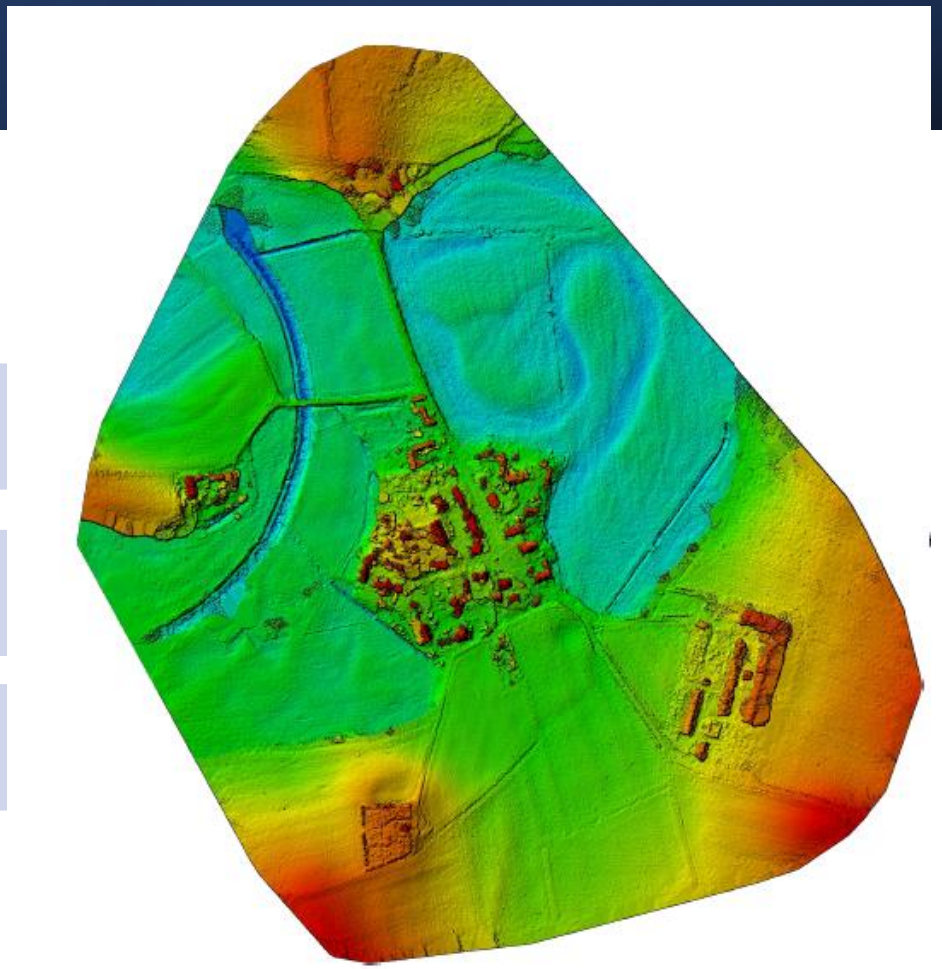




Software – GeoStore® V6

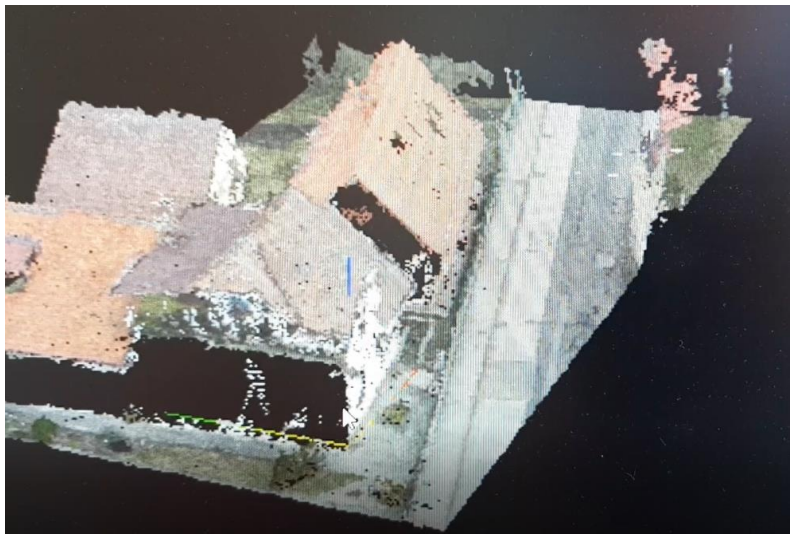
GeoStore® V6 is an advanced GIS system based on Microsoft .NET

- apllication software V6-3D
- graphic editor
- point cloud processed



Point cloud

1



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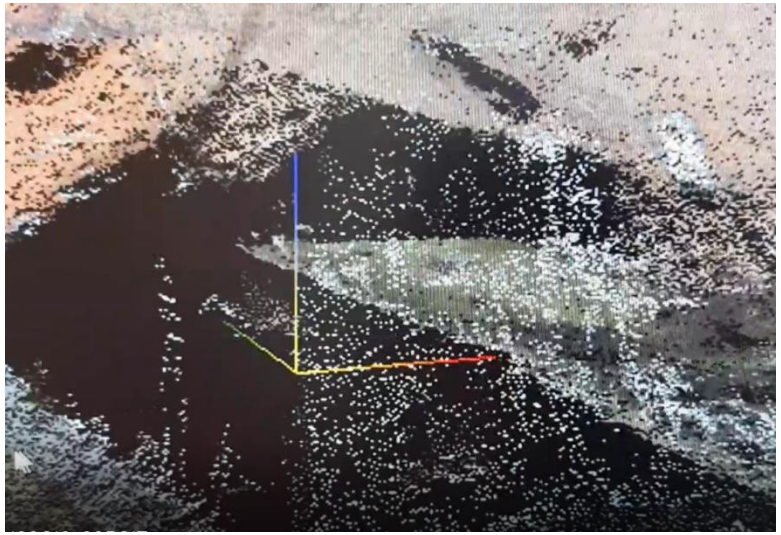
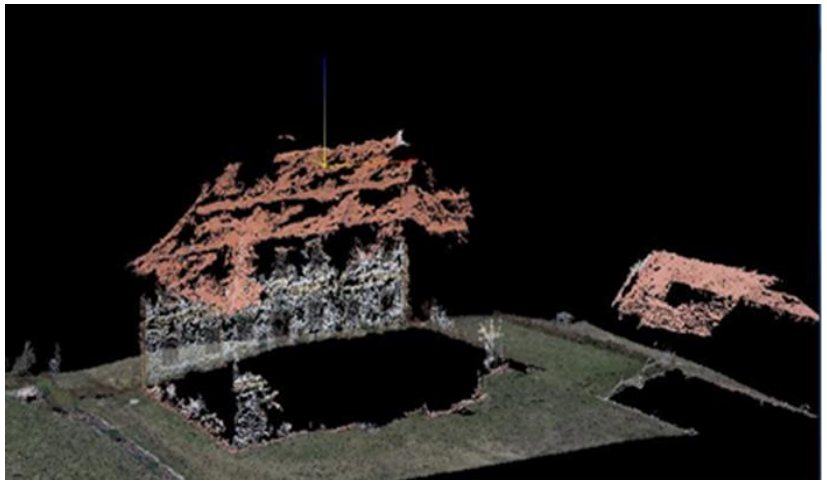


3

Point cloud



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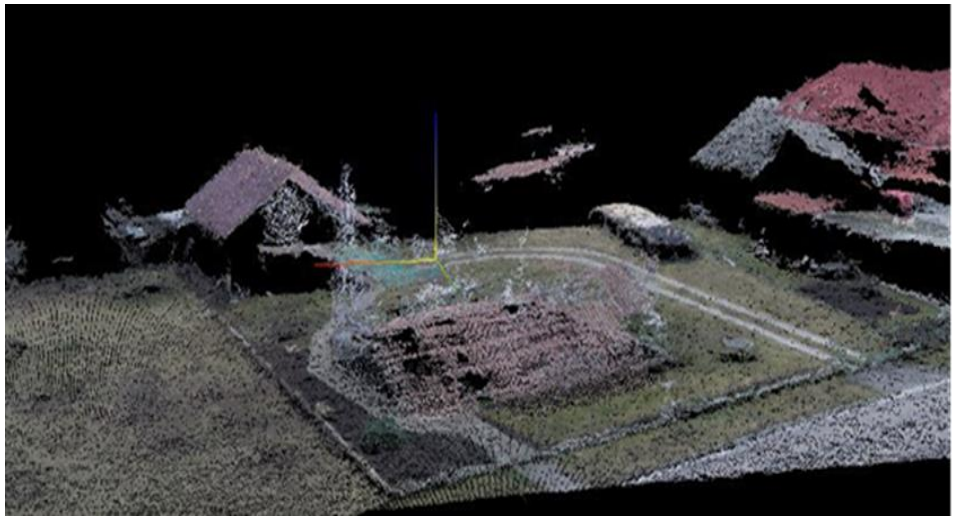
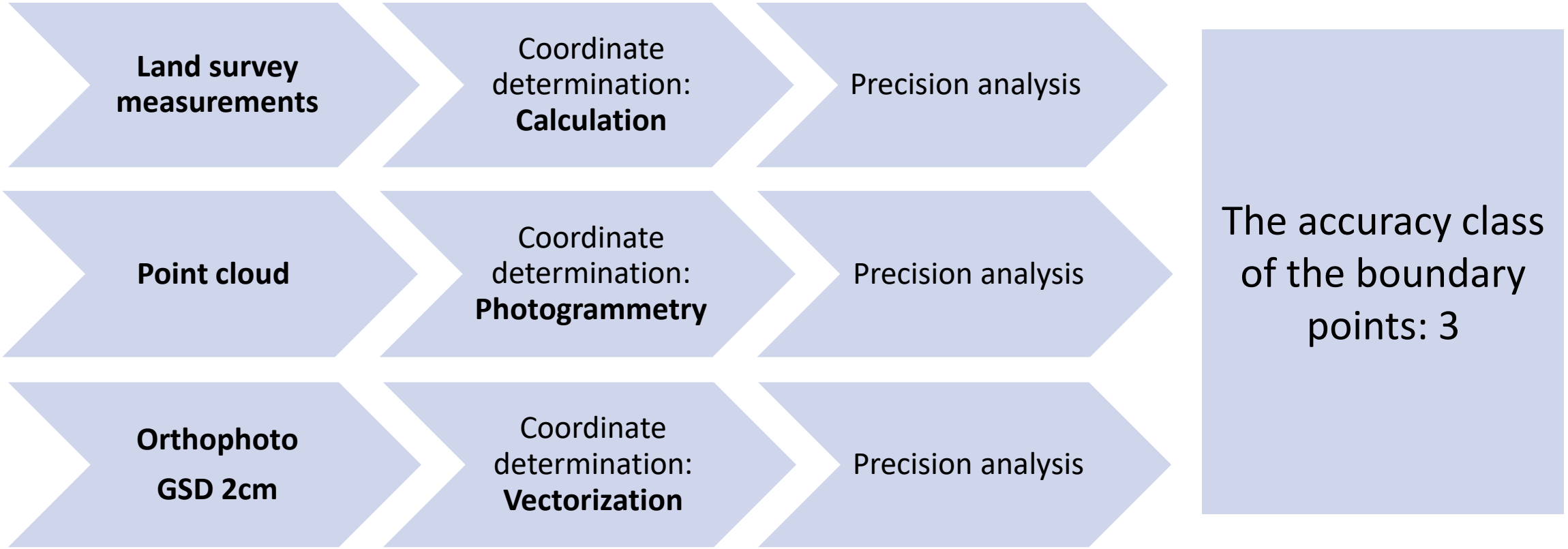


6

Coordinate determination and precision analysis



The accuracy class of the boundary points 3: root mean square error of the coordinates 14 cm (Decree n. 357/2013 Coll.)

Summary

Data taken by unmanned aerial systems can be used for cadastral mapping - determined about 45 % of all border points in the cadastral map, 55 % of the border points were not visible in the orthophoto or in the point cloud and had to be determined in cooperation with the owners

Data taken by unmanned aerial systems is precise enough for accuracy class of boundary points stipulated by cadastral law

Tilted images were useful for coordinate determination

Cooperation between public and private sector

Thank you for your attention