Geodesy, Cartography and Cadastre Authority of the Slovak Republic

Revision of Cadaster Data and other Tools and Methods for Updating Cadaster Content

39. Fachtagung der Vermesssungsverwaltungen von Friaul-Julisch Venetien, Kroatien, Österreich, Slowakei, Slowenien, Südtirol, Trentino, der Tschechischen republik und Ungarn

14 - 16 Mai 2024

Michal Leitman, Martina Behuliaková

The content of the presentation – 2 topics

<u>Long-term activity</u> – Vector cadastral map „implemented“ - VKMi

- the tool for improving the quality of maps
- the principle of realization
- statistical data on cadastral maps
- results for professionals and public

<u>New activity</u> - Testing of photogrammetric and laser scanning

- <u>for cadastral mapping</u>
- for works on the state boundaries and geodetic controls

Task VKMi – vector cadastral map „implemented“

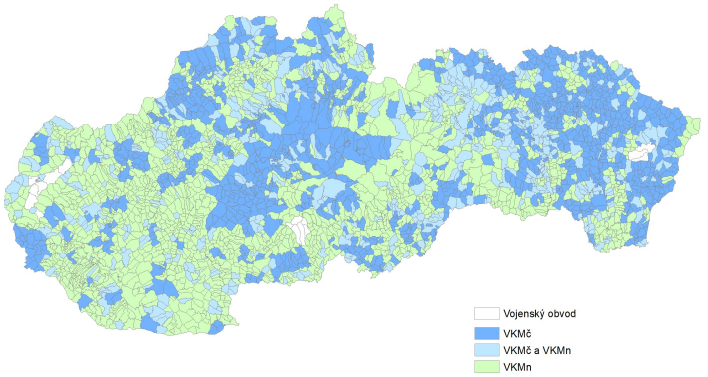
- Slovakia - 3559 cadastral units (17 military areas)

  / 4209 cadastral maps – different quality

  (two or three maps of different type in one area)
- Creation of implemented cadastral maps **– VKMi**
  - start in 2013
  - Since 2015 - cooperation with private surveyors
- VKMi - Cadastral maps, where local numerical results - individual measurements - are incorporated directly into the maps, which were created by other than numerical methods and the surroundings are connected to these data.

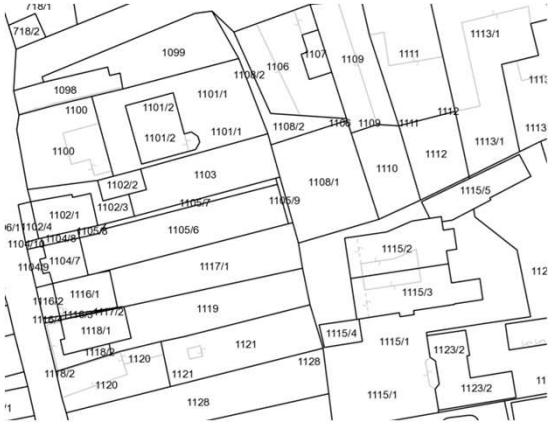
- 636 vector cadastral maps are „implemented“ VKMi

  - it is 15 %



Division of vector cadastral maps

Vector maps	Number of maps
Total number of vector maps	4202
VKM numerical	1897 45%
VKMt (transformed)	1669 40%
VKMi (implemented)	636 15%

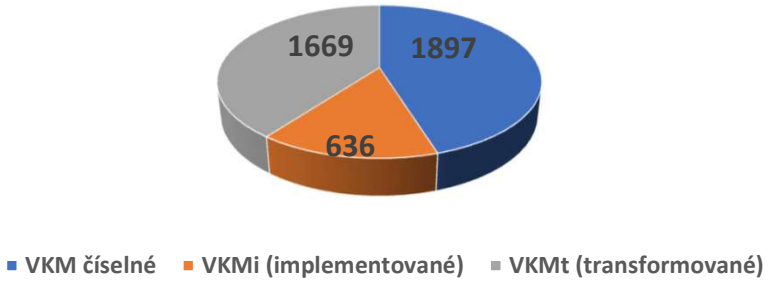


VKM numerical

VKMt (transformed)

VKMi (implemented)

Quantification of cadastral maps

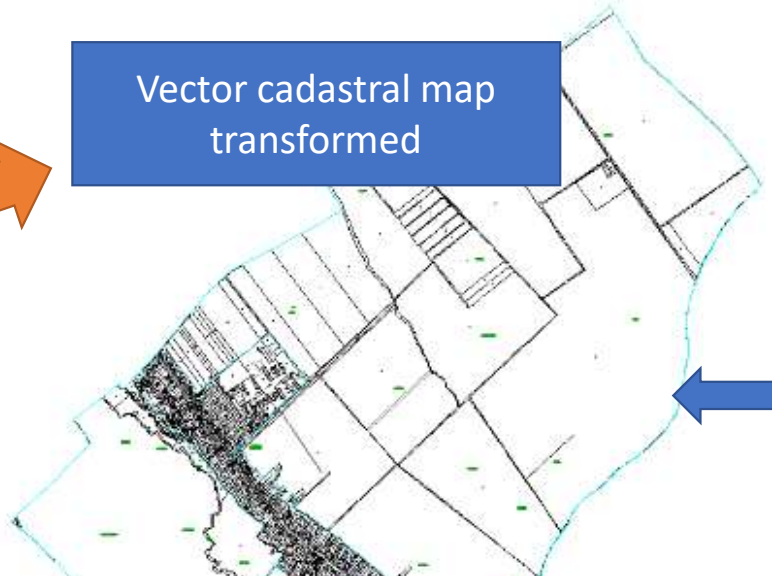


In years 2018 – 2023
119 cadastral units
on a campaign basis with private surveyors

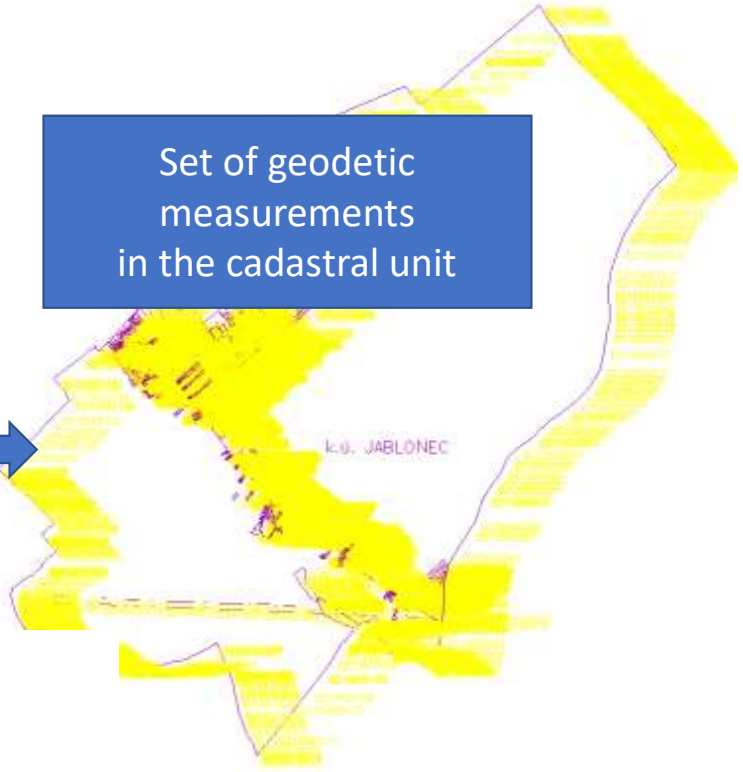
Non-numerical vector cadastral maps and their updating

Non-numerical vector cadastral maps

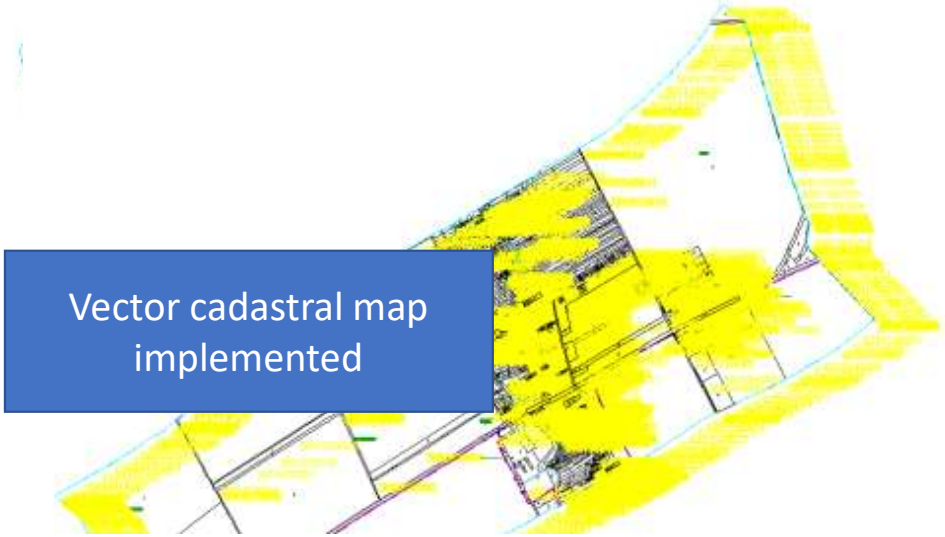
Vector cadastral map transformed



Set of geodetic measurements in the cadastral unit



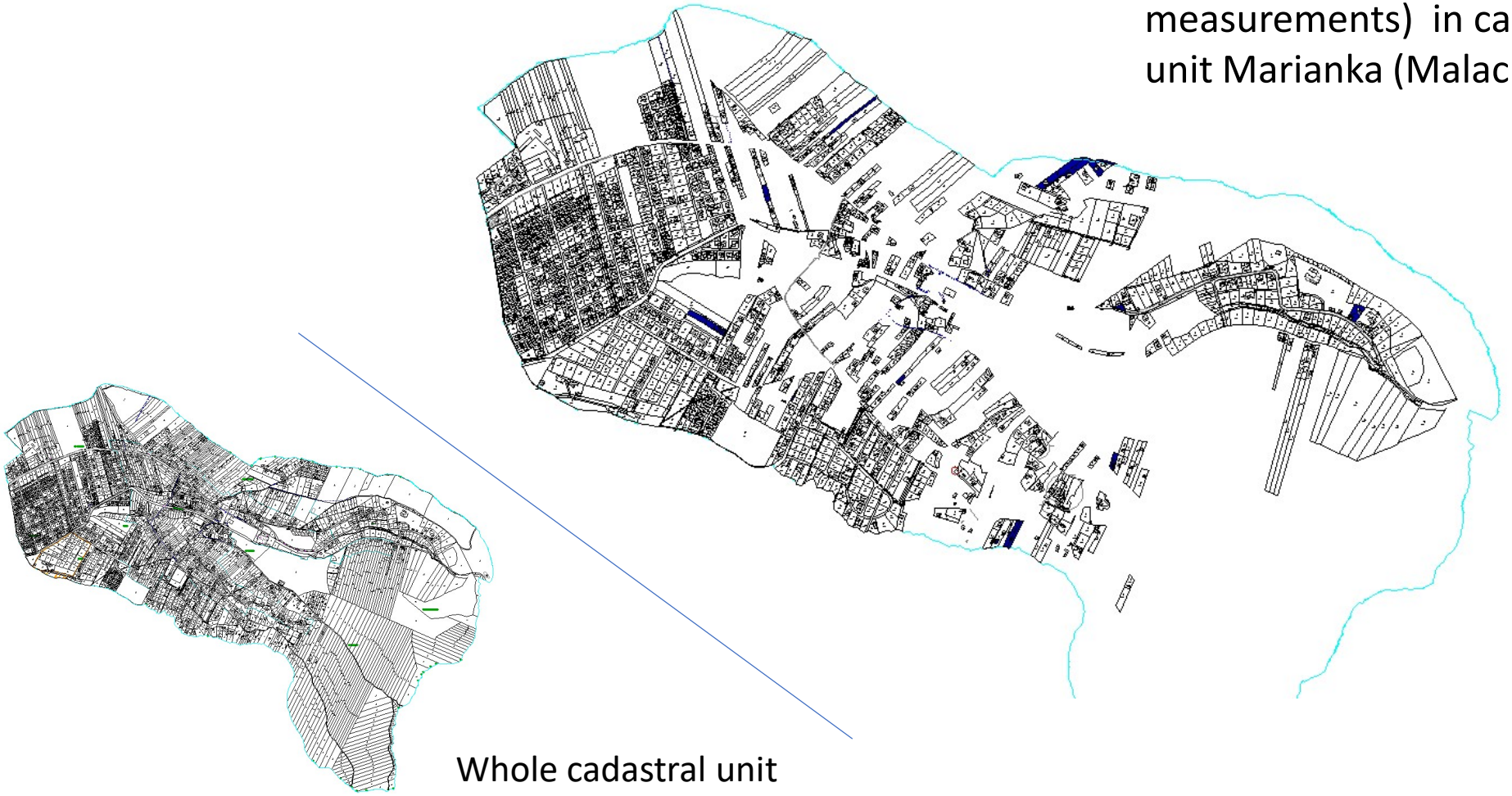
Vector cadastral map implemented



Non-numeric cadastral maps has been reconsidered and they are treated as **partially numeric maps**

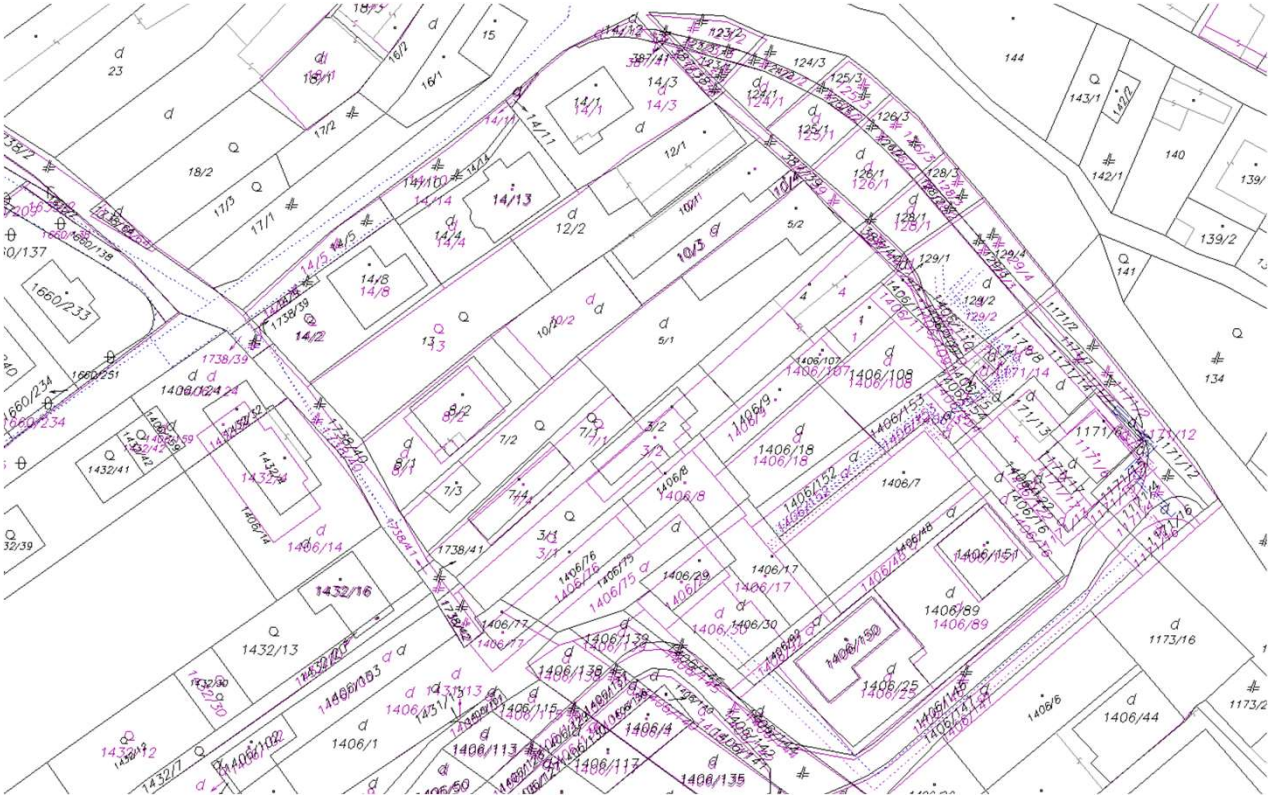
Set of geodetic measurements (SPM)

SPM (set of geodetic measurements) in cadastral unit Marianka (Malacky)



Whole cadastral unit

VKMt vs. measurements



KN832189_3_8 - black

KN832189_SPM - violet

The black state is the original map and violet is after improvement.

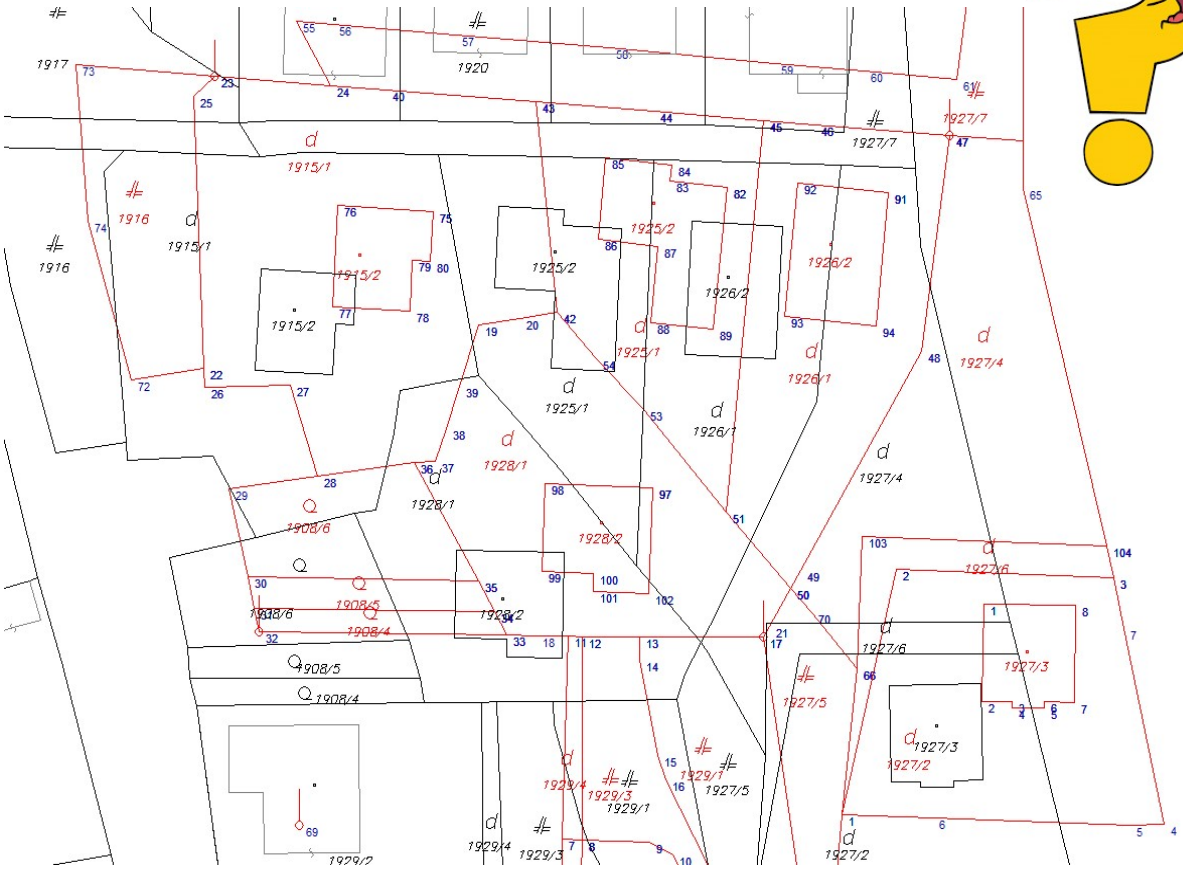
No rights are changed, only the map view is changed - improved.

Cadastral maps in Cadastral unit Limbach (Pezinok)

KN832189_3_8 - black

Which cadastral maps are not suitable for VKMi creation?

- incorrect map maintenance
- wrong drawing of survey sketches into cadastral map
- shifted property boundaries and consequently incorrect investigations, faulty survey sketch drawings
- non-compliance with initial measurements
- survey sketsh made in local coordinates subsequently transformed to S-JTSK so-called quasi-numerical boundaries

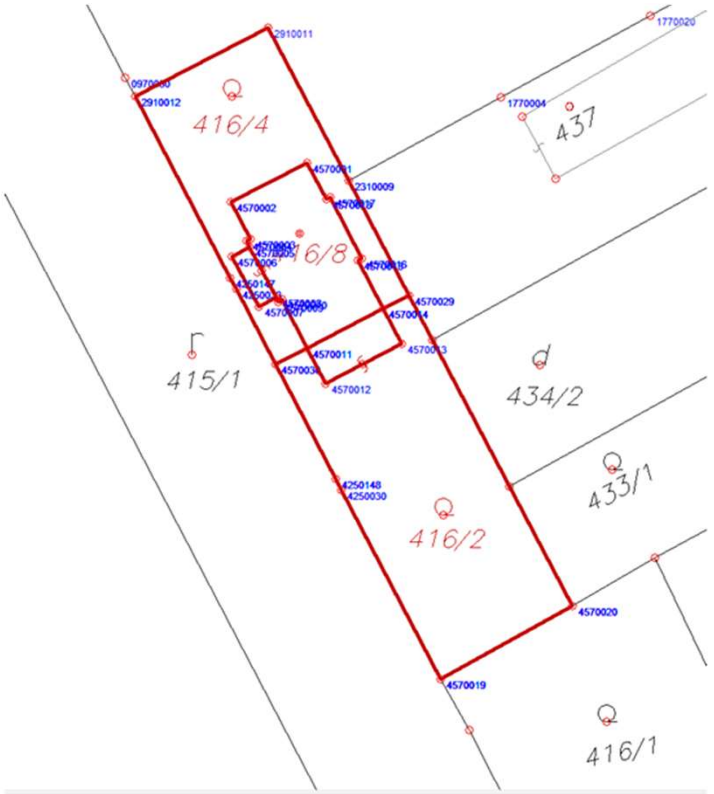


<u>In some areas only a new mapping is the solution how to improve the quality.</u>

Advantages of updating the vector map in an implemented way

- updating only one map file
- immediate overview of the numerical results in the cadastral unit
- complete provision of information for geodetic and cartographic work as for VKM numerical
- easier and faster production of survey sketches
- faster survey sketch verification by cadastral office
- VGPi designed to automate the update of VKMi

VGPi is the technical basis for updating SPM and VKMi according to technical specifications.



New methods of measurement - testing of photogrammetric and laser scanning for cadastral mapping, state boundaries and geodetic controls

start in 2023

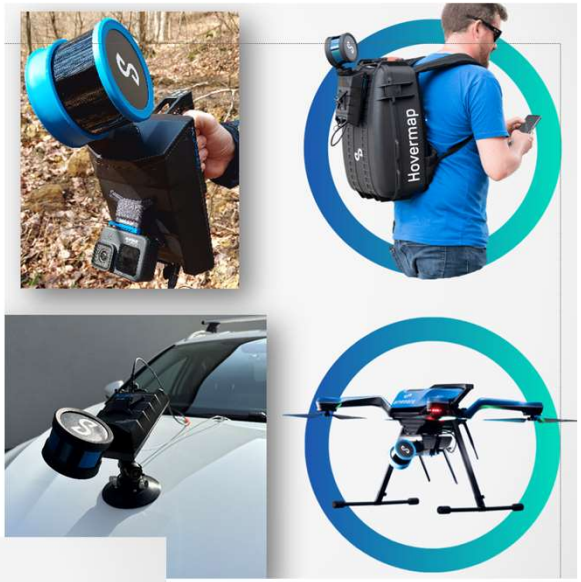
Motivation

- 1. **Cadastral unit - Kalinovo**
  - The Addition of new terestrial measurements
  - The Creation of 3D model from DJI Mavic 3 using DJI Terra
- 2. **Determination of spatial coordinates of points in buildings - gravimetric points**
- 3. **Photogrammetry and laser scanning testing in forested areas**
- 4. **Surveying of watercourses –** usage for state boundaries

  - Realised in 2023 - Geodetic and Cartograpic Institute Bratislava
  - Cooperation with private geodetic companies
  - The Research task – ***The use of modern measurement technologies to improve the quality of cadastral mapping*** – is currently underway - Research Institute of Geodesy and Cartography

Devices, Equipment – platforms, sensors

- **Emesent Hovermap ST-X**
  - universal: handheld, backpack, car, boat, drone
  - SLAM technology
  - 3-fold reflection
  - range 0,5 – 300 m
  - scanning speed 1,9 mil. points/second
  - without GNSS, need VB
  - additional camera – point cloud colouring
  - weight 1,7 kg



- **Microdrones mdLiDAR1000HR**
  - weight: 6,5 kg
  - LIDAR Velodyne 16
  - field of view up to 90°
  - GNSS georeferencing + IMU Trimble APX-15 IMU
  - 2-fold reflection
  - flight time 25 mins
  - 5 Mpix - colouring scans
  - position and height accuracy 0.04 m,
    (accuracy without ground control points)

Ing. Ján Bublavý, GKÚ

Ing. Ján Bublavý, GKÚ

Devices, Equipment – platforms, sensors

- **Lidaretto**
  - universal: handheld, backpack, car, boat, drone, train
  - LiDAR HESSAI – 32 channel
  - 3-fold reflection
  - range 0,5 – 300 m
  - GNSS georeferencing + IMU
  - additional camera - point cloud colouring
  - weight 1,5 kg

- **Drone DJI Mavic 3 Enterprise + RTK module**
  - integrates 20 MP wide-angle camera with a CMOS 4/3 sensor with a pixel size 3,3 µm
  - RTK
  - Flight time 45mins
  - Mapping in one flight: 2 square km

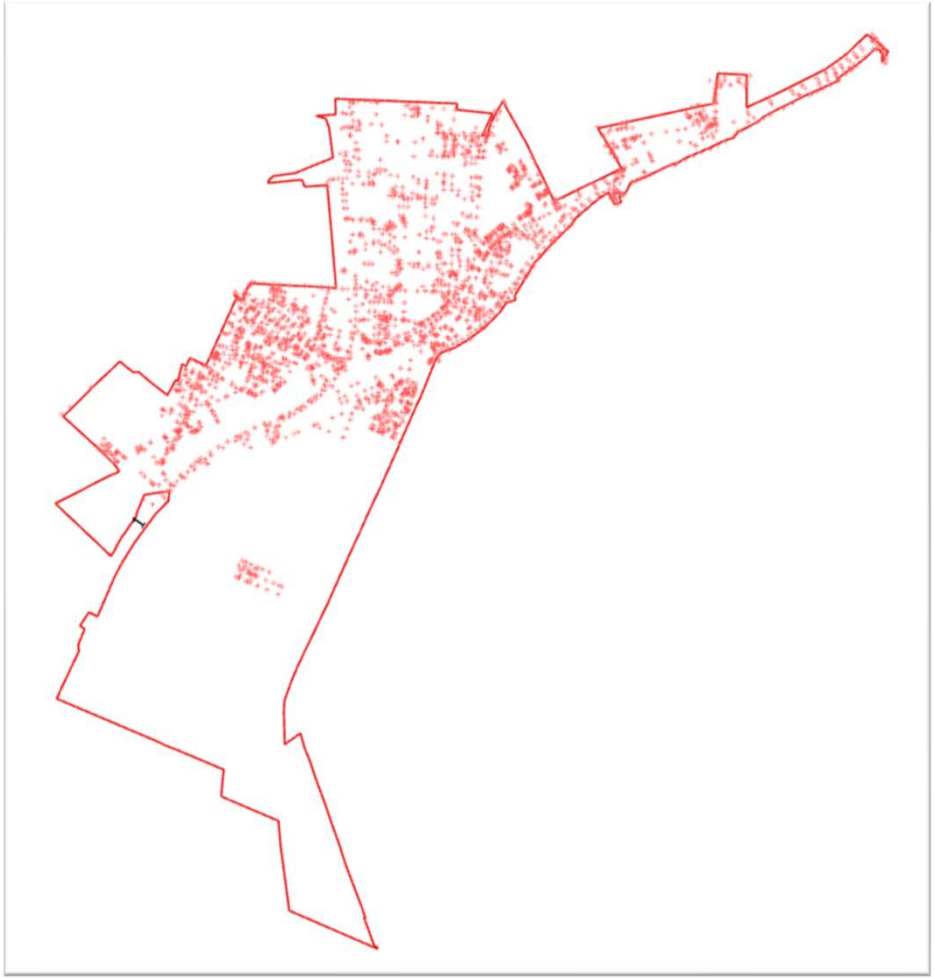
Ing. Ján Bublavý, GKÚ

Devices, Equipment – platforms, sensors

- **DJI Matrice 300 RTK + DJI Zenmuse P1**
  - 45 MP full-frame sensor
  - GNSS RTK connection
  - intelligent oblique sensing
  - Flight time 55 mins
  - pixel size 4.4 µmv

Cadastral unit - Kalinovo

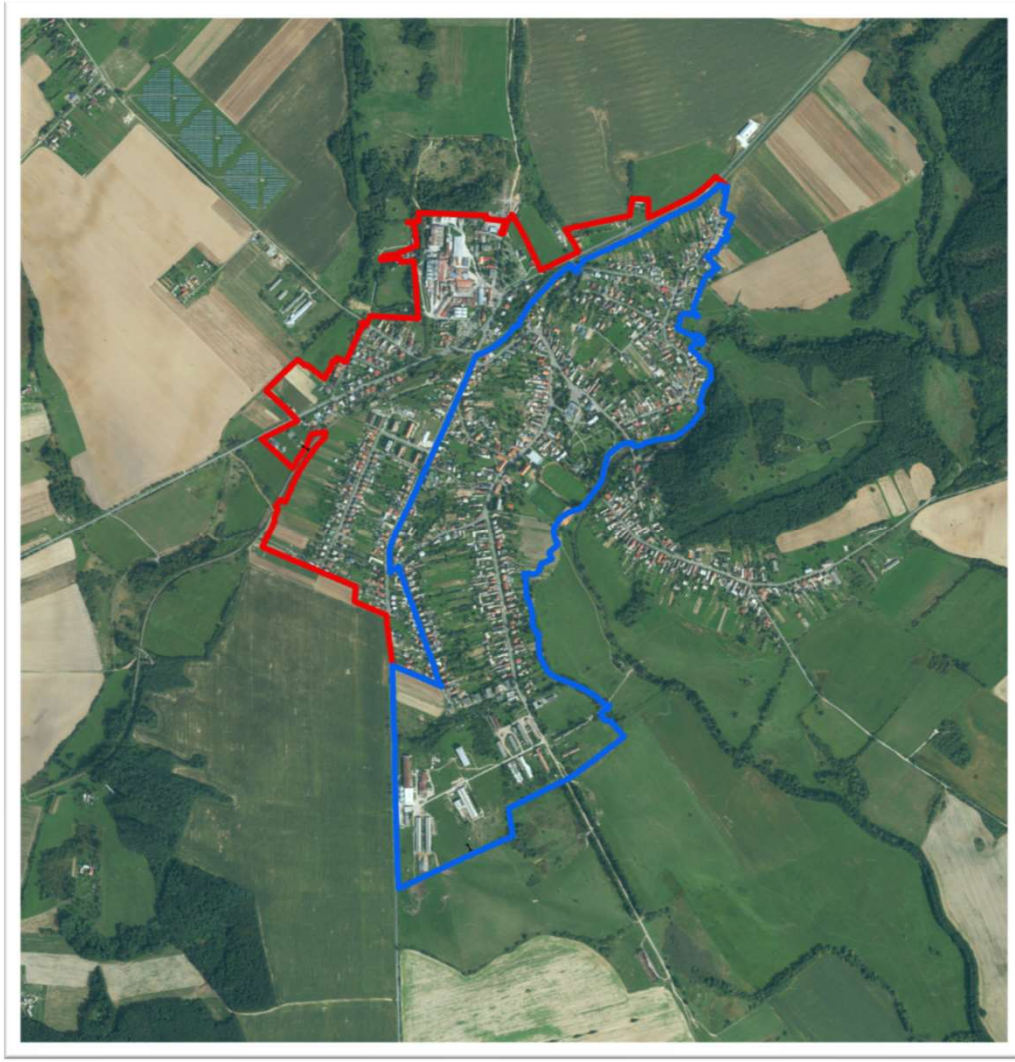
- **Terrestrial measurement**
  - GNSS
  - universal total station technology
    + connection to GNSS



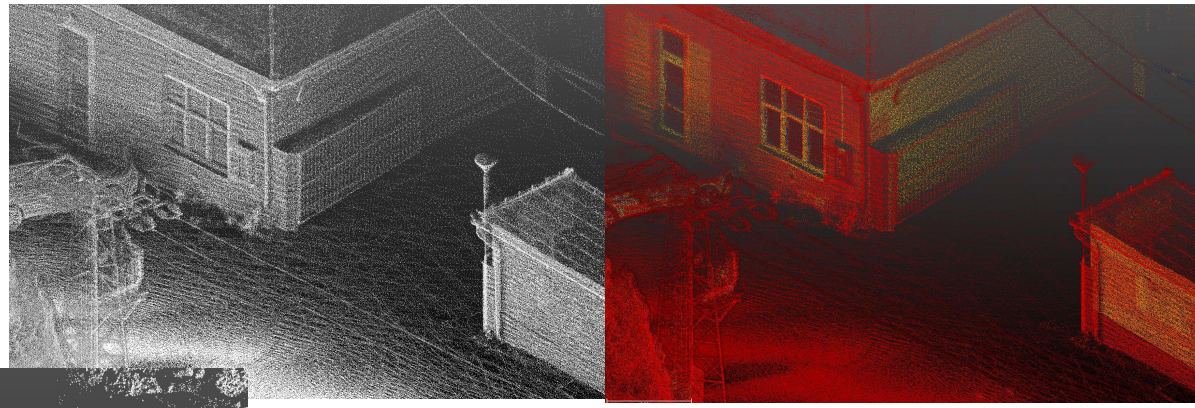
Cadastral unit – Kalinovo - data collection

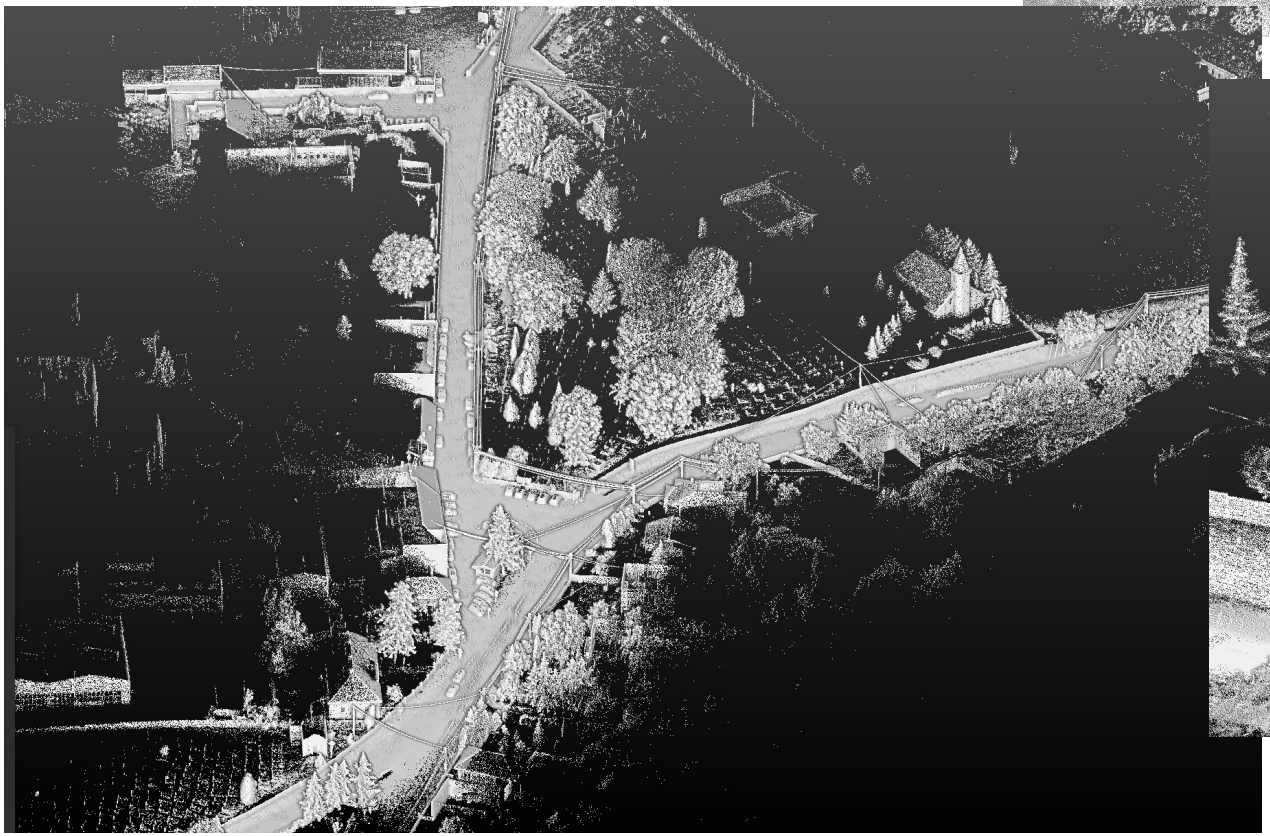
- Phase 1 - **55 ha**
- Phase 2 - **104 ha**
- scanning of street lines with SLAM technology
- laser scanning by drones
- photogrammetric scanning by drones

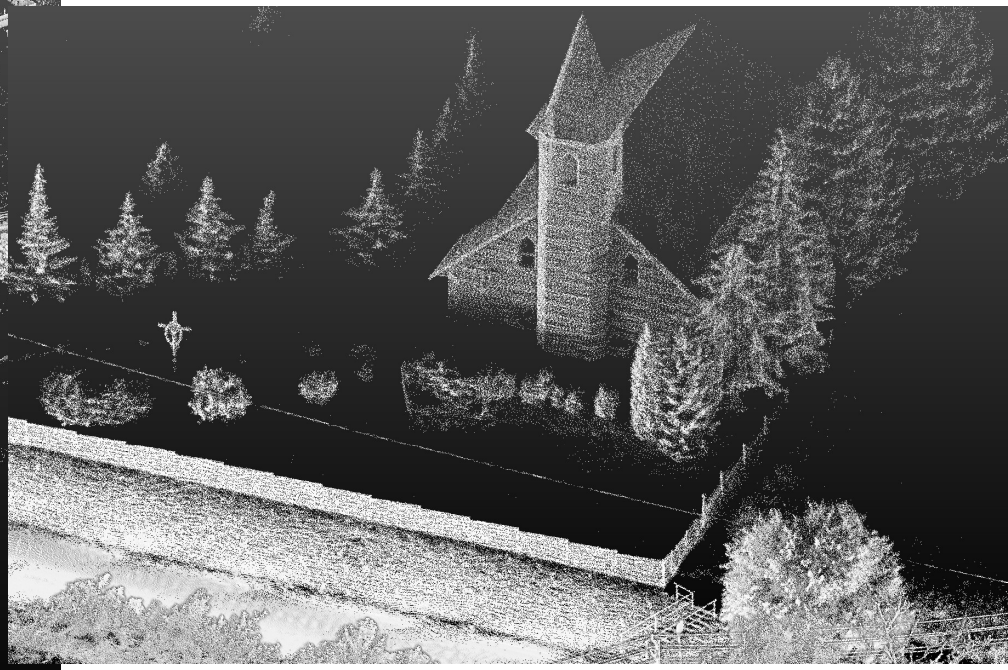
SLAM (simultaneous localization and mapping) enables autonomous robotic mobile scanning of the indoor, outdoor and subterranean environment.



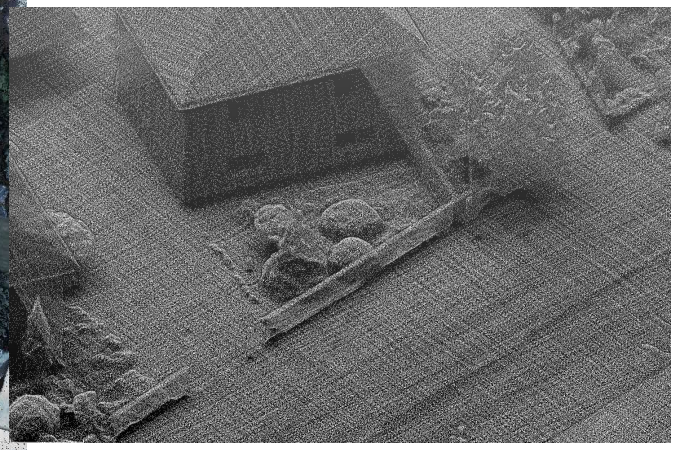
Emesent Hovermap ST-X



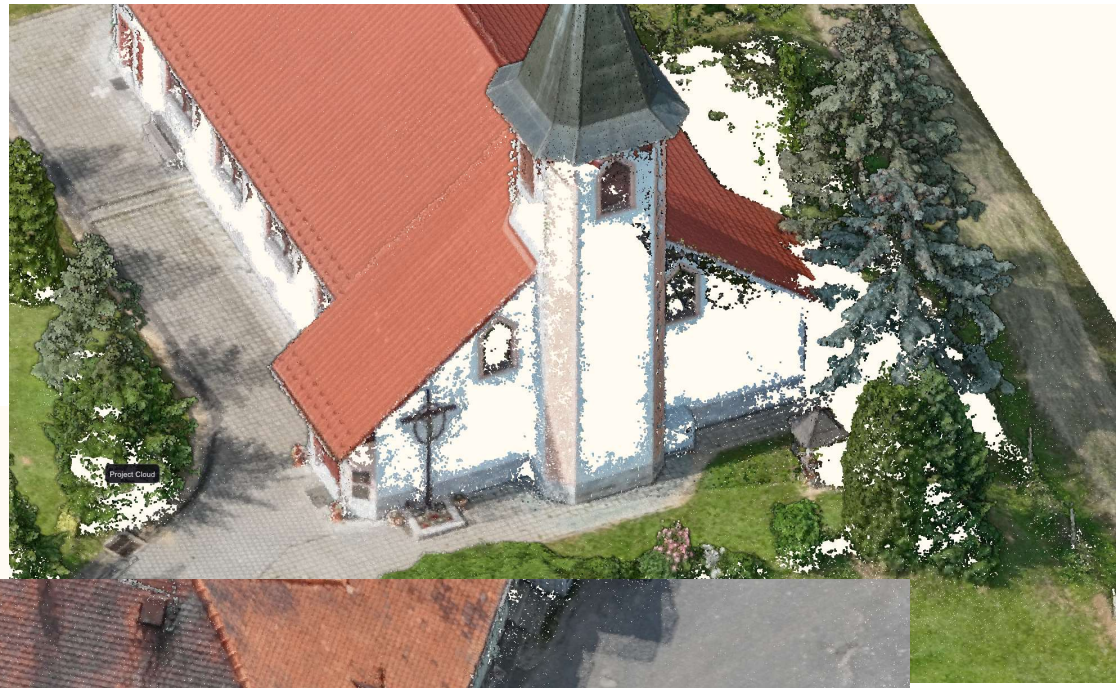




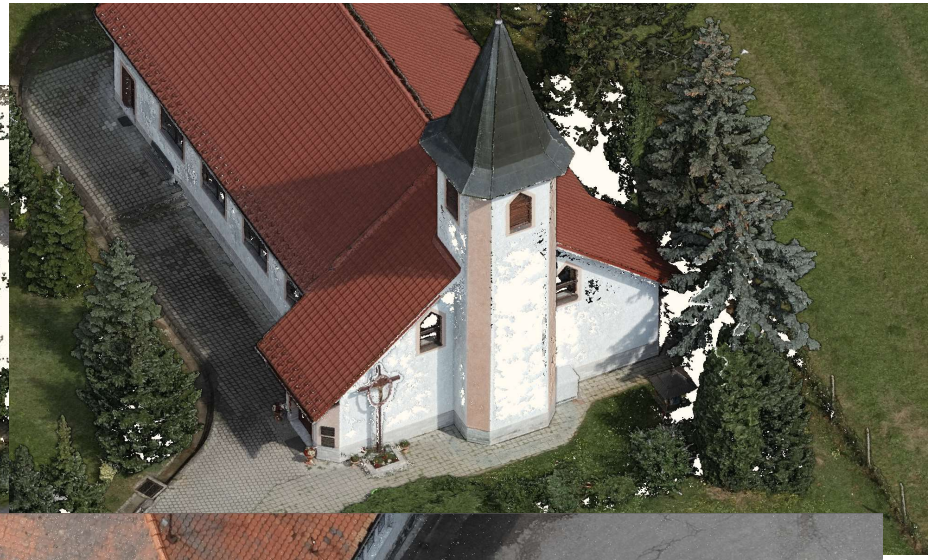
mdLiDAR1000HR



DJI Mavic 3 Enterprise

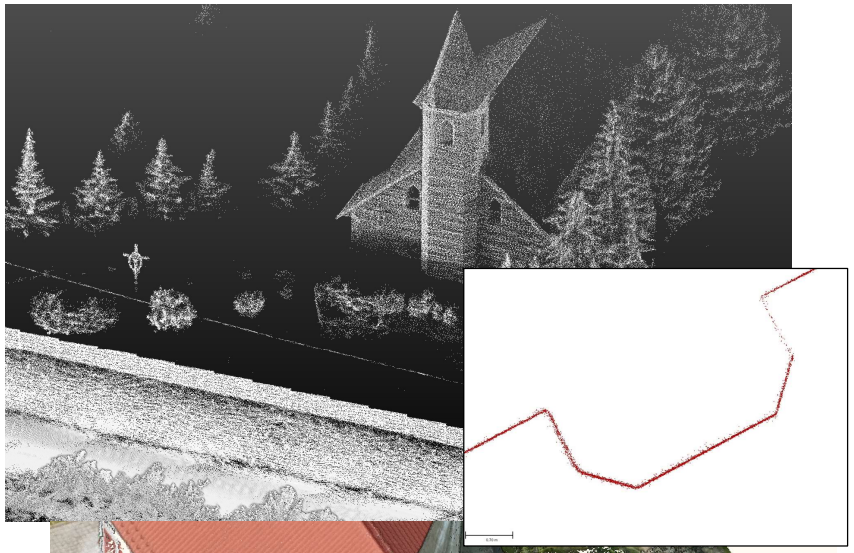


DJI Matrice 300 RTK + DJI Zenmuse P1



The future of new cadastral mapping – comparison - object church

STX



Lidaretto

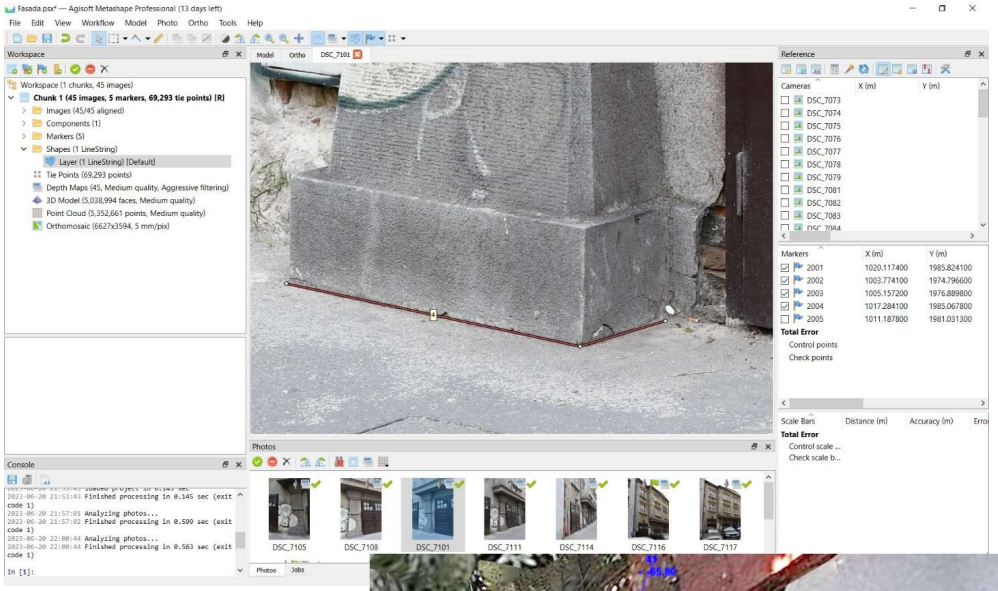
Mavic

P1

Ing. Ján Bublavý, GKÚ

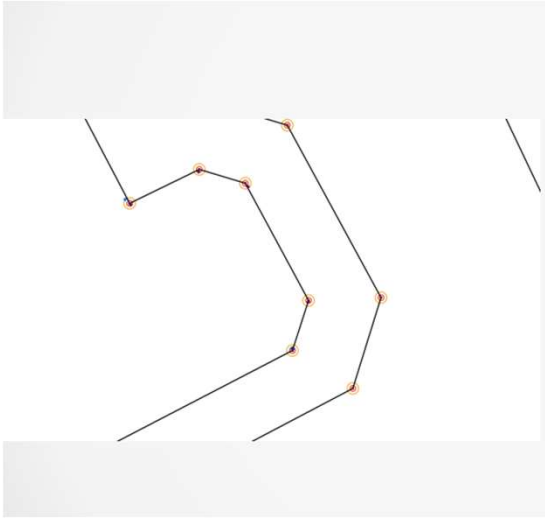
The future of new cadastral mapping

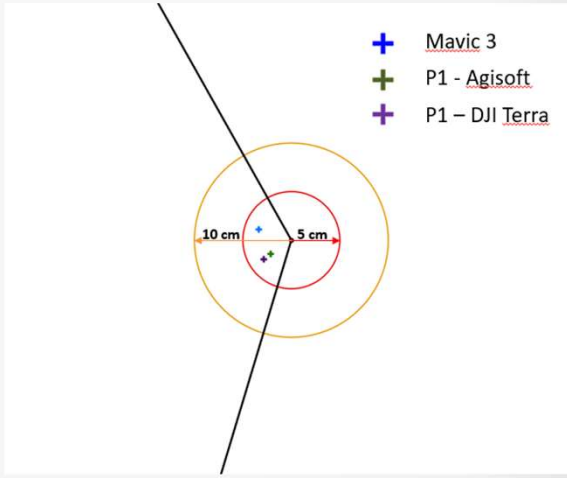
Processing of images



Work with model

comparison with standard terrestrial measurement





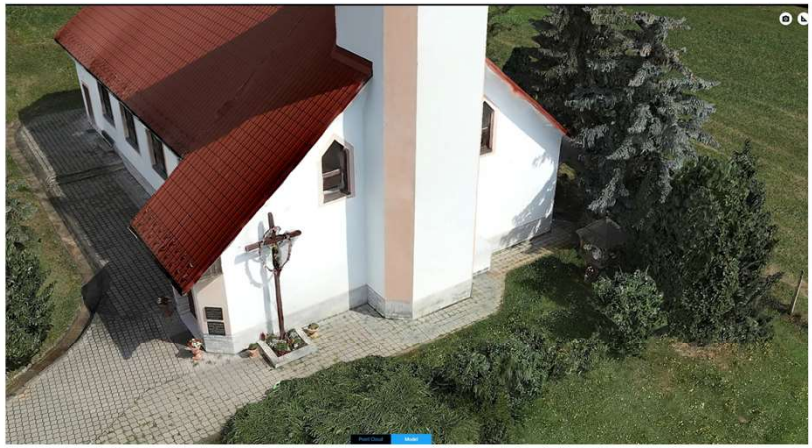
Work with cloud of points

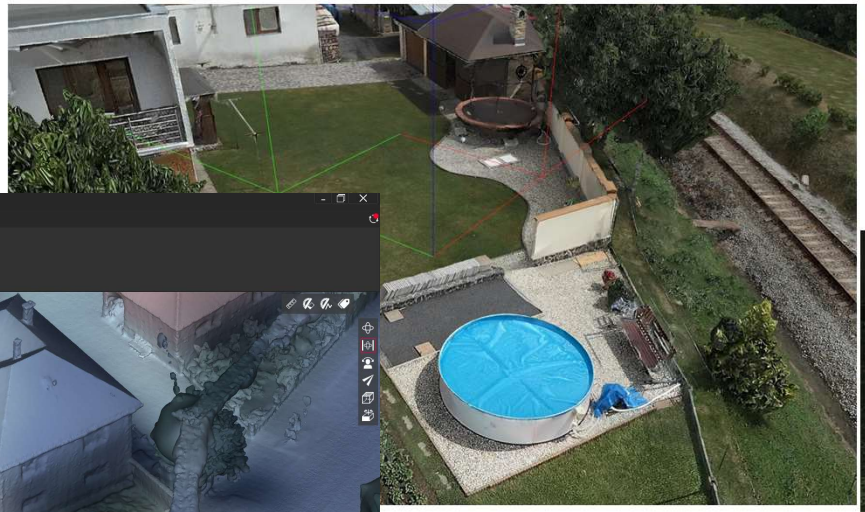
Ing. Ján Bublavý, GKÚ

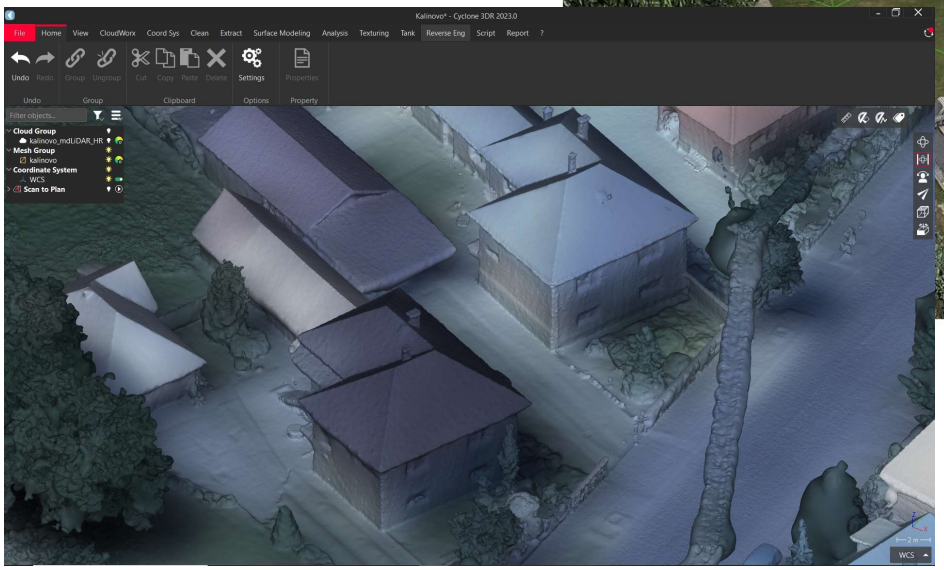
The future of new cadastral mapping

- **A Mesh model**

A 3D mesh is the structural build of a three-dimensional model consisting of polygons.



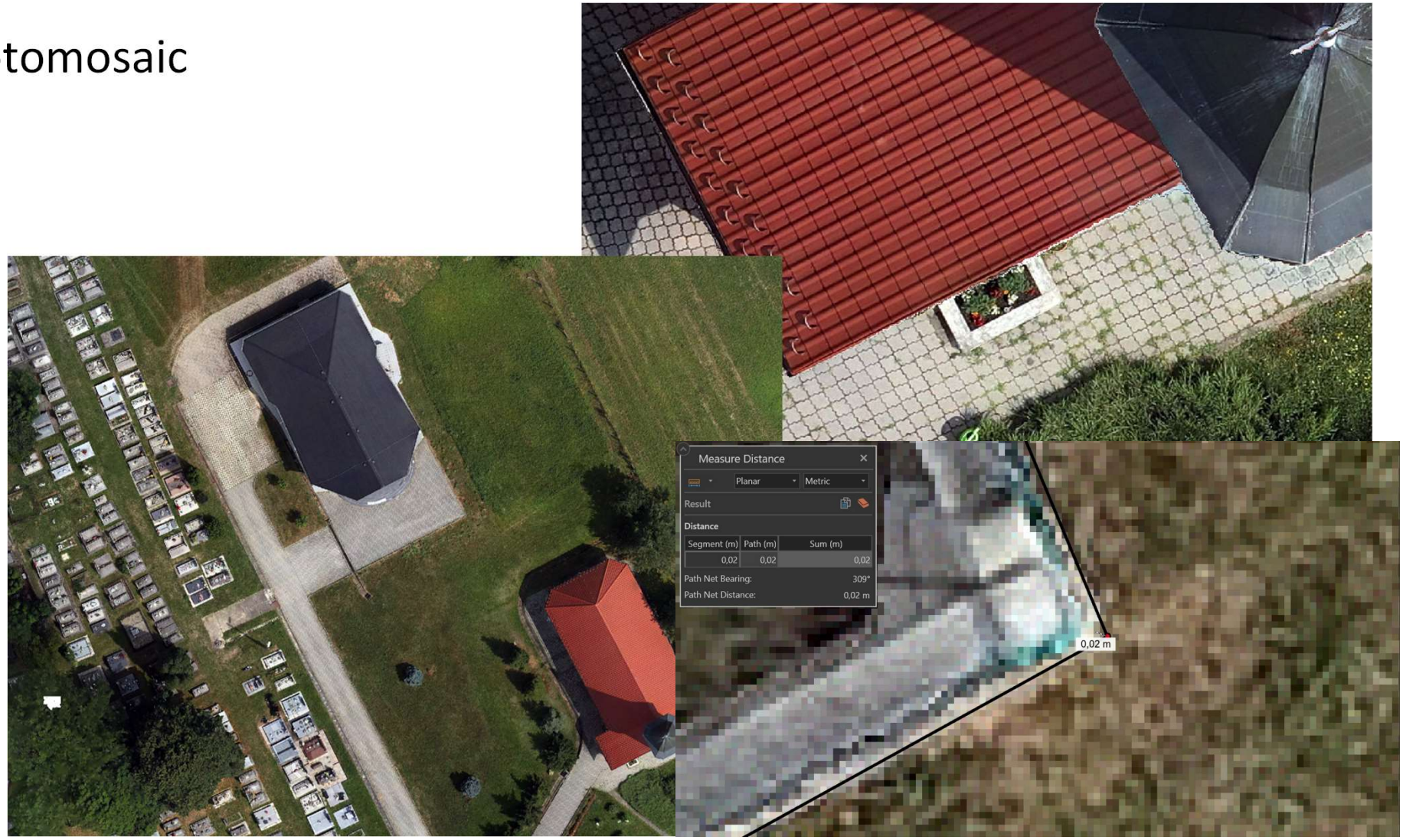




Ing. Ján Bublavý, GK

The future new cadastral mapping

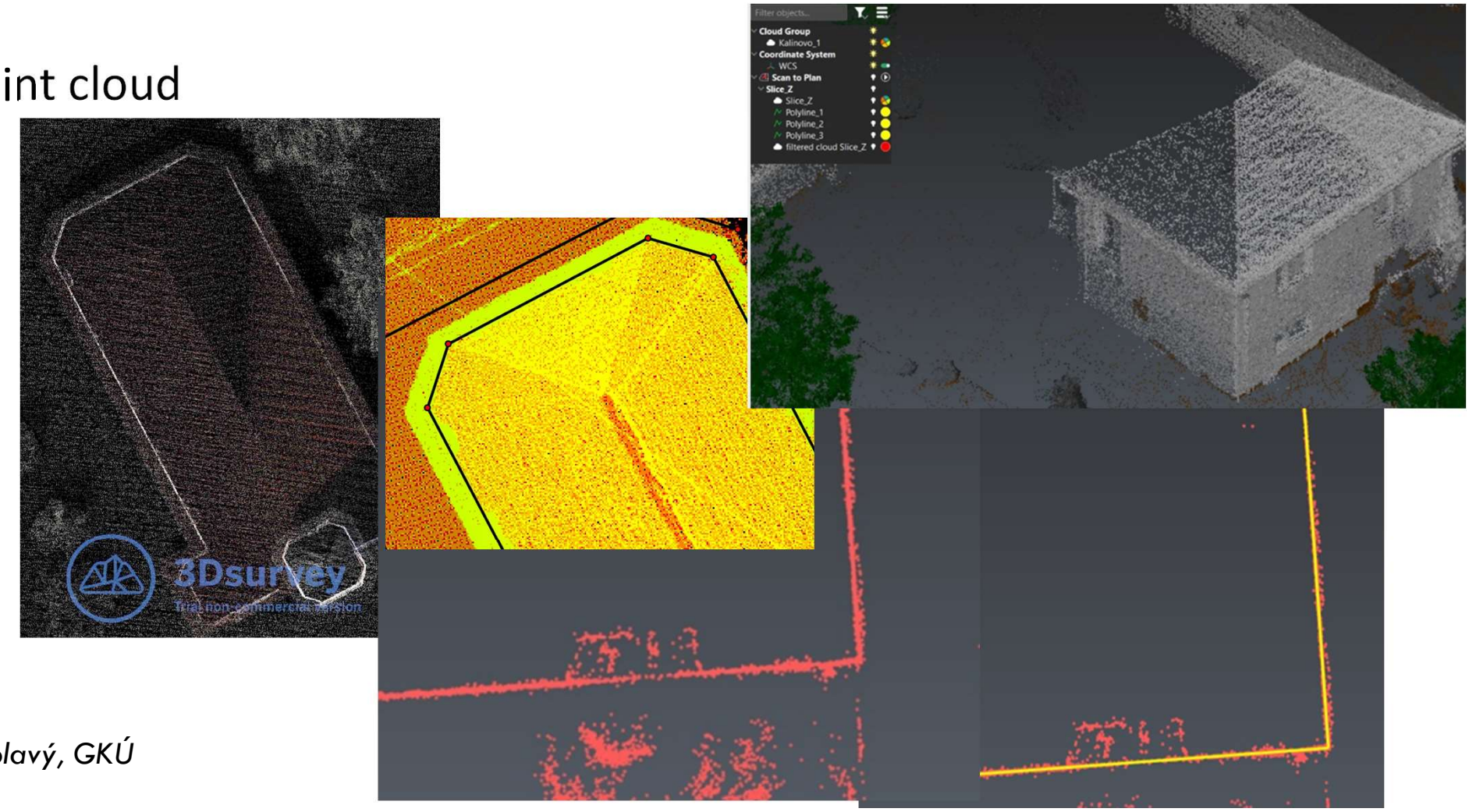
- Orthophotomosaic



Ing. Ján Bublavý, GKÚ

The future of cadastral renewal with new cadastral mapping

- Point cloud



Ing. Ján Bublavý, GKÚ

Recommendation of Geodetic and Cartographic Institute Bratislava

- Cadastral mapping
  1. DJI Matrice 350 + P1 – **oblique photogrammetry**
  2. DJI Mavic 3 Enterprise + RTK – **oblique photogrammetry**
  3. mdLiddar 1000UHR – **preparatory works, buildings - LIDAR, control measurement, smaller data volume capture, 2v1 (LIDAR + ORTO)**
  4. Emesent Hovermap ST-X – **control measurement (handheld, car, drone), buildings**
- State border and geodetic controls
  1. mdLiddar 1000UHR – **waterflows, control measurement of the state border monuments,**
  2. DJI Matrice 350 + LIDAR (RIEGL, Hesai) **determination of ground control points for terrestrial scanner**
  3. Emesent Hovermap ST-X – **gravimetric point determination, control measurement of the state border monuments,**
  4. DJI Mavic 3 Enterprise + RTK - **determination of ground control points for terrestrial scanner, control measurement of the state border monuments.**

Next steps – use of new methods and techologies in cadastre

According to the results of the GKU and VUGK

- set up the technology for the use of new measurement methods

  - for renewal of the cadastre by new mapping

- determination of conditions for the commercial sector - private surveyors - for the delivery of measurement results by new methods
- cadastral works - also for survey sketches

Thank you for attention

michal.leitman@skgeodesy.sk
martina.behuliakova@skgeodesy.sk
stefan.nagy@skgeodesy.sk

jan.bublavy@skgeodesy.sk
andrej.kovacik@skgeodesy.sk