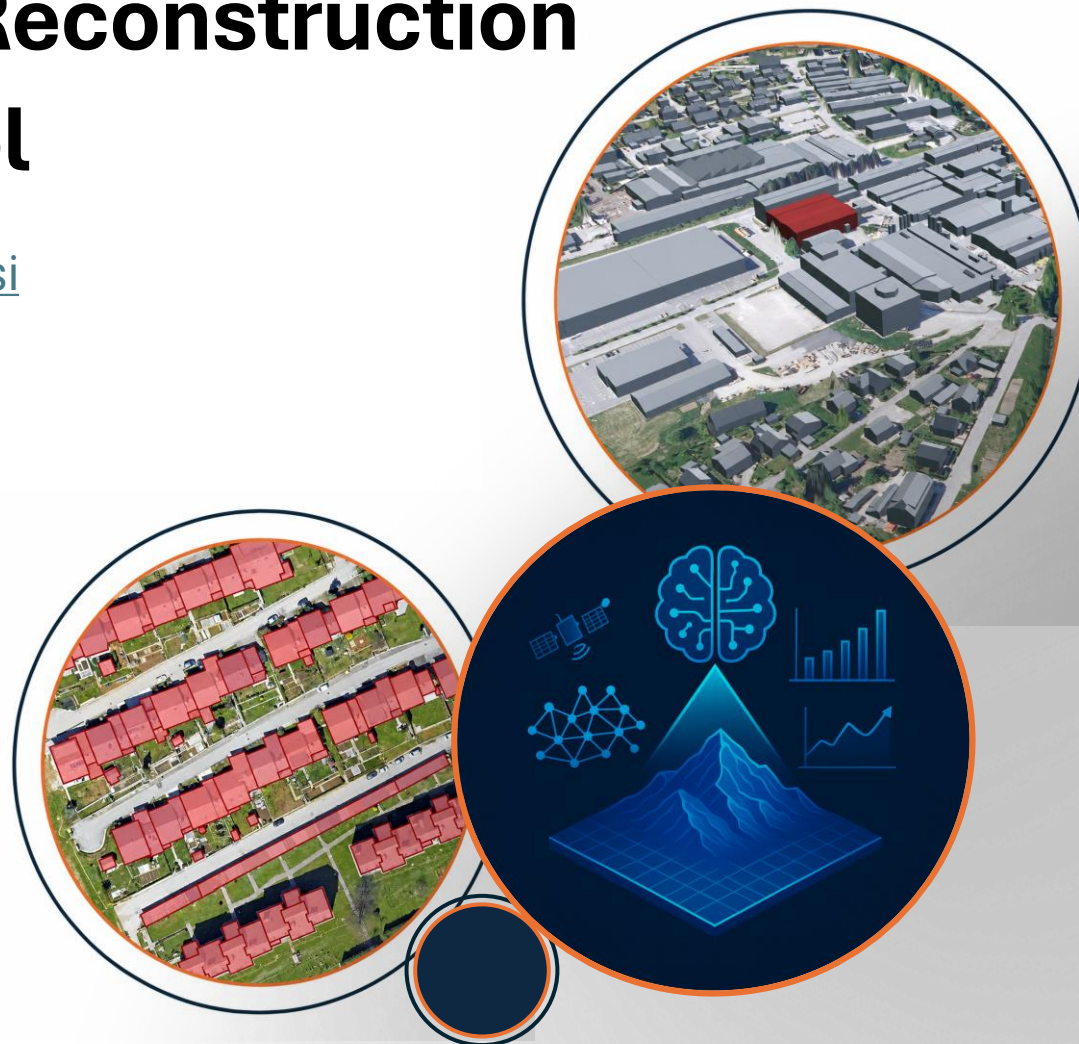


Slovenia's Nationwide End-to-End Workflow for Building Footprint Extraction and 3D Reconstruction with Quality Control

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"Slovenia is moving from periodic remote-sensing acquisition to a repeatable national production workflow for building footprints and 3D buildings."

01

Input data

02

Building footprints

03

3D buildings and attributes

04

Quality control

01

True orthophoto

Delivered images 186 256 captured images

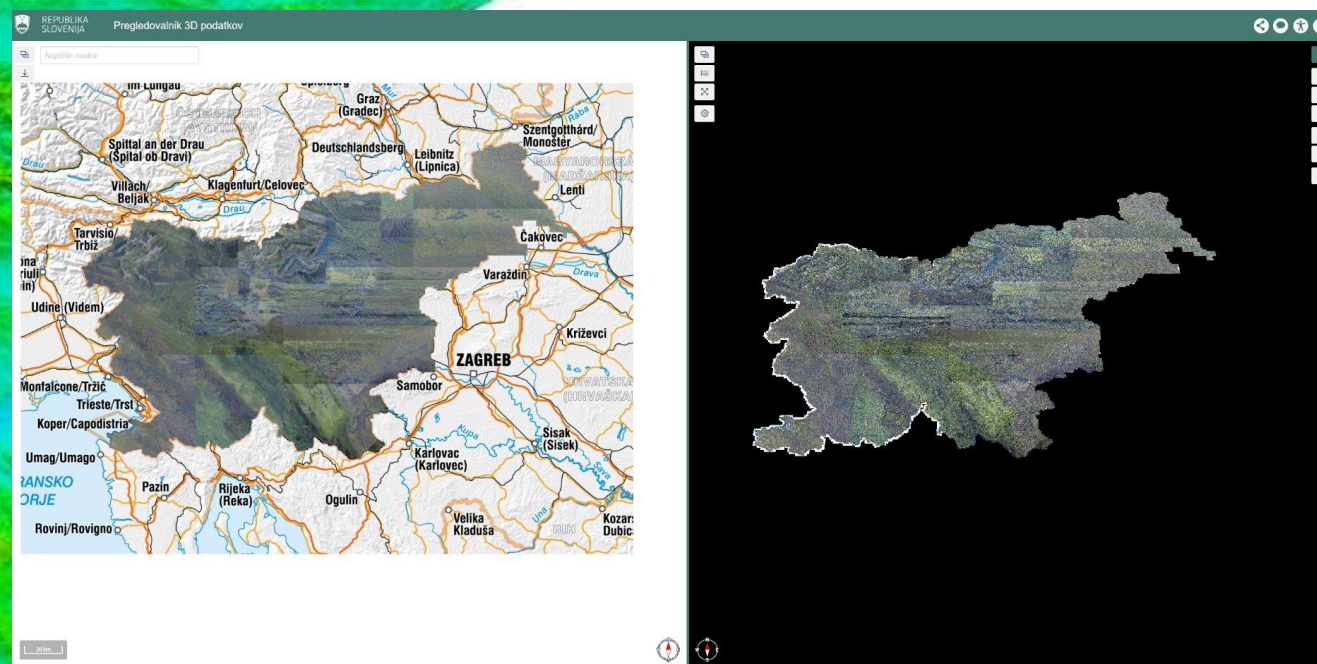
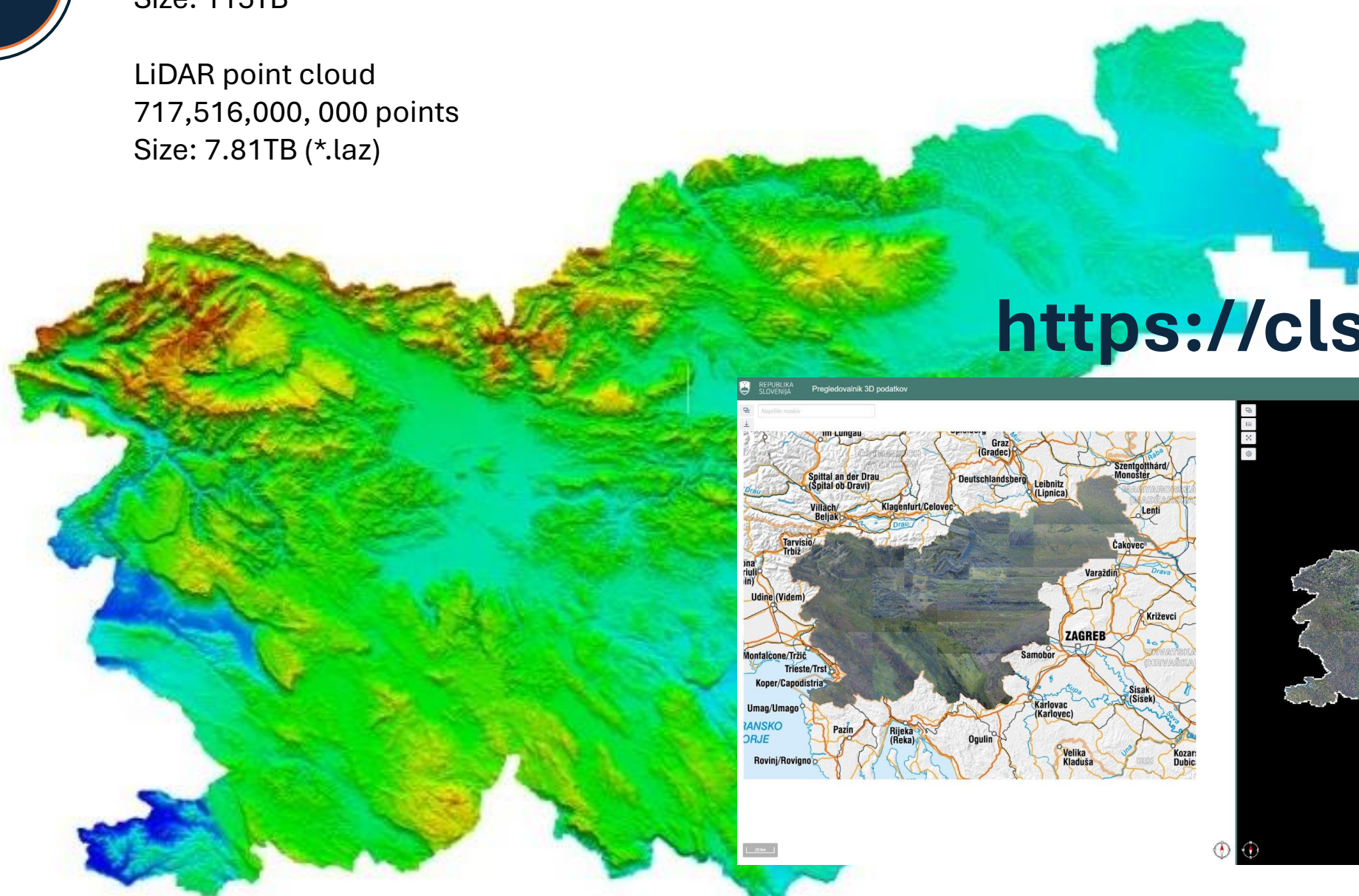
Size: 115TB

LiDAR point cloud

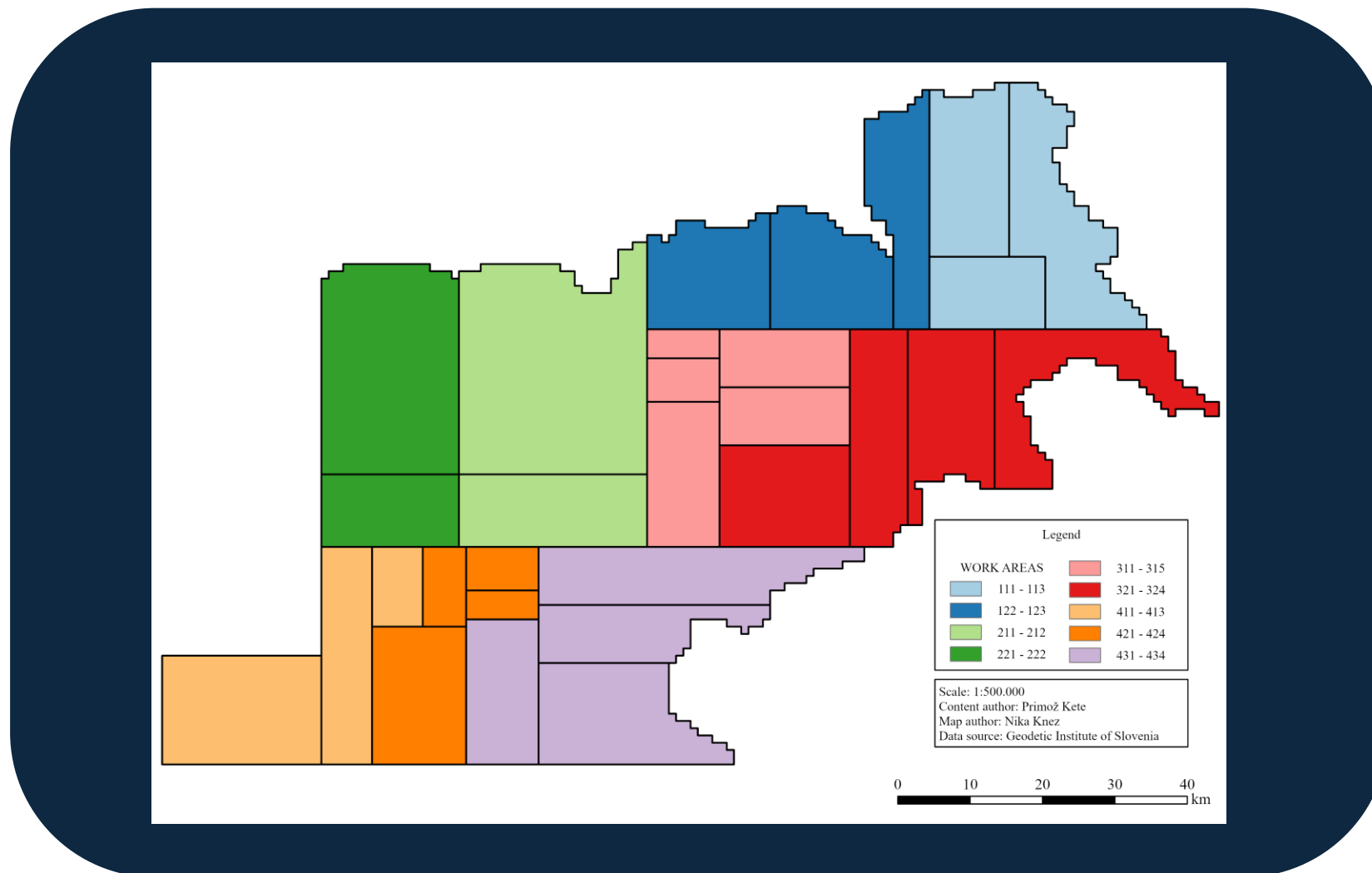
717,516,000, 000 points

Size: 7.81TB (*.laz)

<https://clss.si/>

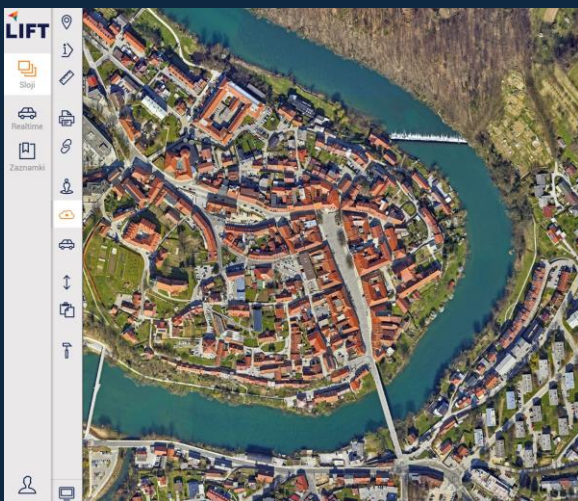


Area of interest – first 1/3 of Slovenia

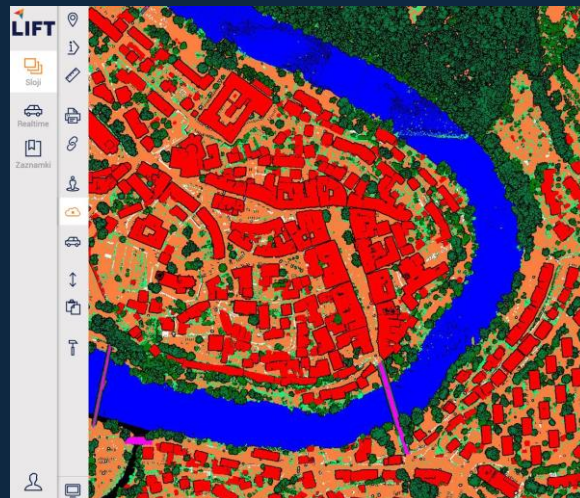


01

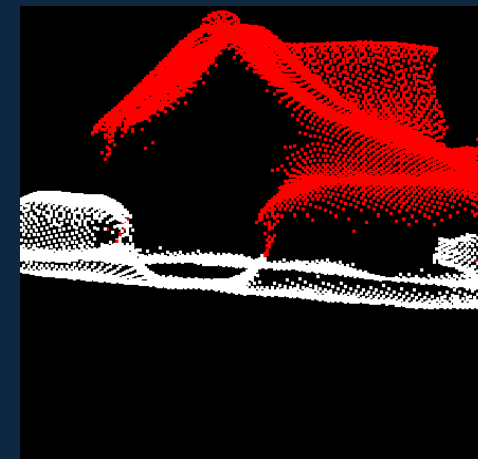
Input data



TRUE ORTHOPHOTO



LIDAR POINT CLOUD

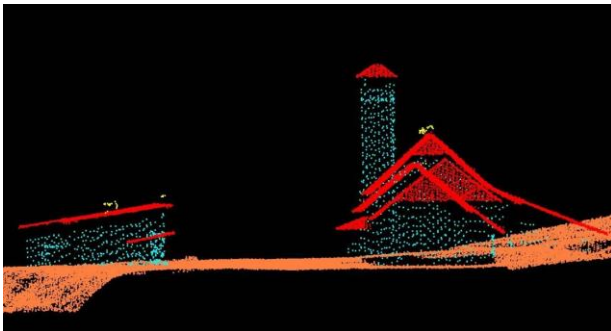
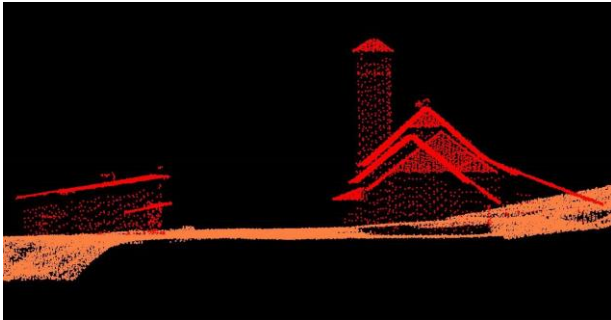


**PHOTOGRAMMETRIC POINT
CLOUD**

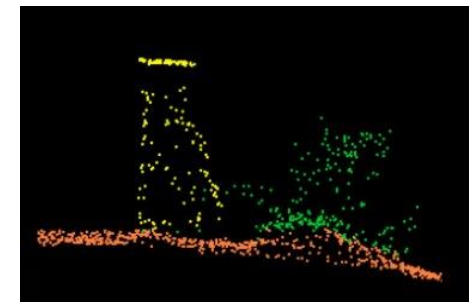
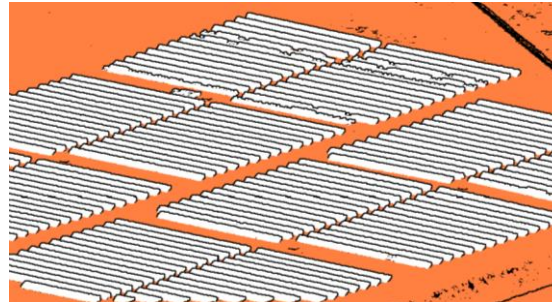
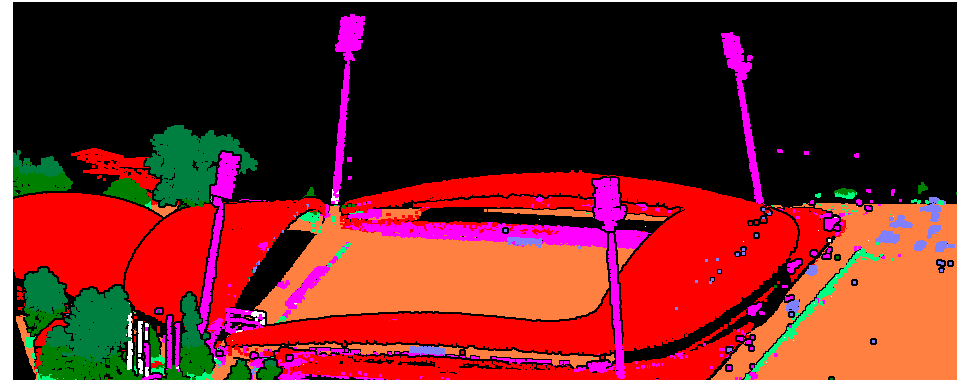
01

Point cloud classification

NEW CLASSIFICATION FROM CLASS BUILDINGS



OTHER CLASSIFICATION





2,5 building footprints

True Orthophoto



Building classification



nDSM



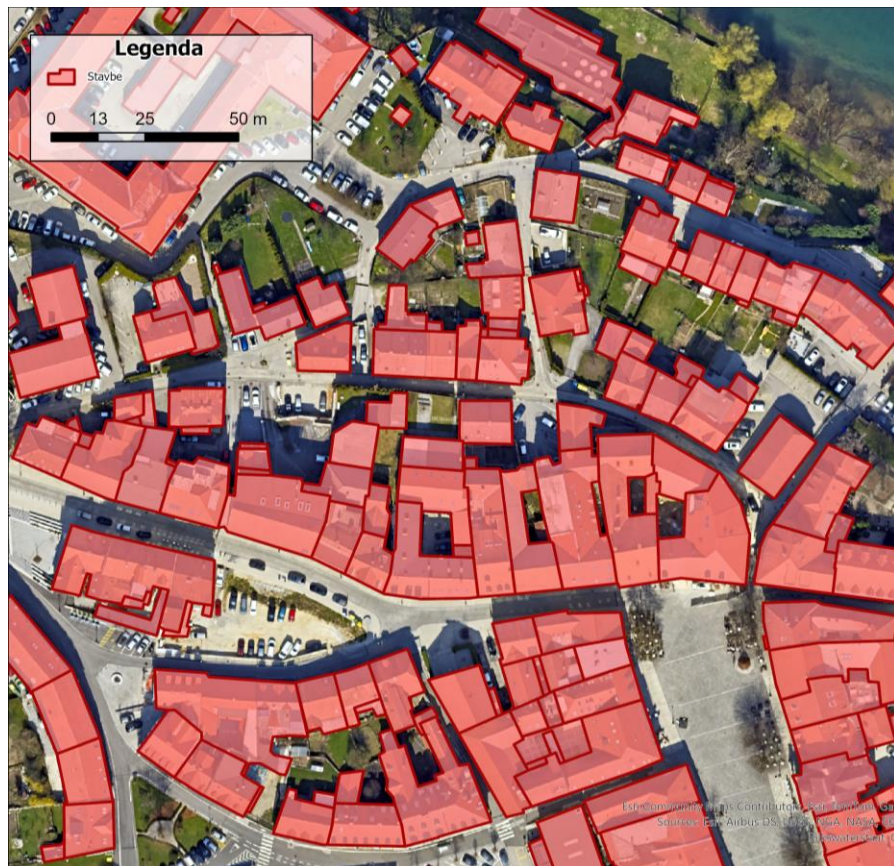
02

Building breaklines



02

2,5 building footprints



Accuracy - demands:

- minimum dimensions of building footprint details: **0,5 m**
- minimum dimensions of roof details: **1 m²**
- horizontal and vertical accuracy: **± 1 m (RMSE)**

Building modelling:

- minimum building area: **4 m²**
- minimum building height: **2 m**



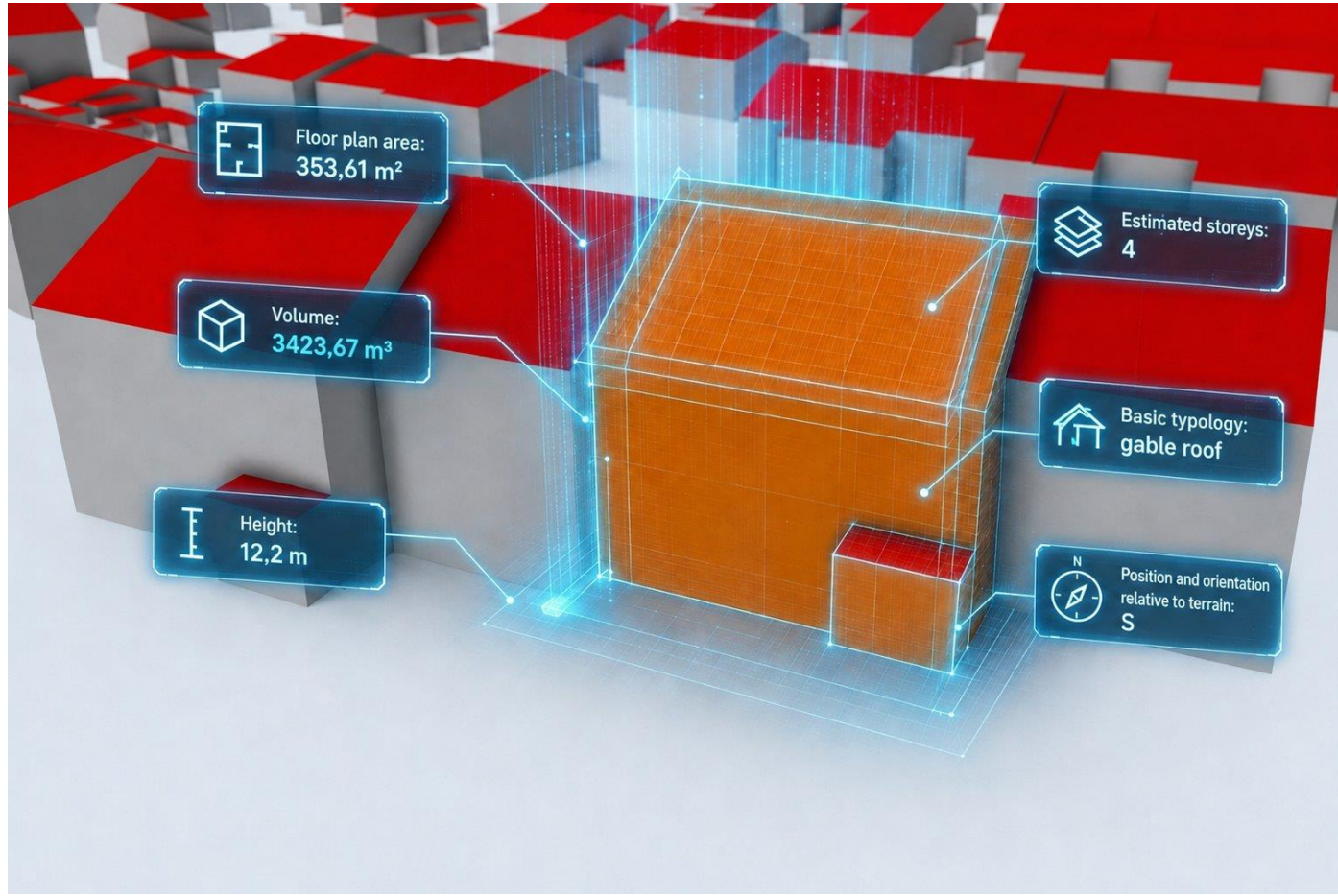
02

Manual steps in the workflow

- Transfer of unique building identifiers from Topographic Database and Cadastre building dataset
- Spatial analysis to identify inconsistencies and discrepancies
- Manual inspection of buildings missing in comparison with either of the two source datasets, as well as buildings smaller than 4 m² (10% / 2%).
- Manual correction of building subdivision/segmentation errors (3%)

03

3D buildings



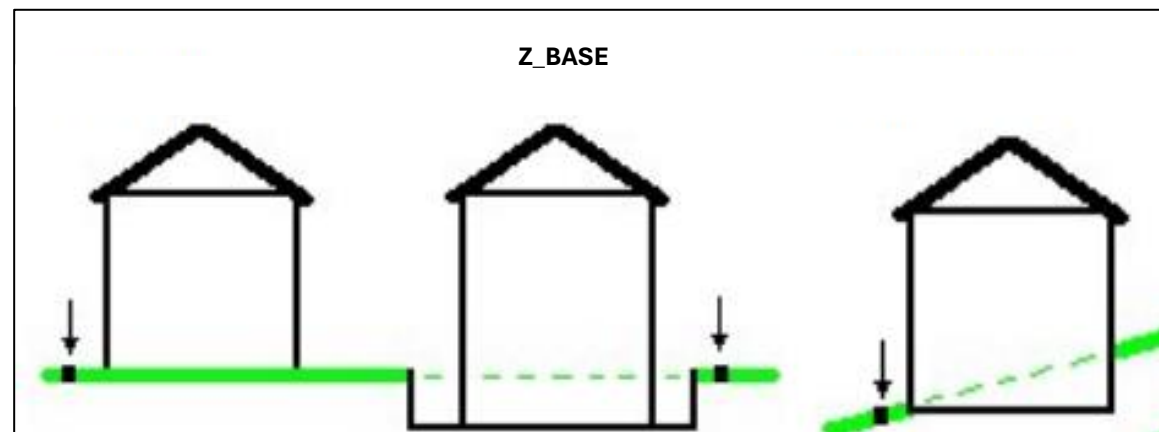
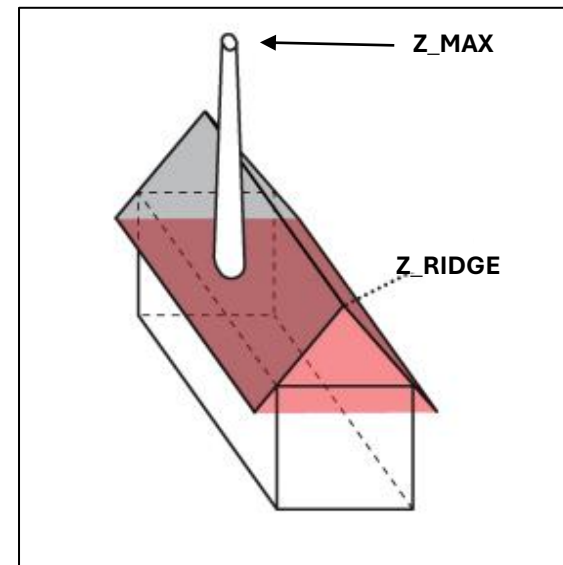
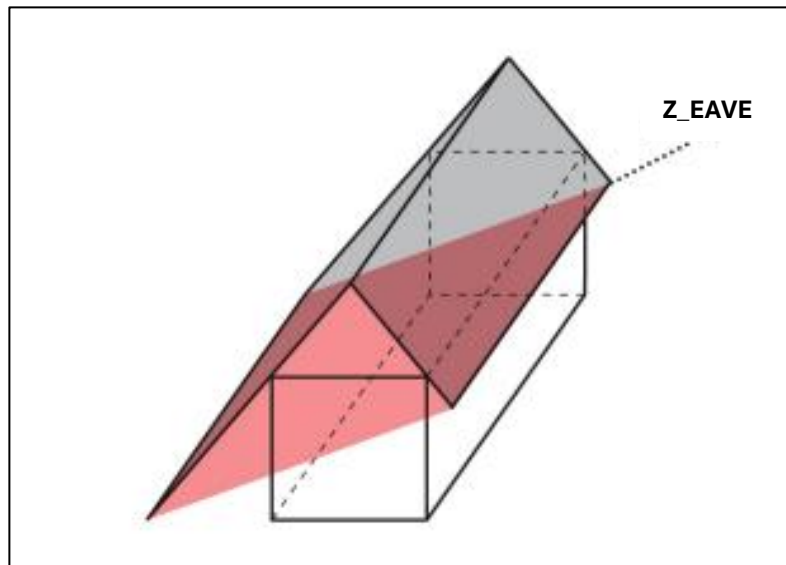
03

3D buildings - attributes

Models and footprints enriched with attributes:

height

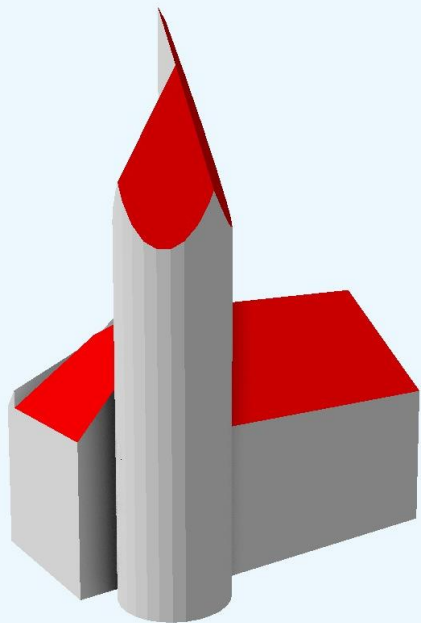
- Z_MAX
- Z_RIDGE
- Z_EAVE
- Z_BASE
- Area
- Roof type
- Volume (VOL and VOL_PART)
- Acquisition method



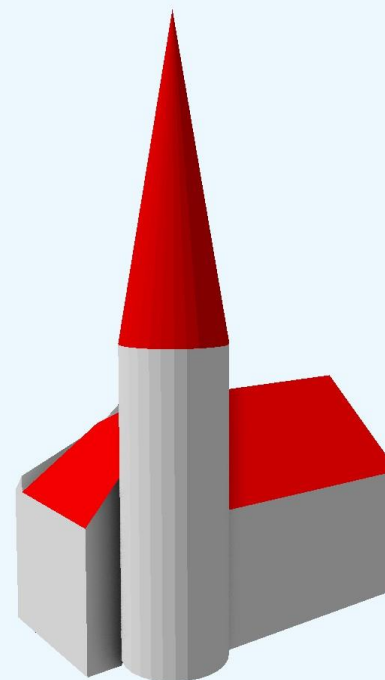
03

3D buildings - exceptions

3D reconstruction
software tool



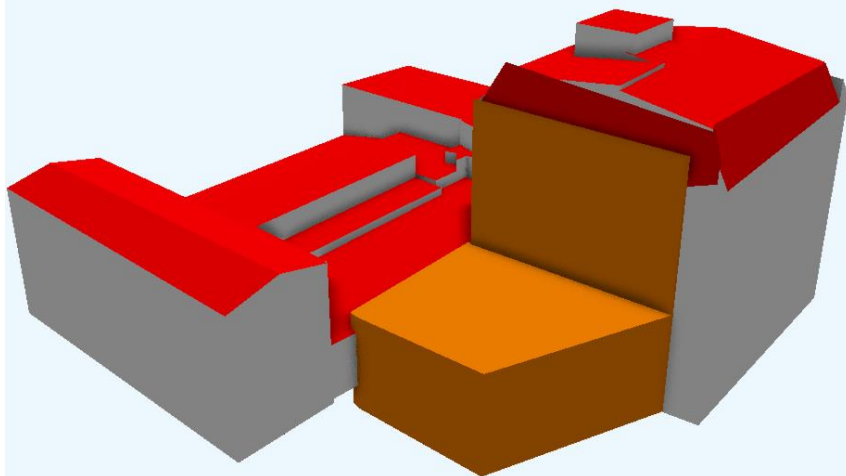
After fix



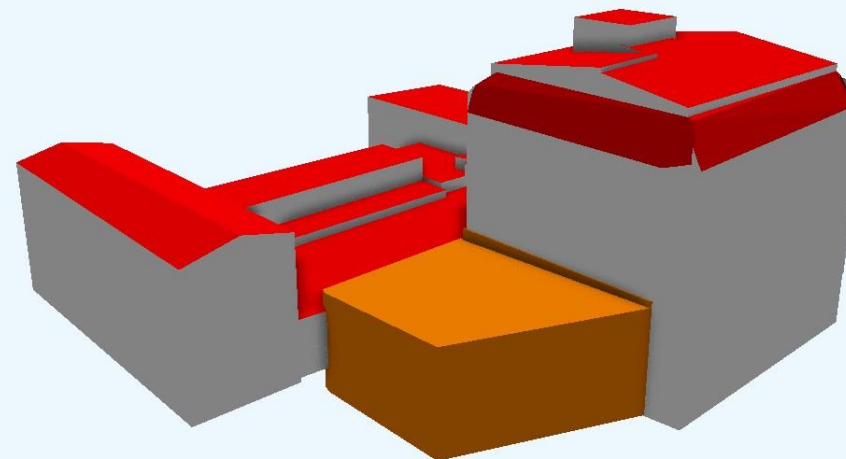
03

3D buildings - exceptions

3D reconstruction software tool



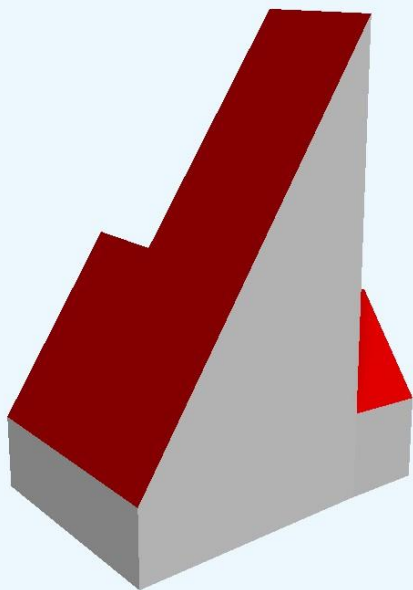
After fix



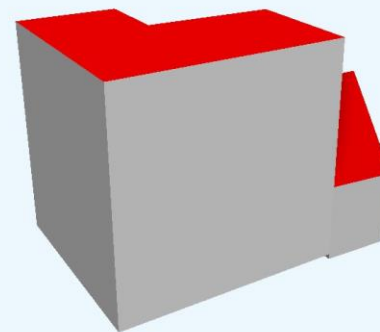
03

3D buildings - exceptions

3D reconstruction
software tool



After fix

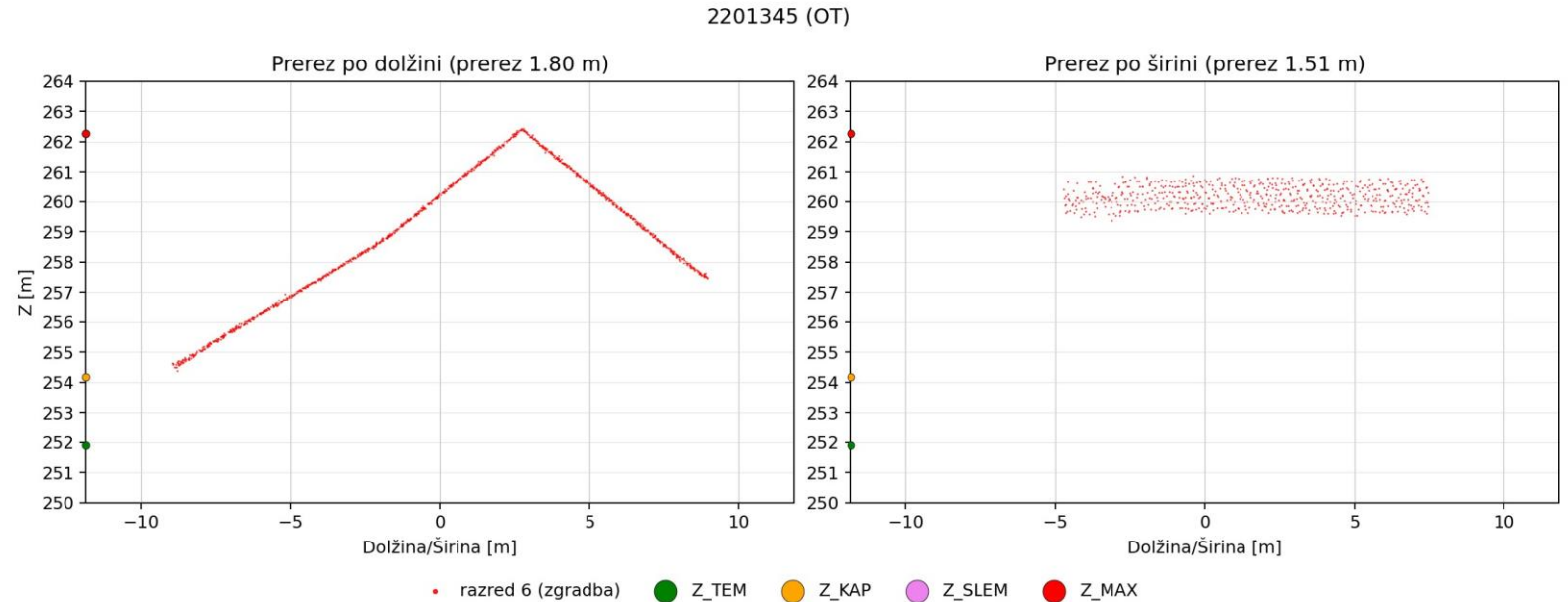


03

3D buildings – quality control

Attributes and models are checked for:

- $Z_MAX - Z_RIDGE < 5m$
- $Z_RIDGE - Z_EAVE < 8m$
- $Z_MAX \geq Z_RIDGE \geq Z_EAVE > Z_BASE$
- $HIGHT\ OF\ THE\ BUILDINGD \geq 1.5m$



03

3D buildings



ISO 19157 QE

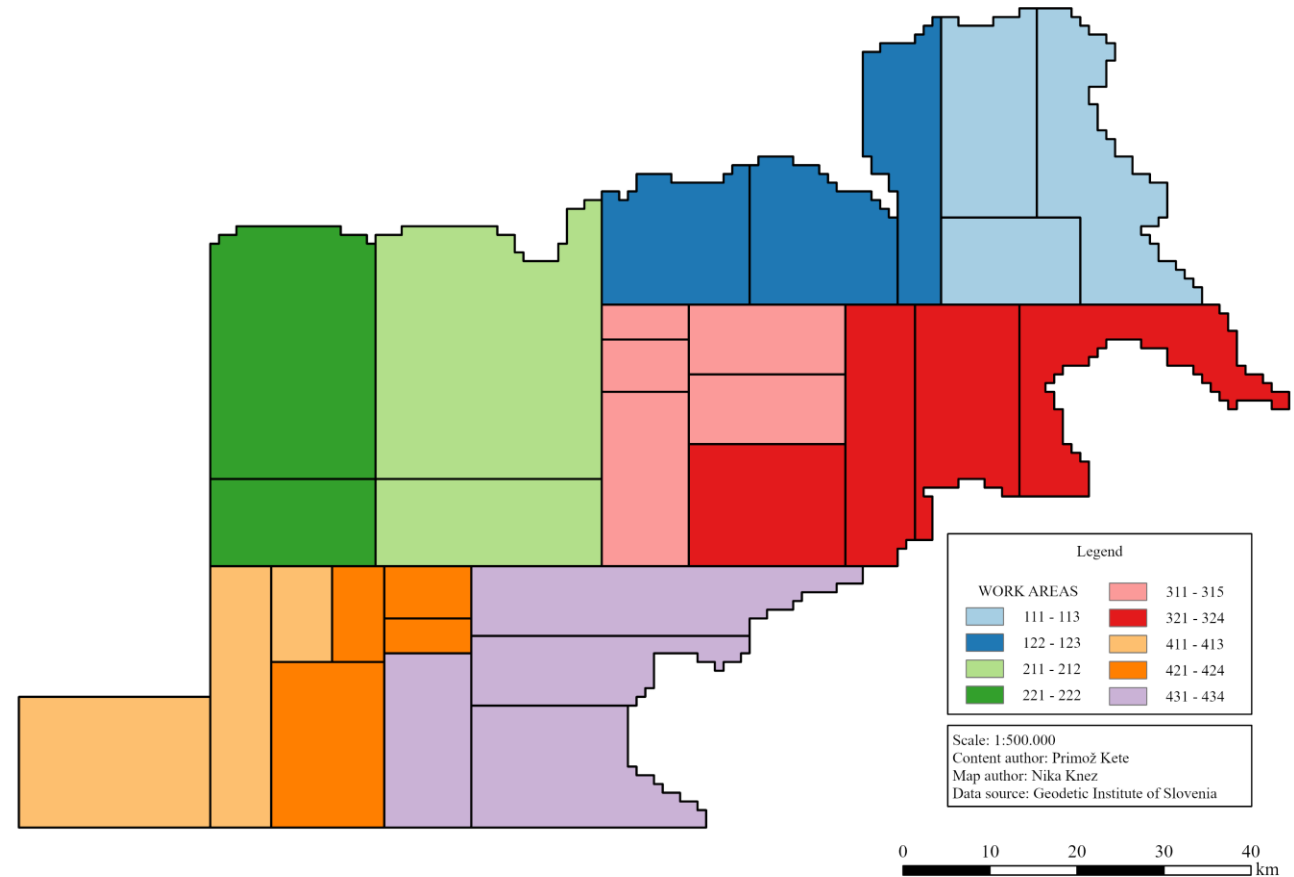
- The quality evaluation (QE) is conducted in accordance with the international standard ISO 19157 — Geographic Information — Data Quality.
- Quality evaluation is performed based on several data quality elements and measures, each with a predefined Acceptance Quality Level (AQL).
- The evaluation is carried out for each individual LOT, with a total of nine LOTs within the project area.
- A separate quality evaluation is applied to 2.5D polygons and 3D building models.

SAMPLING

- Certain data quality elements/measures are evaluated across the entire dataset, while others are assessed through a sampling method.
- A semi-random (systematic) area-guided sampling approach is used, structured on a hierarchical grid of 100 x 100 meters. The sample size comprises 500 buildings/LOT.

ISO 19157 QE

- The basis for the spatial definition of the LOT is the CLSS block and the 1×1 km hierarchical grid.
- An additional criterion for defining the LOT is the number of features, i.e. the population size.
- When assigning a building to a LOT, the building must be entirely contained within a single LOT with all its parts.



2.5D Data quality measures and AQL

QUALITY ELEMENT	QUALITY SUB-ELEMENT	QUALITY MEASURE	ACCEPTABLE QUALITY LEVEL (AQL)
COMPLETENESS	Commission	Excess of CLSS building footprint polygon	1 %
	Omission	Omission of CLSS building footprint polygon	5 %
		Deficiency relative to DTM/KN building data	0 %
		Missing attributes in CLSS building footprint dataset	0 %
POSITIONAL ACCURACY	Absolute positional accuracy	Horizontal accuracy of characteristic point of CLSS building polygon	± 1 m RMSE
		Vertical accuracy of characteristic point of CLSS building polygon (Z_KAP)	± 1 m RMSE
THEMATIC ACCURACY	Correctness of non-quantitative attributes	Correct assignment of unique building identifiers from DTM and KN	0 %
	Accuracy of quantitative attributes	Accuracy of calculated characteristic heights (Z_TEM, Z_MAX, Z_SLEM)	± 1 m RMSE
LOGICAL CONSISTENCY	Format consistency	Format consistency of dataset	0 %
	Domain consistency	Domain consistency of all attributes	0 %
	Topological consistency	Topological consistency of polygons	0 %
	Conceptual consistency	Adequacy of building segmentation into parts	10 %
		Adequacy of level of detail of building polygons	10 %
TEMPORAL QUALITY	Temporal consistency	Temporal consistency of DVIR attribute	0 %
	Temporal validity	Temporal validity of DVIR attribute	0 %

3D Data quality measures and AQL

QUALITY ELEMENT	QUALITY SUB-ELEMENT	QUALITY MEASURE	ACCEPTABLE QUALITY LEVEL (AQL)
COMPLETENESS	Commission	Excess of CLSS building 3D model	Result from the 2.5D dataset
	Omission	Omission of CLSS building 3D model	Result from the 2.5D dataset
		Deficiency relative to 2.5D building footprints	0 %
		Missing attributes in CLSS 3D building model dataset	0 %
POSITIONAL ACCURACY	Absolute positional accuracy	Horizontal accuracy of 3D modelling	$\pm x$ m RMSE (reported value only; exceeding the threshold does not result in rejection)
		Vertical accuracy of 3D modelling	$\pm x$ m RMSE
THEMATIC ACCURACY	Correctness of non-quantitative attributes	Correct assignment of the unique identifier (ID_PROD)	0 %
		Correct determination of roof type	10 %
	Accuracy of quantitative attributes	Accuracy of the modelled volume	$\pm x$ m ³ RMSE
LOGICAL CONSISTENCY	Format consistency	Format consistency	5 %
	Domain consistency	Domain consistency of all attributes	0 %
	Topological consistency	Topological consistency	0 %
	Conceptual consistency	Correctness of volume calculation	2 %
		Adequacy of the level of detail of the CLSS 3D building model	0 %
TEMPORAL QUALITY	Temporal consistency	Temporal consistency of creationDate attribute	x %
	Temporal validity	Temporal validity of creationDate attribute	0 %



Thank you!

Contacts:

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