

# **Use of aerial survey and laser scanning for production of national data base of surface water hydrology**

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# Floods and other weather events in the last years in Slovenia

Ljubljana 2010



Ljubljana 2012



Ljubljana 2014



River Soča, Tolmin Nov. 2012, NW of Slovenia



River Mura, Turnišče Apr. 2013, NE of Slovenia



River Vipava, Renče Jan. 2014, SW of Slovenia



River Krka, Straza Sep. 2012, SE of Slovenia





Sleet in Slovenia jan. 2014



# Land slides after heavy rain

Obrežje pri Zidanem mostu Sep. 2010



Kozjansko Sep. 2014



Log pod Mangartom,  
650 m asl., year 2000



Road to Italy cca. 1000 m asl., year 2000



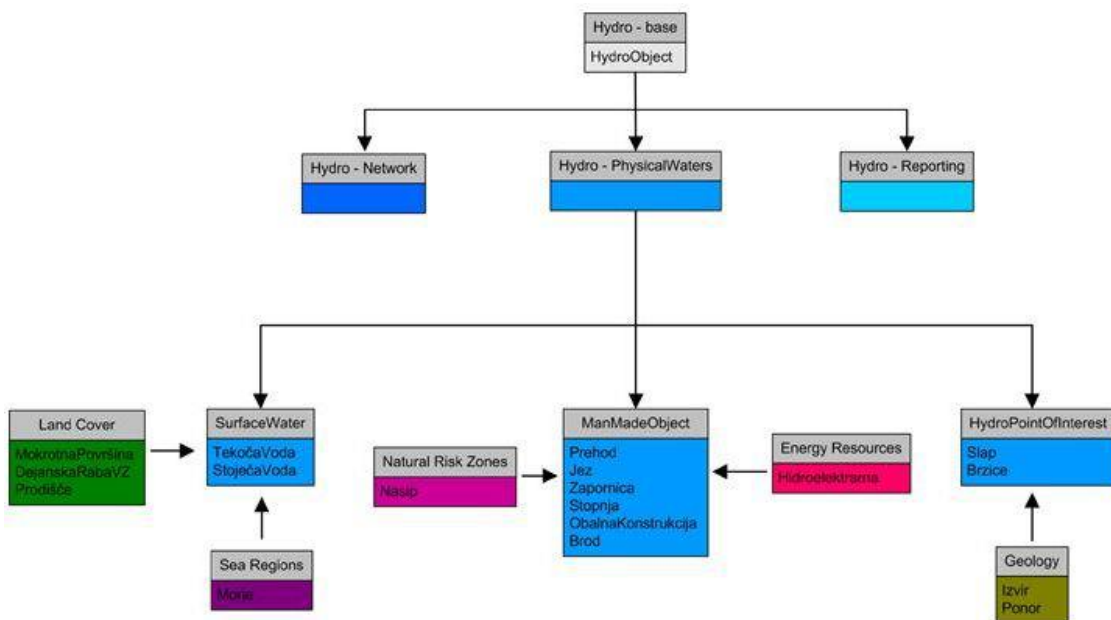
# Data base of surface water hydrology – data model

National surface water hydrology data model is based on the INSPIRE directive.

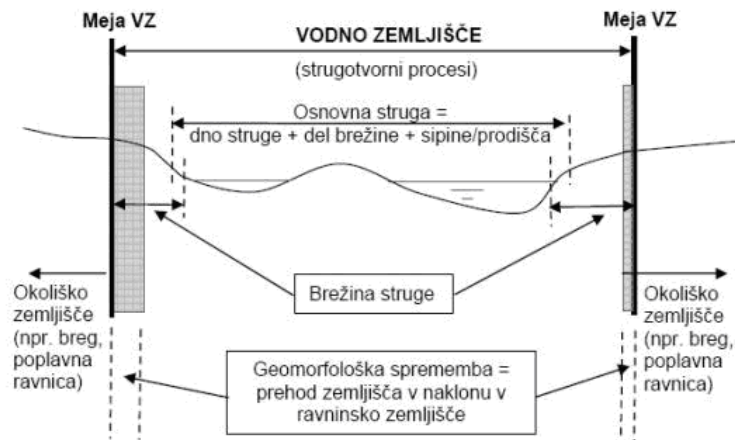
Main feature types with several attributes are: watercourse (river, creek, channel...), standing waters (lake, pond, industrial reservoir...), manmade objects (crossing, dam, embankment...), hydrographic points of interest (spring, waterfall, vanishing point...)

Hydrography data is captured as points, polylines and polygons, dependent on capturing rules and criteria.

Land use (water areas) data include areas, which are primarily used by water. The main criteria for capturing of these areas is geomorphological border of the riverbed.



PRILOGA: Shematski prikaz prečnega prereza vodotoka z določitvijo meje vodnega zemljišča



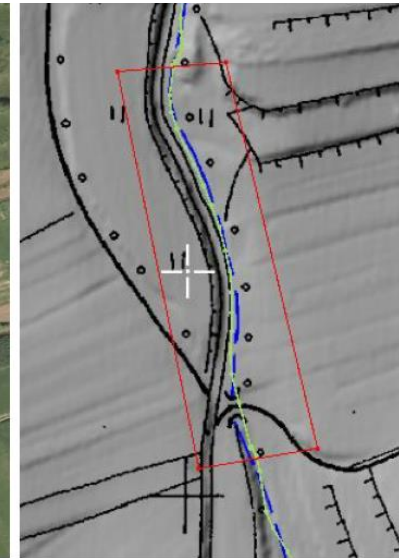
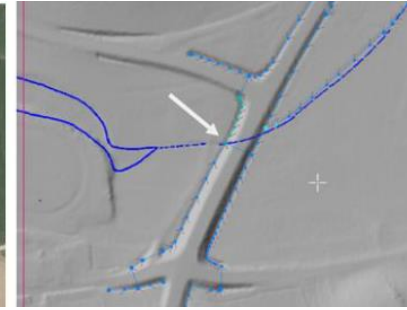
# Data base of surface water hydrology – project

## Project development:

- pilot project started in 2010
- only using aerial photographs (CAS)
- need data of laser scanning (LSS)
- project started in 2015 and will be finished in 2016

## Input data:

- basic 3D data:
  - oriented aerial photographs
  - results of laser scanning
- additional 2D data:
  - orthophoto
  - old topographic maps 1:5000 and 1:25000
  - topographic database 1:5000
  - ...



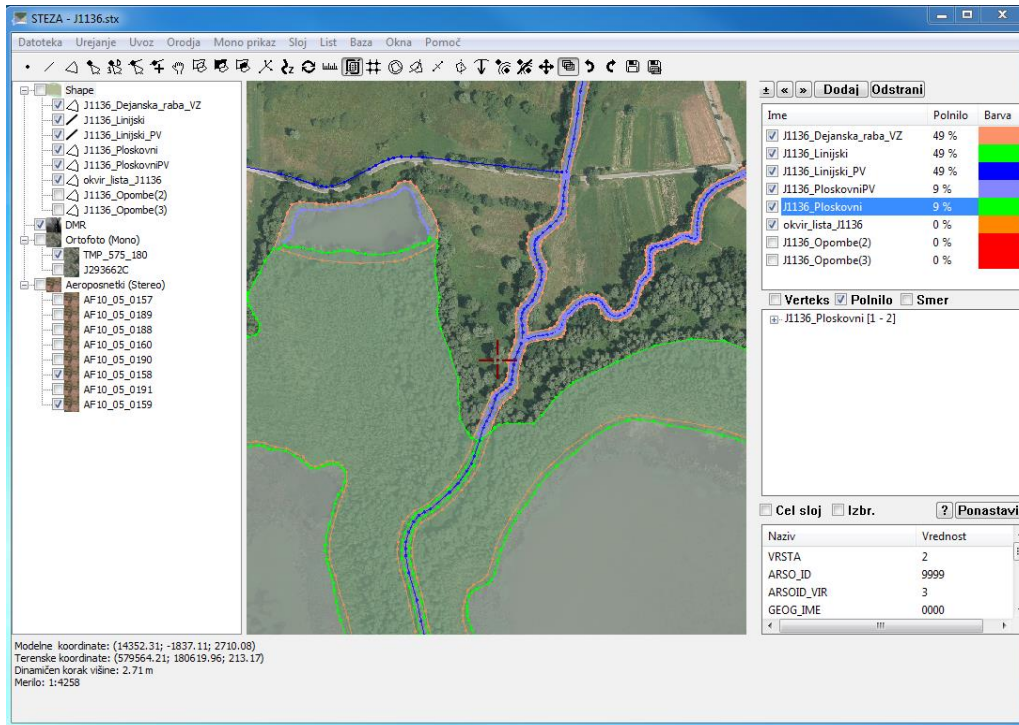
# New photogrammetric data collection software

Input data: aerial images, EOP, data from calibration reports

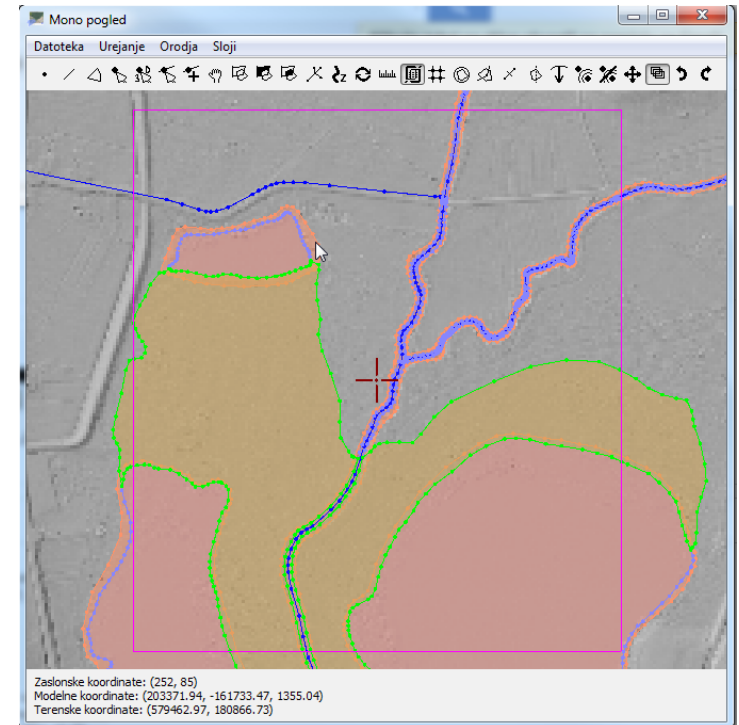
Advantages: data base designed for the project

Quality control: different controlling procedures are built in

stereo screen



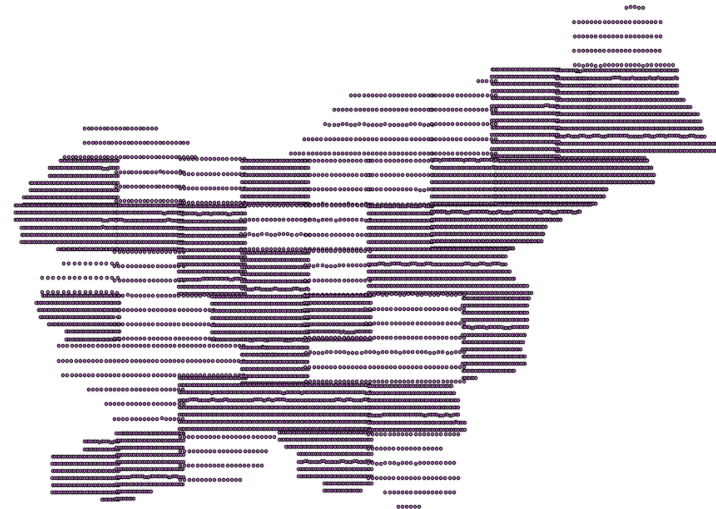
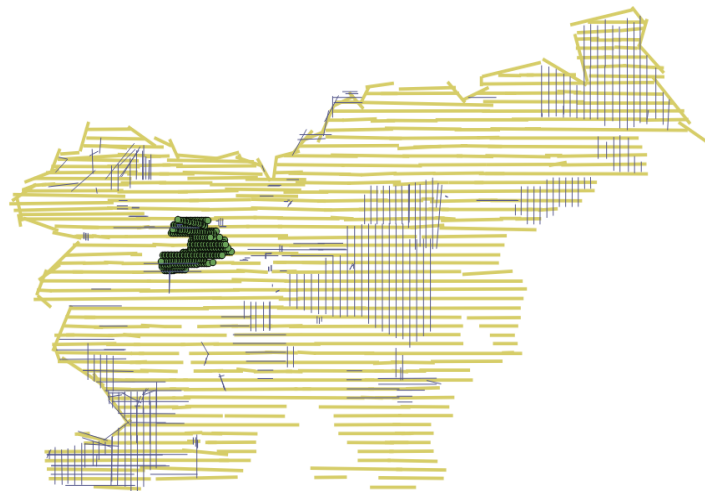
mono screen



Developed in Slovenia by University of Maribor (FERI) nad Geodetic Institute of Slovenia (GIS)

# Cyclical Aerialphotographing of Slovenia (CAS)

- the oldest aerial images in the archive are from year 1943 (RAF)
- till 1970 – Military Geographic Institute from Belgrade was making aerial imagery
- in 1971 started Slovenian servis of aerial photography
- between 1975-80 was finished first cycle of systematic covering the whole country
- in 2006 started digital era of aerial imagery
- so far 13 cycles (1 - 5 years) of coverage was finished



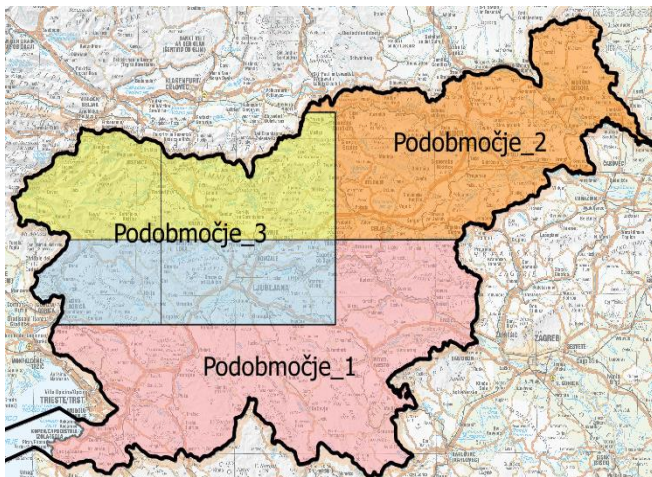
# CAS – present situation

## Project division:

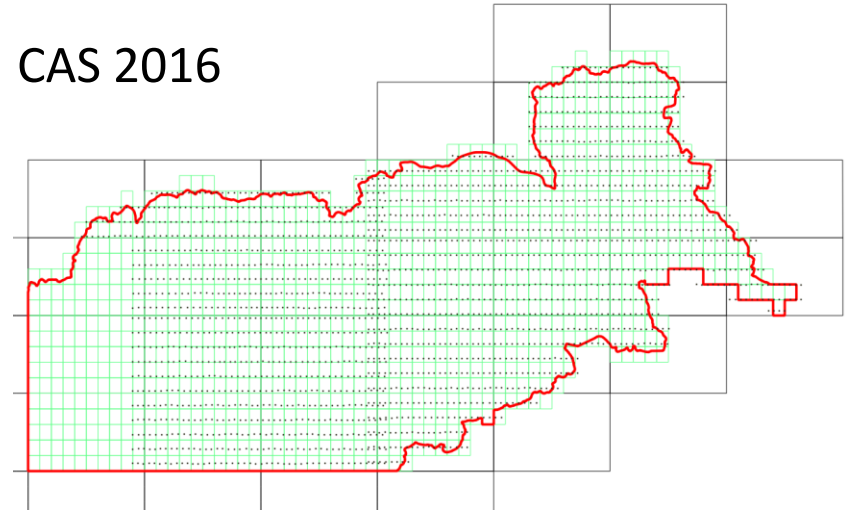
- 12 photogrammetric blocks
- 4 blocks per year => 3 years cycle

## Imagery:

- coverage 30/60 until 2014
- from 2015 coverage 30/80
- GSD =< 25 cm
- RGB images (8 bit)
- PAN, R, G, B, IR (12 bit or more)
- exterior orientation parameters



## CAS 2016



## DTM

- old data 5 x 5 m grid until 2014
- now data from aerial laser scanning 1 x 1 m grid

## Orthophoto:

- RGB (8 bit) with GSD 25 cm and 50 cm
- CIR (8 bit) with GSD 50 cm

# CAS – use and challenges

## Use of CAS results:

- 3D collection for data base of surface water hydrology
- agriculture subsidiary
- updating of topographic maps
- ...

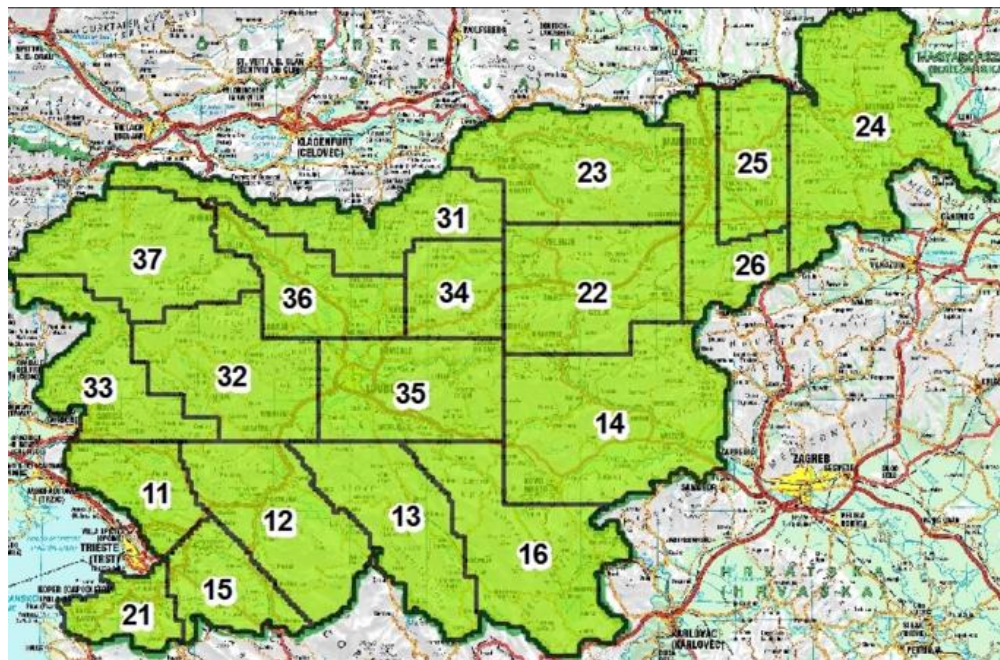
## Challenges:

- alpine region
- different division of sub-areas
- smaller and different GSD
- flying in summer - vegetation
- requirement to fly the same strips
- increasing imagery overlap from 30/80 to 60/80
- near true or true orthophoto



# Laser scanning of Slovenia (LSS)

- LSS started in 2011, but the company which was chosen in the international tender went bankrupt
- LSS continued 2014 and finished in 2015: another Slovenian company (Flycom) did the laser scanning and Geodetic Institute of Slovenia (GIS) produced final results
- Locally developed software (gLIDAR) by Faculty of Electrical Engineering and Computer Science at the University of Maribor (FERI) was used for processing the final results.
- Requirements:
  - density of 5 pts/m<sup>2</sup> and for smaller areas 2 pts/m<sup>2</sup>,
  - accuracy in height 15 cm and 30 cm in planimetry.



# Results of LSS

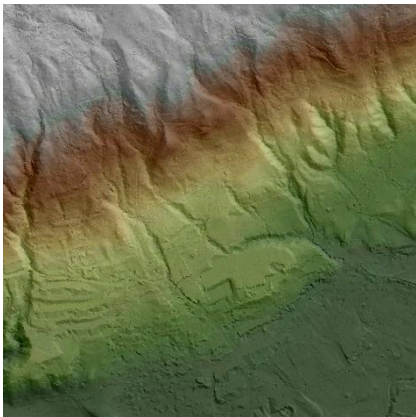
## - Final results:

- georeferenced and classified point cloud in file of 1x1 km (GCPC - LAS),
- terrain point cloud in file of 1x1 km (TPC - LAS),
- DTM in file of 1x1 km (1x1m in ASCII) and
- shaded relief from DTM of file 5x5 km (tif + twf) GSD=1m.

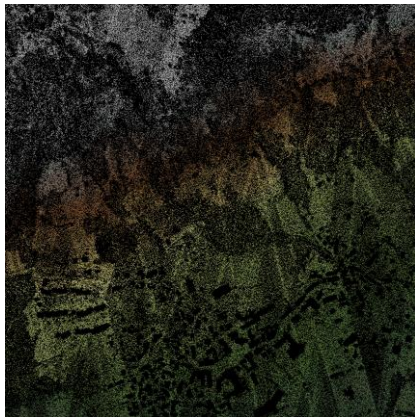
- All results in one coordinate system cca. 9 TB (18 TB)

Results available on internet for free: [http://gis.arso.gov.si/evode/profile.aspx?id=atlas\\_voda\\_Lidar@Arso](http://gis.arso.gov.si/evode/profile.aspx?id=atlas_voda_Lidar@Arso)

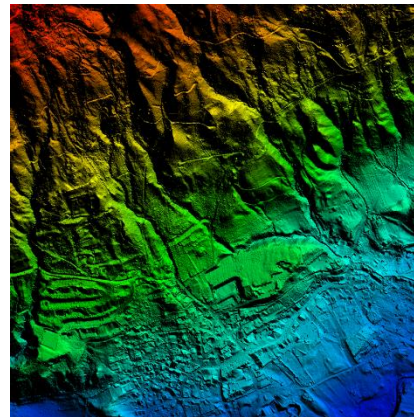
GCPC



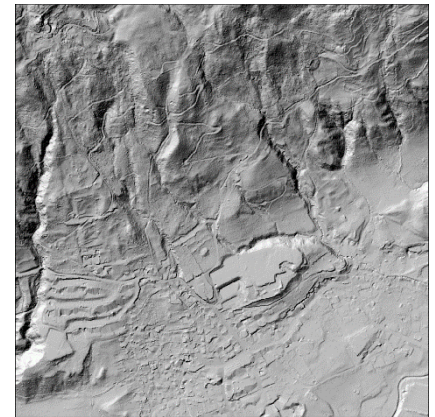
TPC



DTM



shaded relief





Backgrounds ▾

Layers Search

SPATIAL UNITS

- Lidar data fishnet in D48GK projection (1km2)
- Lidar data fishnet in D96TM projection (1km2)
- Areas of Lidar data
- Lidar

Point GKX:510745 GKX:120749

Višina: 286,9 m.n.m.

- Lidar data fishnet in D96TM projection(1km<sup>2</sup>)
- Name of the fishnet: 510\_121
- Date of scanning: od 12. 3. 2014 do 20. 10. 2014
- Download instructions (SLO)
- Data download GKOT (D96TM)
- Data download OTR (D96TM)
- Data download DTM (D96TM)
- Technical report
- Fishnet for Slovenija (D96TM)

- Areas of Lidar data
- Area: 22
- Data status: Predano na ARSO

0,6km

sarso.gov.si/lidar/gkot/b\_22/D96TM/TM\_510\_121.zlas

Name of each 1x1km tile: E and N: e.g. 510\_121 (LL) E = 510.000 m, N = 121.000 m

Date of scanning: e.g. from 12.3.2014 to 20.10.2014

Download instructions (SLO)

Data download GKOT (D96TM) – GCPC

Data download OTR (D96TM) - TPC

Data download DTM (D96TM)

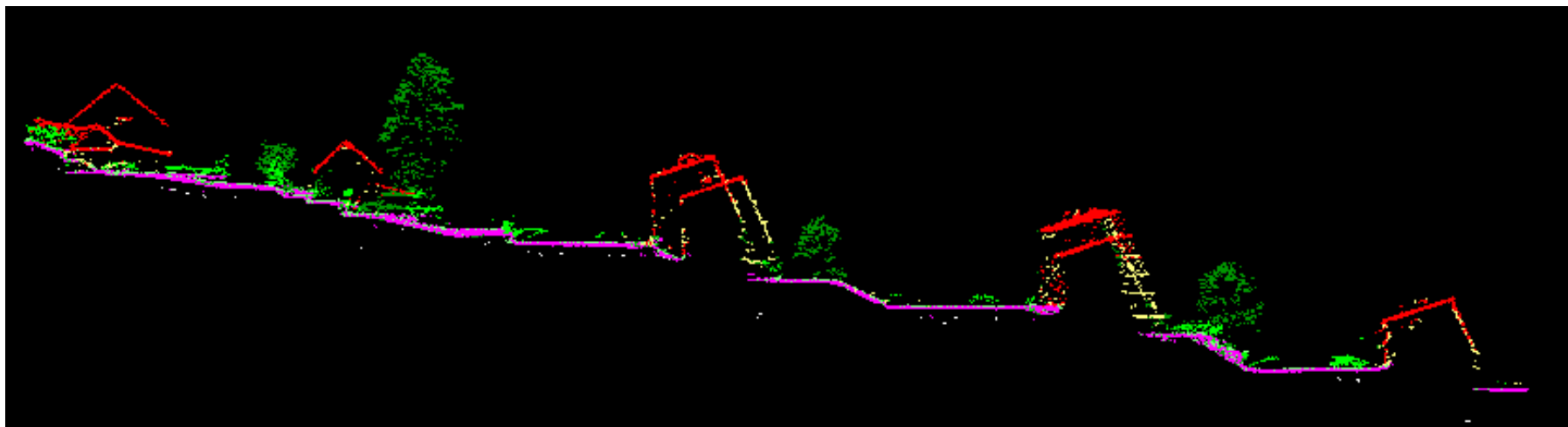
Technical report (SLO)

Fishnet of Slovenia (shp, dtb ...)

# QC of LSS – collected data

Quality control of scanned data: georeferenced point cloud cut strips with files less than 2GB (GPC - LAS)

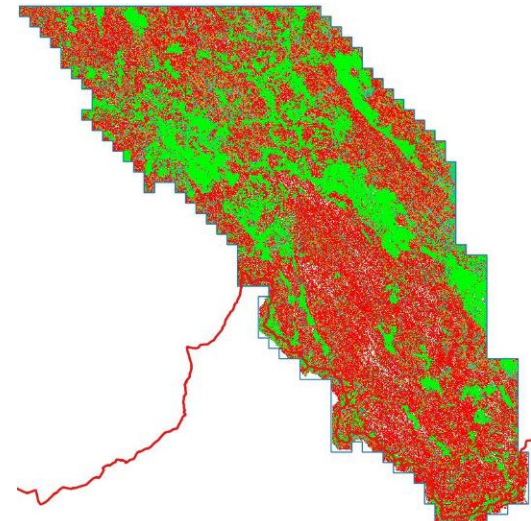
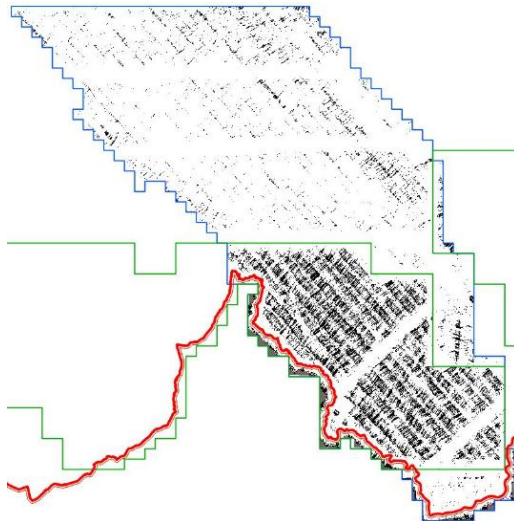
- completeness – using provided shapes
- cross strips and strips overlapping
- point density
- relative height accuracy (1/2 of absolute height accuracy)
- absolute height accuracy (comparing with GNSS field check points)
- absolute planimetric accuracy (comparing with GNSS field check points measured on road signs and sport fields)



# QC of LSS – results

## Quality control of results for a block:

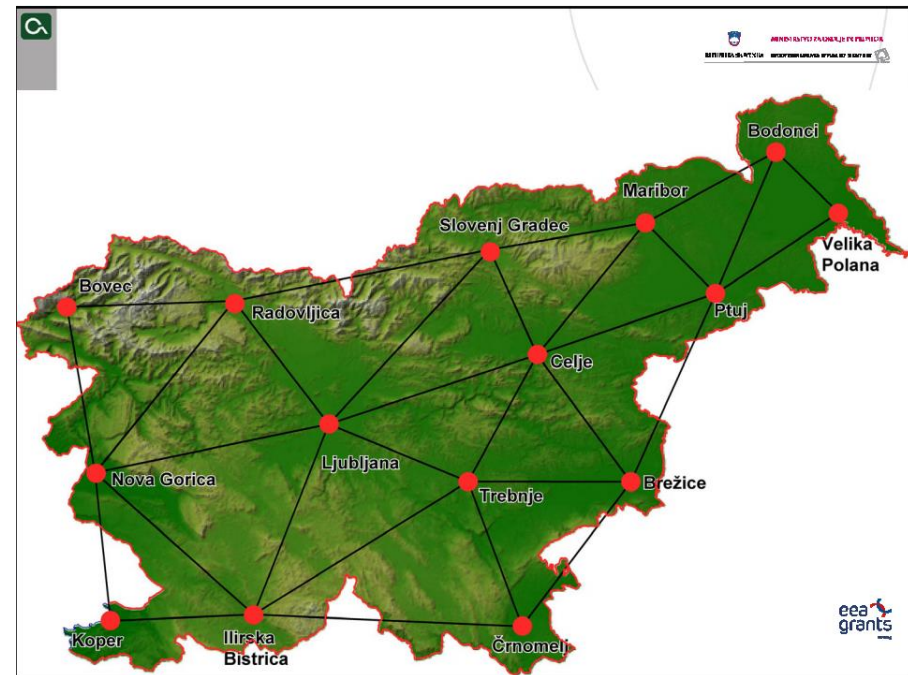
1. administrative control of naming of all files
2. visual control of shaded relief of DTM
3. visual control of TPC
4. visual control of completeness of GCPC
5. control of classification (5 % sample) of buildings comparing with orthophoto from CAS: completeness (98%) and correctness (92%)
6. absolute height accuracy of DTM: specified 15 cm (RMSE – 1 sigma), more than 4000 points measured on the field were used as check points



# Data collection for LSS

## Equipment used:

- scanner: RIEGL LMS-Q780
- platform: helicopter
- GNSS: Novatel OEMV-3
- INS: IGI Aerocontrol Mark II.E 256 Hz
- the largest scanning angle:  $\pm 30^\circ$
- error of scanning angle: 0,25 mrad
- angle accuracy: “roll/pich”  $= < 0,004^\circ$ ,  
“heading”  $= < 0,01^\circ$ , location accuracy is 5 cm
- synchronisation error between INS, GNSS  
and laser scanner is 0,005 ms
- height of the sensor above ground  
from 1200 m to 1400 m
- GNSS infrastructure: SIGNAL  
<http://www.gu-signal.si/>



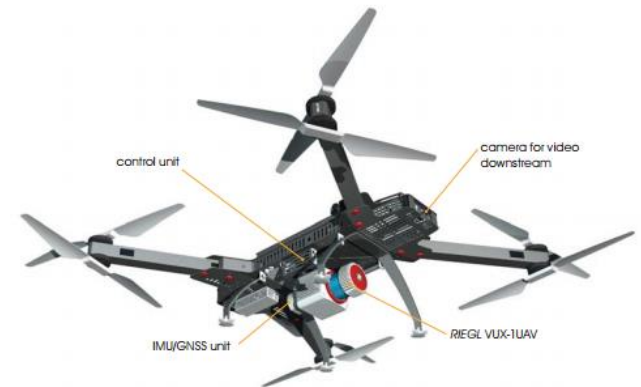
# LSS – use and challenges

## Use of LSS results:

- 3D collection for data base of surface water hydrology (GCPC, TPC and DTM)
- national data base of DTM
- ...

## Challenges:

- updating method for LSS results (CAS, medium format aerial cameras, UAV, local laser scanning)
- new laser scanning of the whole country
- simultaneous collection of aerial photography and aerial laser scanning





**Thank you for your  
attention!**