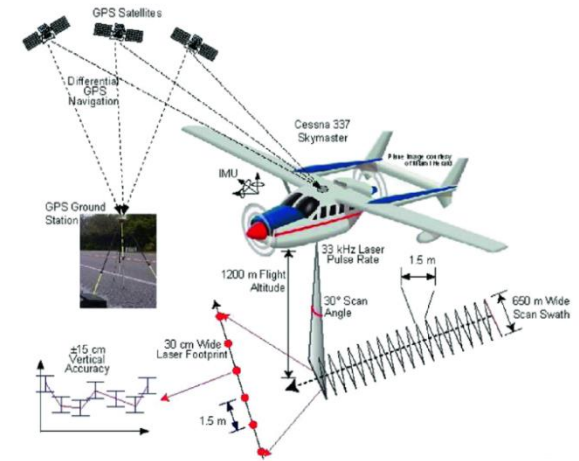
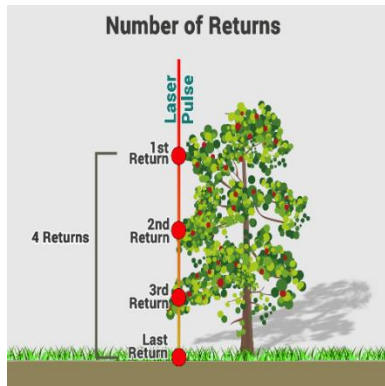


Delivering more accurate height data for mountain peaks in Slovakia

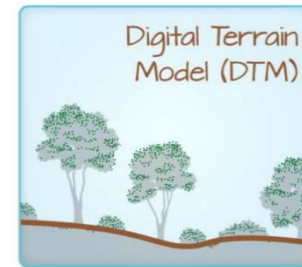
Matúš Fojtl, Katarína Leitmannová,
Eva Miklušová, Linda Gálová,
Gabriel Nagy et al.

Motivation

- **LiDAR - Light Detection And Ranging**
(Airborne Laser Scanning – **ALS**)



- **Digital Terrain Model (DTM 5.0)**
 - bare-earth raster grid

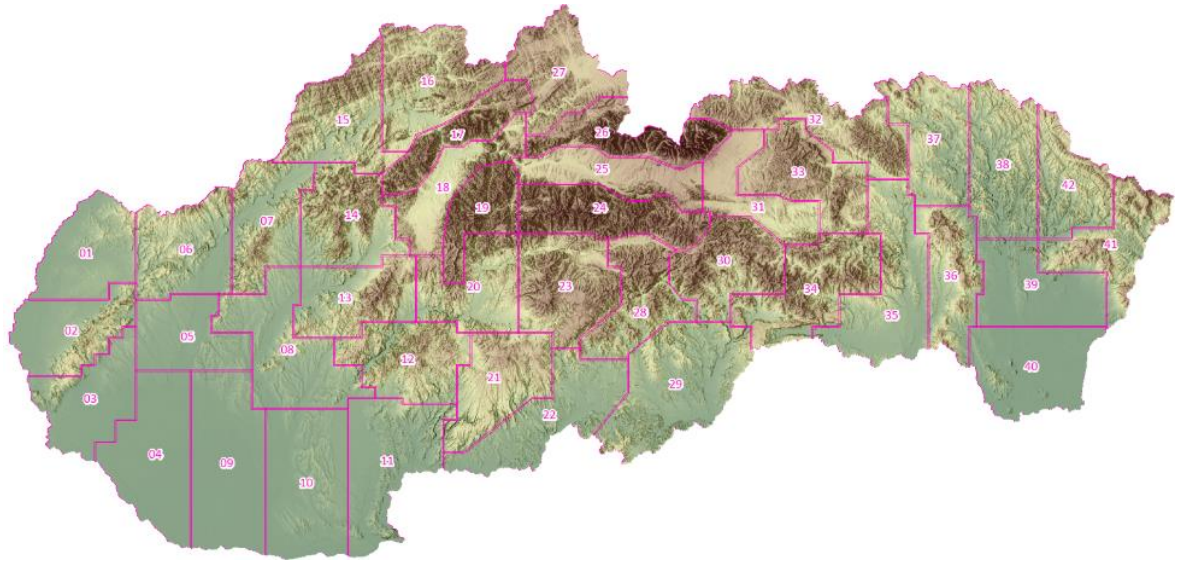


- **Digital Surface Model (DSM 1.0)**
 - natural and built features



1st cycle of ALS project

- project duration
2017 – 2023
- scanning density:
17 – 52 p / m²
- absolute vertical accuracy of point cloud at ellipsoidal heights in ETRS89:
m_h <0,01m ; 0,09m>
- absolute positional accuracy of point cloud in ETRS89-TM34:
m_p <0,07m ; 0,17m>
- area of Slovakia: 49 035 km²
- number of lots: 42
- area of lots: 738 – 1 806 km²
- completed 100% area of Slovakia



<https://www.geoportal.sk/en/zbqis/als/>
<https://www.geoportal.sk/en/zbqis/als/1st-cycle/>

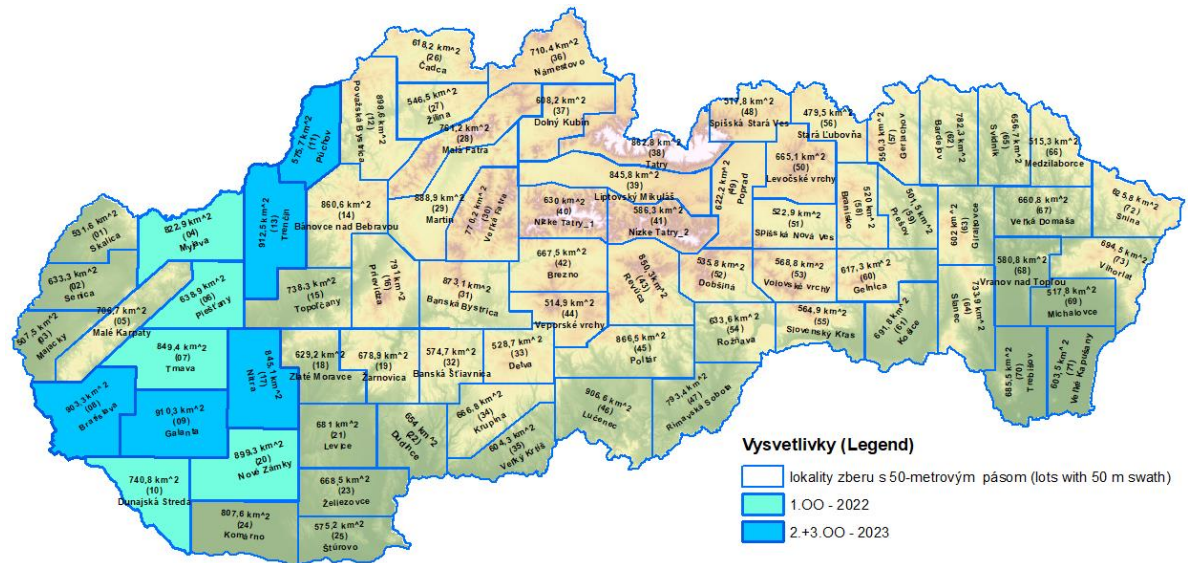


2nd cycle of ALS project

- project duration
2022 – 2026
- area of Slovakia: **1/3 of 49 035 km²**
- number of lots: **73**
- area of lots: **480 – 910 km²**
- scanning density:
34 – 45 p / m²
- contracted 16% area of Slovakia

- absolute vertical accuracy of point cloud at ellipsoidal heights in ETRS89:
 $m_h \langle 0,01m ; 0,05m \rangle$

- absolute positional accuracy of point cloud in ETRS89-TM34:
 $m_p \langle 0,04m ; 0,14m \rangle$



<https://www.geoportal.sk/en/zbqis/als/>

<https://www.geoportal.sk/en/zbqis/als/2nd-cycle/>



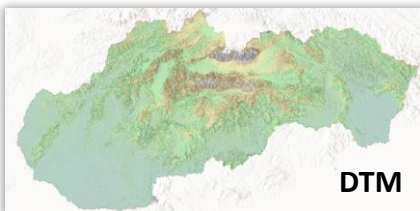
Provision of ALS products

FREE OF CHARGE

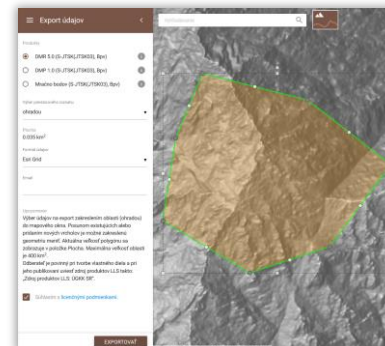
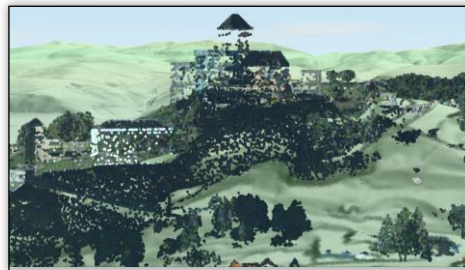
■ 1st cycle:



Products	Manner		Online		Off-line
	Format		Cloud - ZIP	Map client ZBGIS - Export (Terrain)	
DTM 5.0	TIFF 1 x 1 m S-JTSK(JTSK03)+Bpv ETRS89-TM34+h _{ETRS89}	whole area of Slovakia		Smaller volume data	the customer centers - Order form
DSM 1.0					Spatial products e.g. Land consolidation
Classified Point Clouds	LAS / LAZ S-JTSK(JTSK03)+Bpv ETRS89-TM34+h _{ETRS89}	X		400 km ² 2 km ²	lot-by-lot basis



Classified Point Cloud



Data export (Terrain)

<https://www.geoportal.sk/en/zbgis/airborne-laser-scanning/als-products-providing/provision-als-products.html>



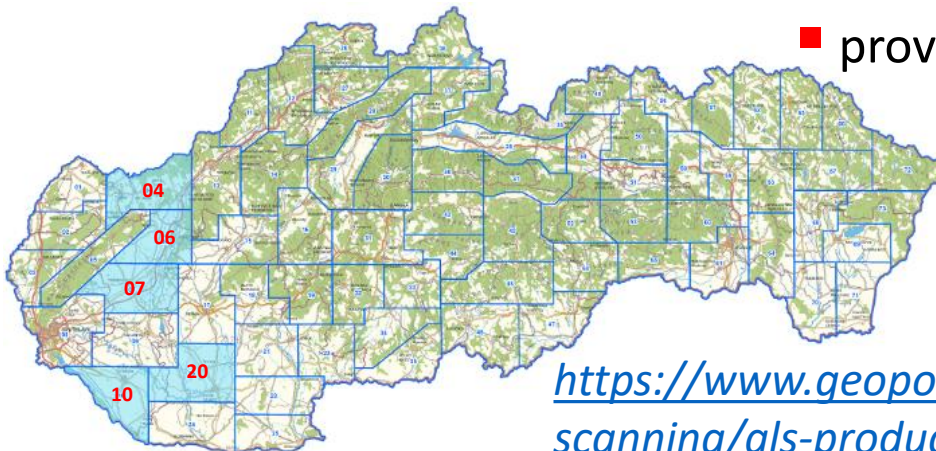
Provision of ALS products

FREE OF
CHARGE

■ 2nd cycle:



Products	Manner Format	Online	Off-line
		Cloud - ZIP	the customer centers - Order form
DTM 6.0	TIFF 0,5 x 0,5 m S-JTSK(JTSK03)+Bpv ETRS89-TM34+h _{ETRS89}	lot-by-lot basis	Spatial products e.g. Land consolidation
DSM 2.0			
Classified Point Clouds	LAZ S-JTSK(JTSK03)+Bpv ETRS89-TM34+h _{ETRS89}	X	lot-by-lot basis



■ provided Lots

04, 06,
07, 10,
20

Note:

S-JTSK (JTSK03) – EPSG: 8353
Bpv – EPSG: 8357
ETRS89-TM34 – EPSG: 3046
h_{ETRS89} – EPSG: 4937

<https://www.geoportal.sk/en/zbqis/airborne-laser-scanning/als-products-providing/provision-als-products.html>

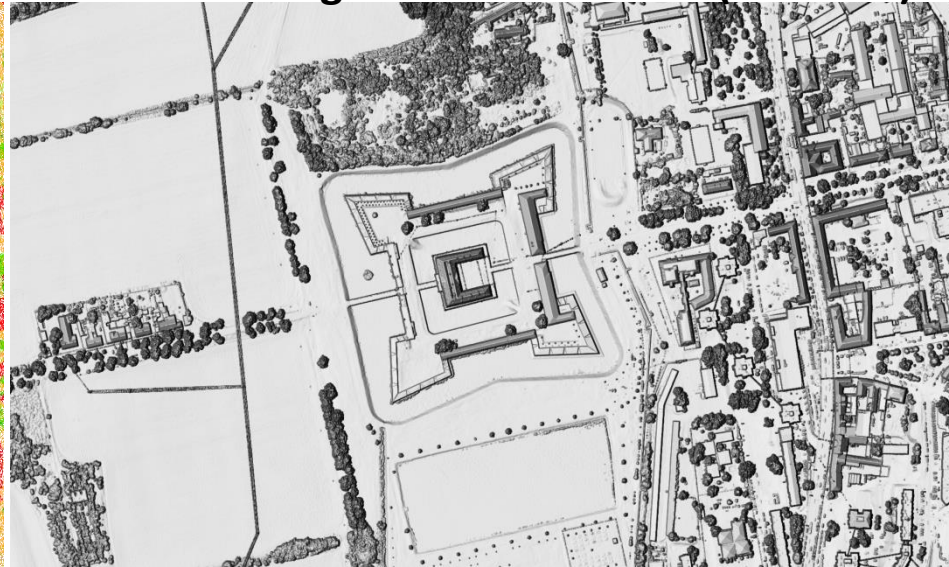


ALS products

Classified Point Cloud



Digital Surface Model (DSM 1.0)



Digital Terrain Model (DTM 5.0)



*Manor house
in Holíč*

ALS products: areas of use

- **within our Authority (UGKK SR):**
 - Refinement/updating of topographical data:
 - refinement of the water courses,
 - **refinement of the location (position, height) of geomorphological features (peaks, saddles, etc.) and verification of their names**
 - processing of the Orthophotomosaic of Slovakia,
 - national border updating,
 - 3D building modelling – LoD 2.
- Land Consolidation
- Academic community
- Archaeology and Protection of Cultural Heritage
- Environment (Landslides, Flood maps, Landscape ecology, etc.)
- Construction and Architecture
- Crisis management

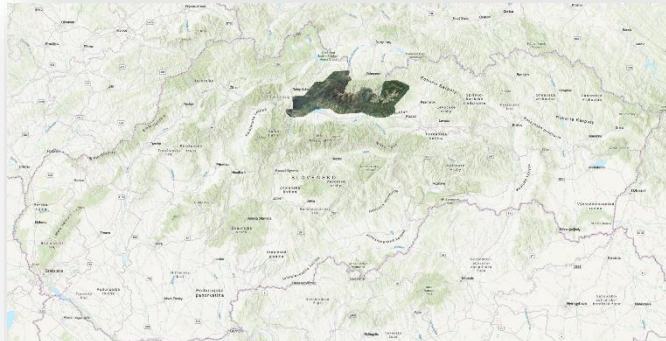
Refinement of position of geomorphological features and verification of their names

Why:

- availability of new data (DTM 5.0),
- need for comprehensive revision and updating of Geonames,
- different literature - different values of heights and names,
- questions from the public – for example inaccuracies in heights, locations of peaks, missing names.

Project:

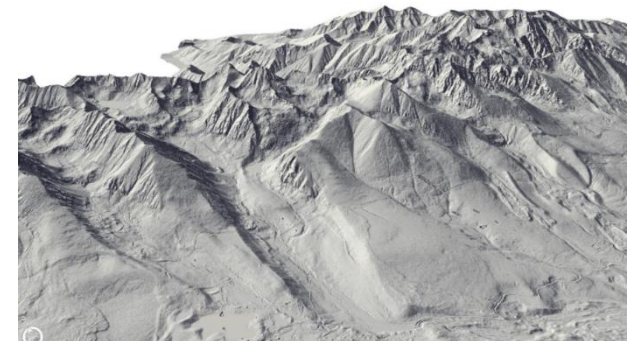
- started in 2021
- test location – **Tatra Mountains**



■ Point Cloud coloured by Orthophoto



■ DSM



■ DTM

Refinement of position of geomorphological features and verification of their names

Cause of the problem:

- **original heights** -various sources (various quality – different technologies)
 - the heights of the main peaks were determined according to the height of the trigonometric point (TP),
- heights of peaks **without TP** were determined from aerial images or only by carto-metric method,
- without the exact location of the feature (coordinates) - it is not possible to determine the correct height,
- Database of standardised GN – 130 000 GN, created from the Basic maps (1:10 000, 1:25 000, 1:50 000) and Topographic maps (1:25 000, 1:50 000),
- the ambiguous identification of GN location was limited by the scale and technologies used at the time.

Present:

- GNSS
- Airborne laser scanning (LiDAR)

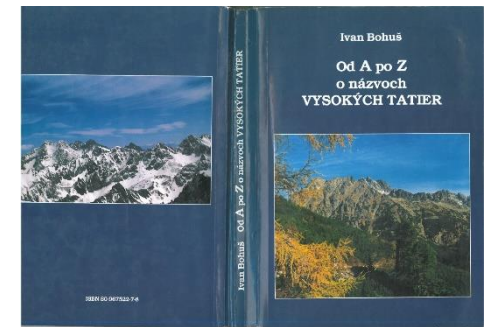
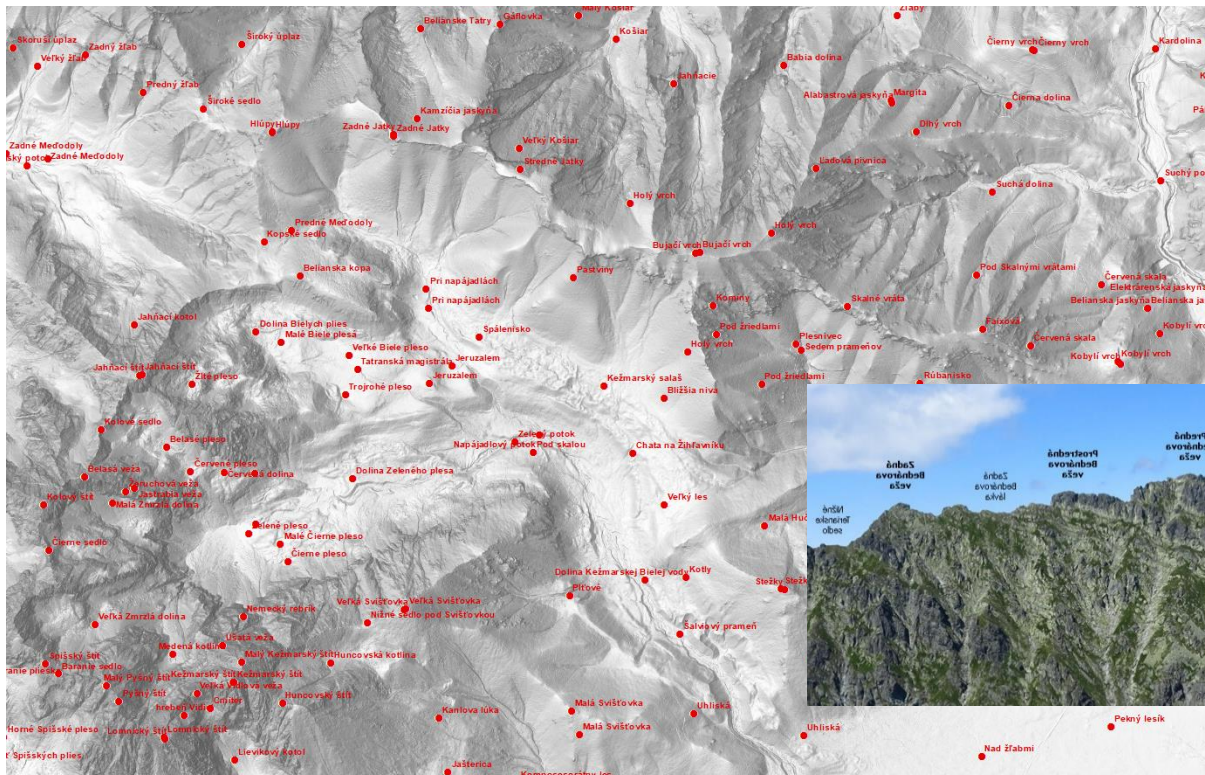
Refinement of position of geomorphological features and verification of their names

■ **Materials used:** Location -Tatra Mountains

■ **DTM 5.0**

■ **Database of standardised GN – feature class Peak, Saddle**

■ **Various map and book documents**



Refinement of position of geomorphological features and verification of their names

■ Technological procedure - first step:

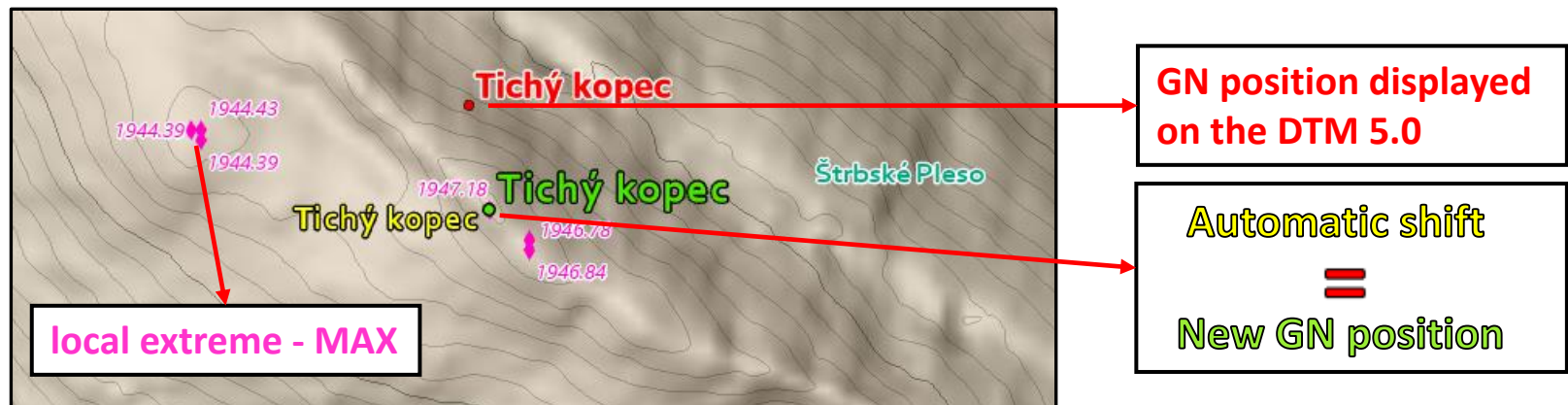
- from **DTM 5.0** - automatic generation of local extremes using *ArcPython script*

- **maximums** - to identify and locate peaks

- **minimums** - to identify and locate saddles

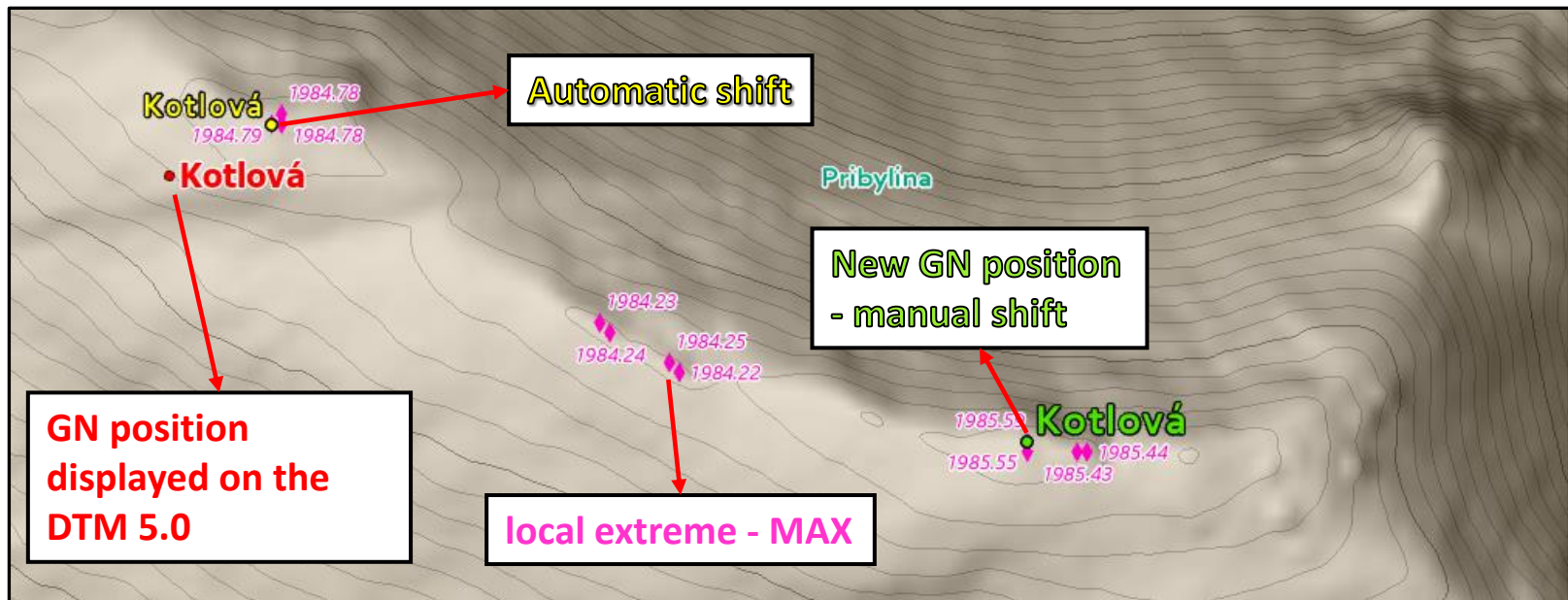
■ Automatic shift of the GN position:

- under the condition of the suitability of the shift



Refinement of position of geomorphological features and verification of their names

- Technological procedure - second step:
 - Manual shift of the GN position:
 - after analysing the GN location on available raster maps

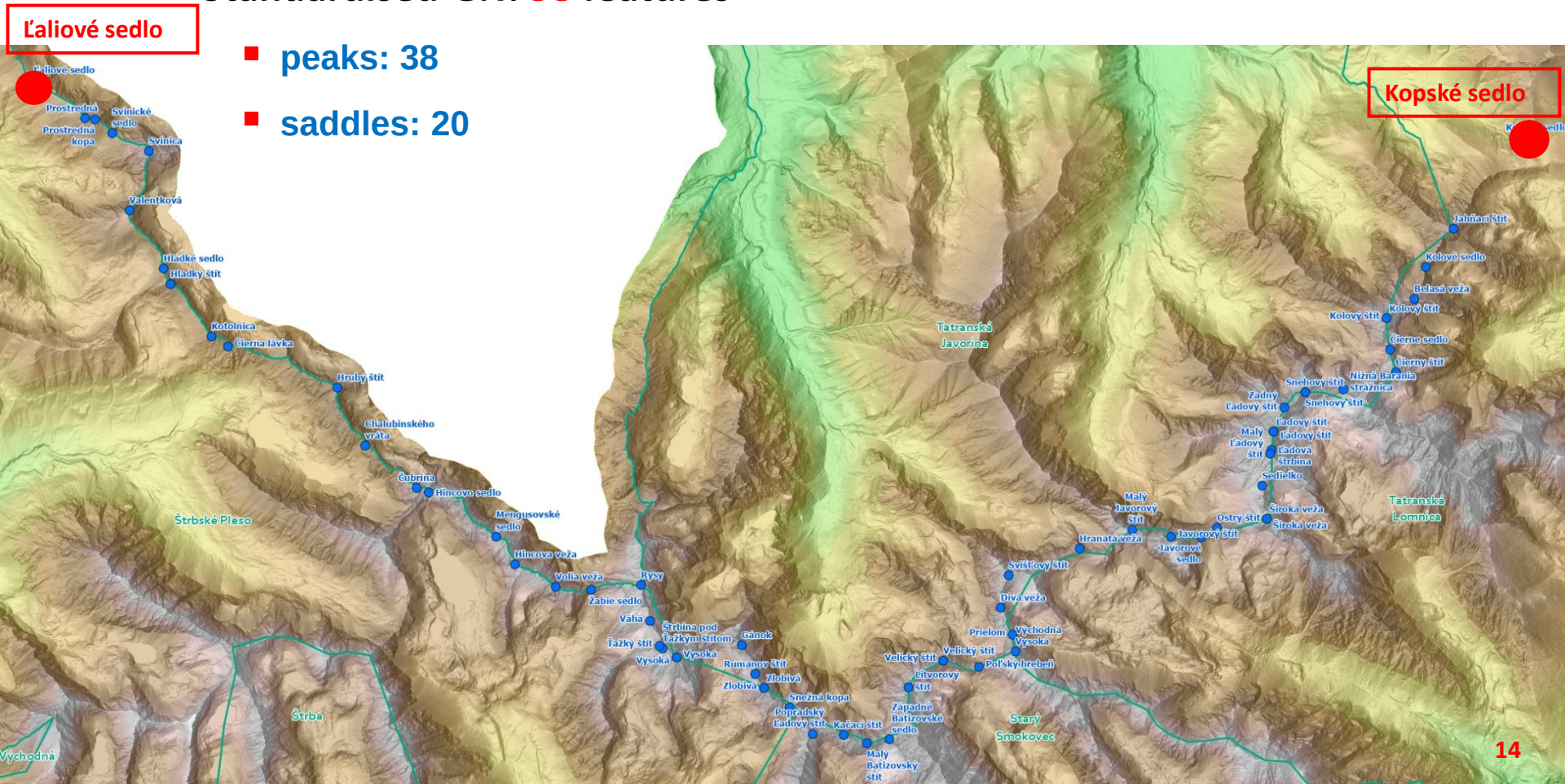


Proposal for new location of GN features

- GN features on the **main ridge** of the High Tatras (part of Tatra Mountains)

- ## ■ Standardised GN: 58 features

- peaks: 38
- saddles: 20

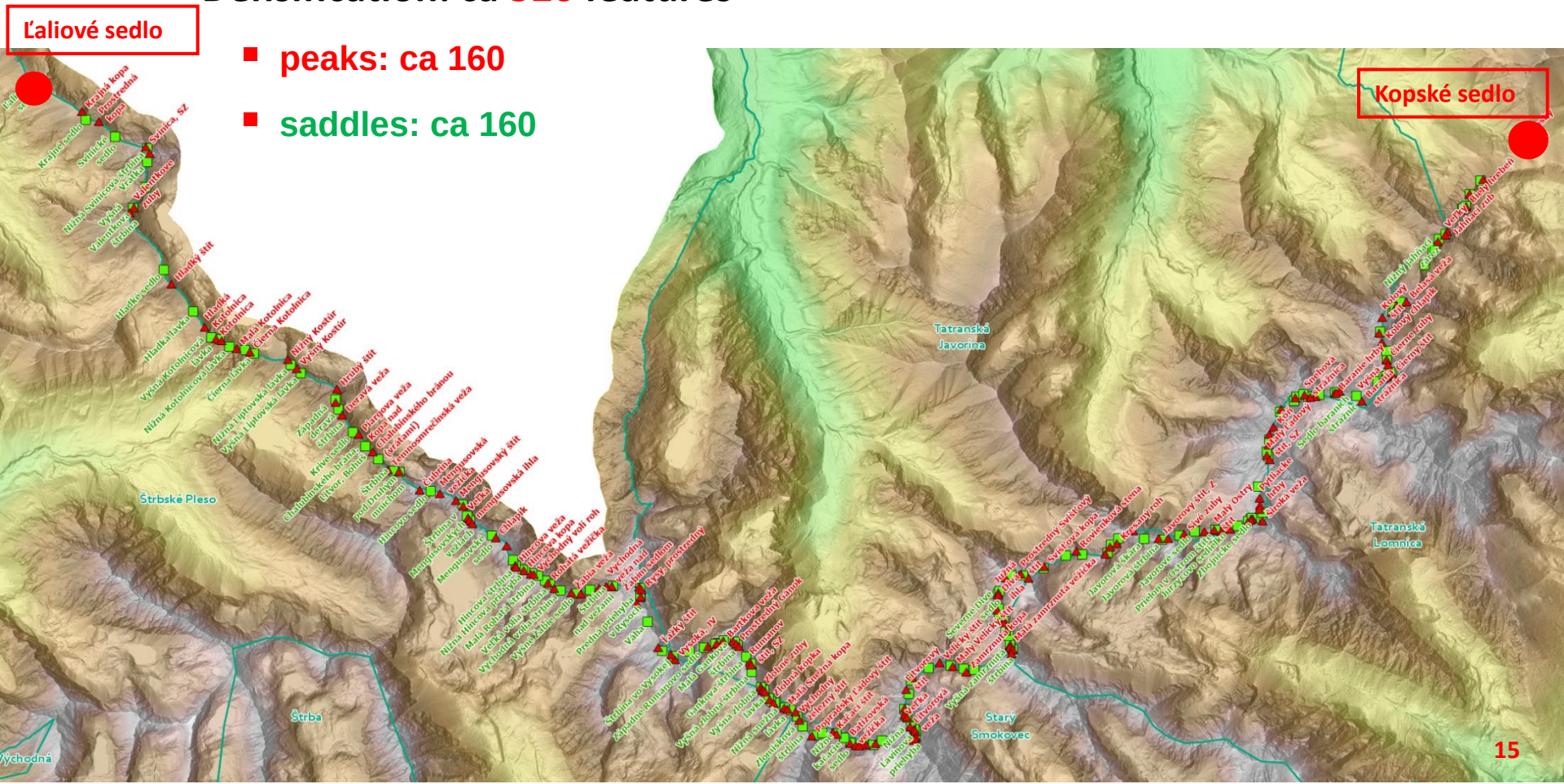


Proposal for new location of GN features

- densification (position, height and name) of GN features (category Peak and Saddle) on the **main ridge** of the High Tatras.

- Densification: ca **320** features

- **peaks: ca 160**
- **saddles: ca 160**



Proposal for new location of GN features

- densification (position, height and name) of GN features (category Peak and Saddle) on the **side ridges** of the High Tatras.

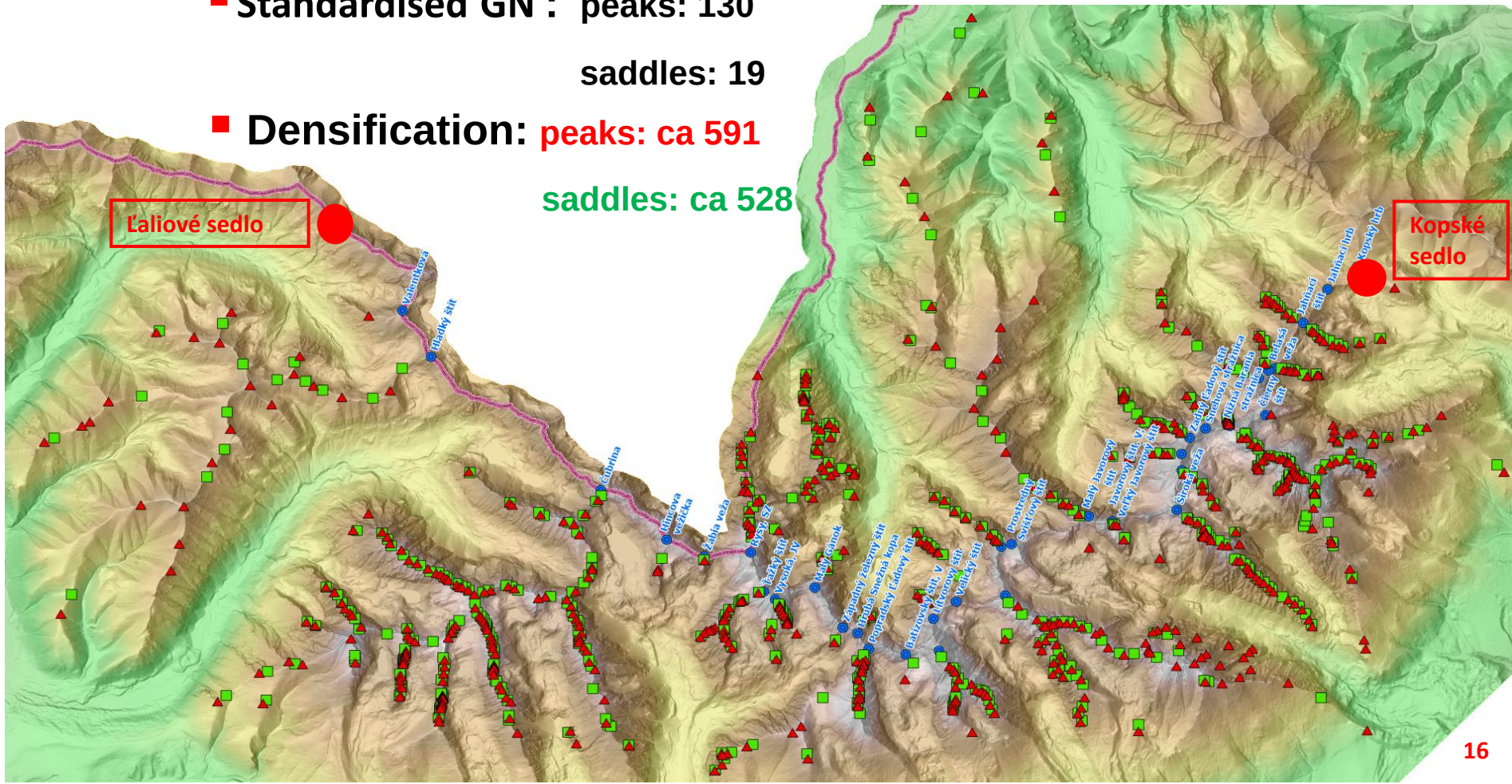
■ **Standardised GN : peaks: 130**

saddles: 19

- **Densification: peaks: ca 591**

saddles: ca 528

- Side ridges: 35



Proposal for new location of GN features

■ densification of Belianske Tatry

■ Standardised GN:

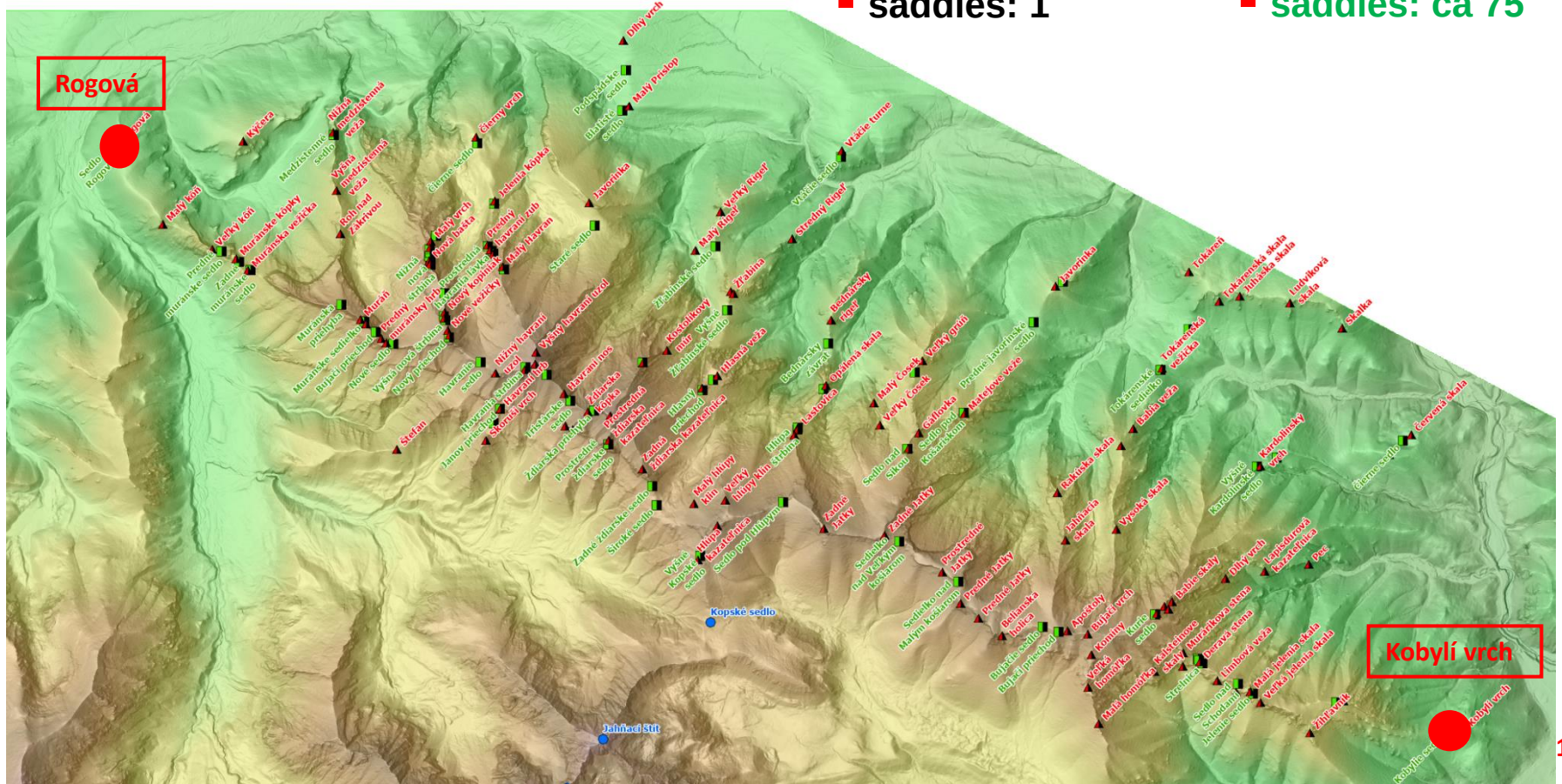
■ peaks: 22

■ saddles: 1

■ Densification:

■ peaks: ca 117

■ saddles: ca 75



Proposal for new location of GN features

■ densification of Západoé Tatry

■ Standardised GN:

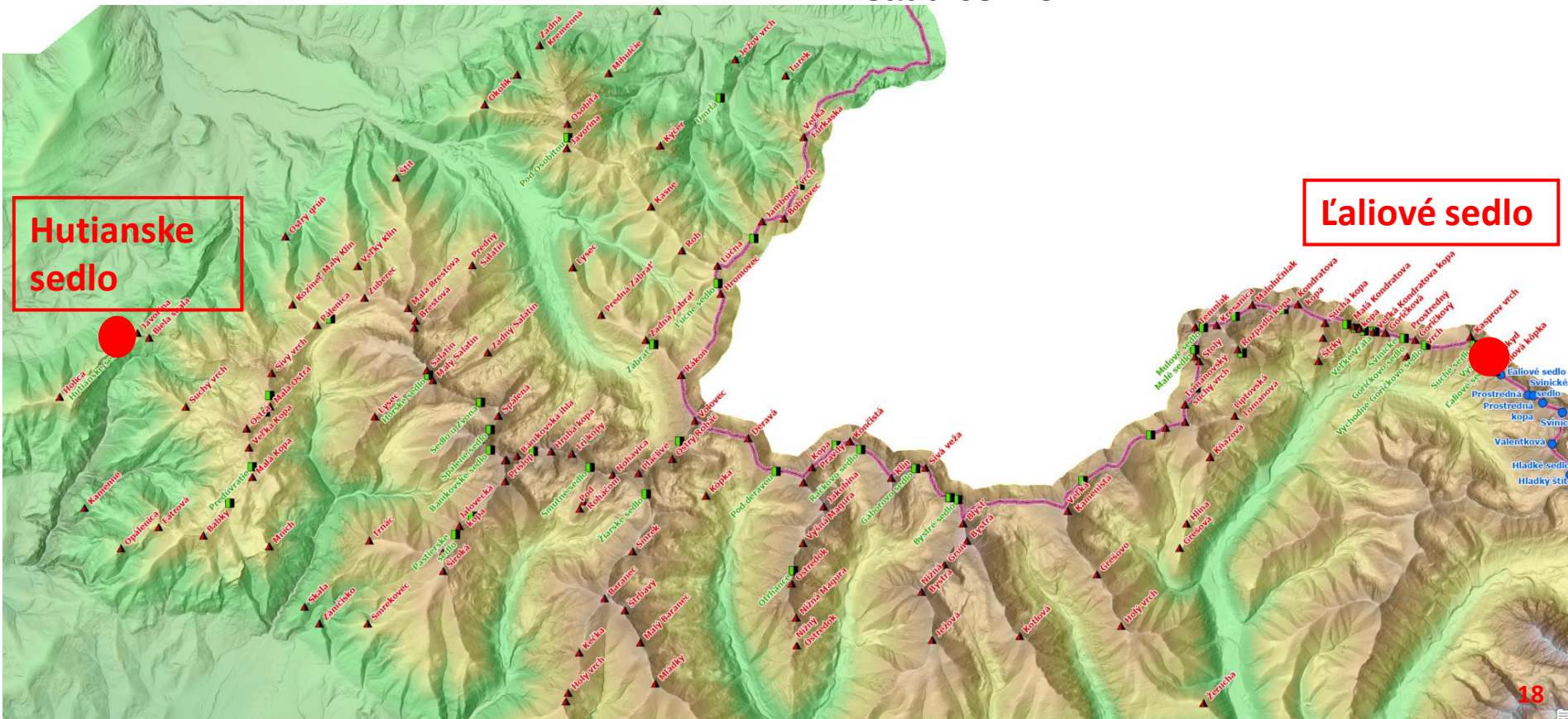
■ peaks: 88

■ saddles: 23

■ Densification:

■ peaks: ca 148

■ saddles: ca 58



Next steps

- communication with experts and specialists of the Tatra Mountains and **approval of proposed changes and additions**
- editing of our location and name proposals by representatives of selected entities via the **online Arc GIS portal application**
- checking and densifying **other feature class categories**:
 - e.g.: valley, ridge, tarn
- communication with geomorphologists from the Slovak Academy of Sciences
 - update of GMU boundaries above DTM 5.0
- obtaining more detailed documentation
 - publications, schematic maps, etc.
- continuing to **refine the features of other mountain ranges**
 - location and Geonames control



**Thank you for
your attention.**

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