

# LANDSYSTEM UNITS IN MUSALA CIRQUE AND THEIR RELATION TO TERRESTRIAL PROCESSES

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# About the present study



- This study presents results obtained under the project “Models of contemporary Periglacial Morphogenesis” – a first stage of Bulgarian Periglacial Programme – a programme for observation and research of terrestrial processes in Bulgarian highest mountains

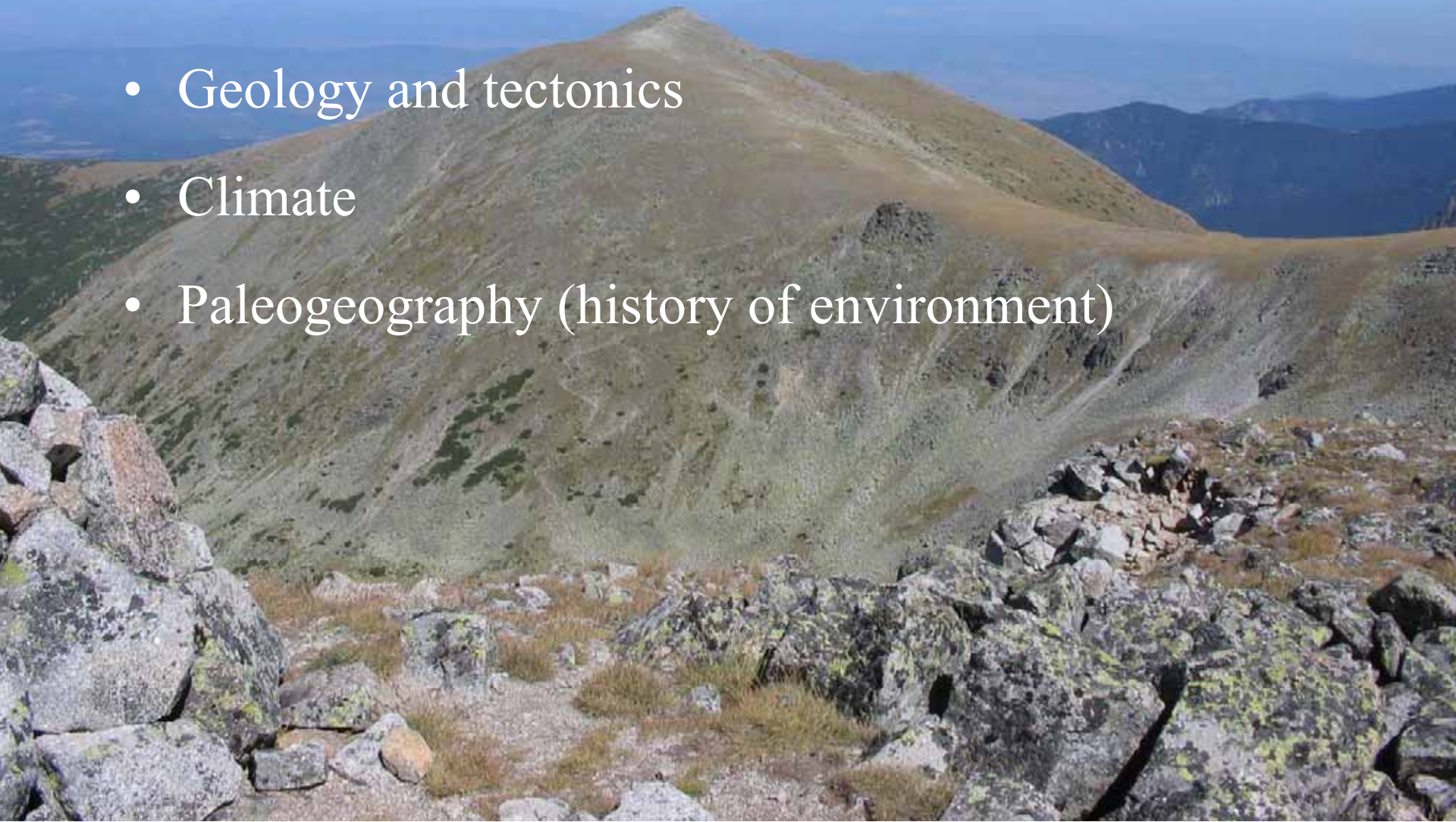
# Bulgarian cold environments

- Cold environments – areas where natural processes are strongly influenced by frost and frost action
- In Bulgaria – the areas above 1850 – 1900 m a. s. l.
- Most typical – highest parts of Rila and Pirin mountains above the timberline (2100 m a. s. l. to 2900 m a. s. l.)



# Factors for cold environment formation and diversity

- Geology and tectonics
- Climate
- Paleogeography (history of environment)





# Research site

- **Musala cirque** – a terraced relict cirque from Pleistocene glaciation in Rila mountain
  - area – 2,451 km<sup>2</sup>
  - altitude – 2386 to 2925 m a. s. l.
  - defined on catchment basis





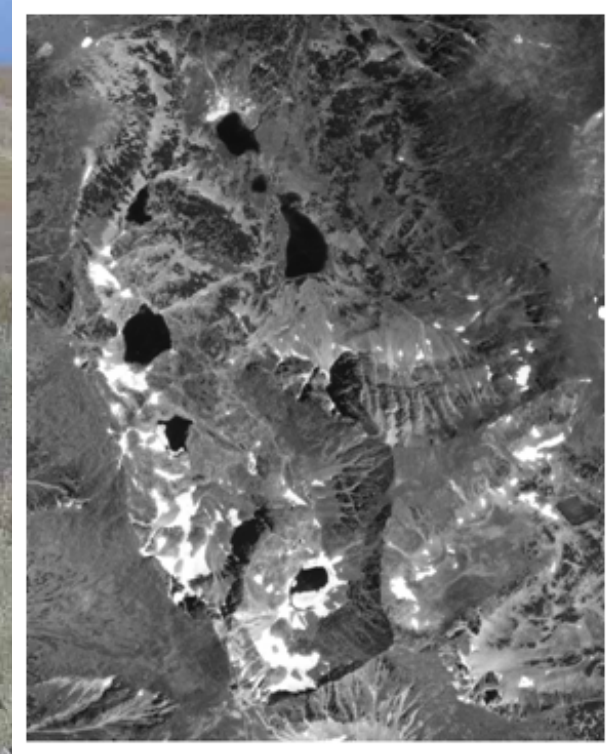
# Landsystem units

- These are large-scale “bricks” of environment – territories that are characterised by internal uniformity in bedrock, topography, soil and vegetation
- These are parts of land systems (or geosystems) – larger landscape features that have specific combination of the main natural components (relief, climate, vegetation, waters, soils) and usually include whole catchments



# Methods for landsystem mapping

- Main method — interpretation of aerial photographs at work scale 1: 2 500
- Support methods:
  - analysis of terrestrial digital photographs
  - control at 2 field visits during 2006 terrain season





# Mapping techniques

- GIS mapping on a digital terrain model

- hypsometry

- slope tilts

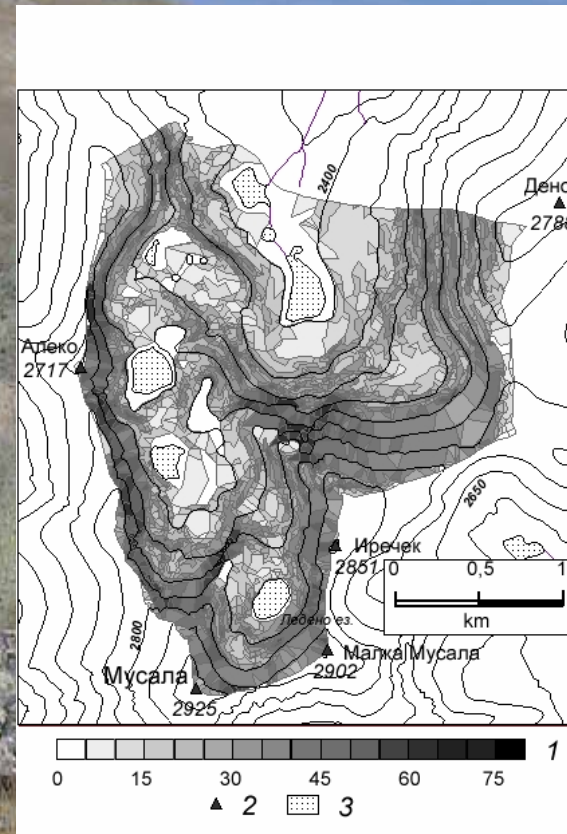
- New map layers

- elements of relief

- type of land cover

- landsystem units

(overlay of the first two layers)

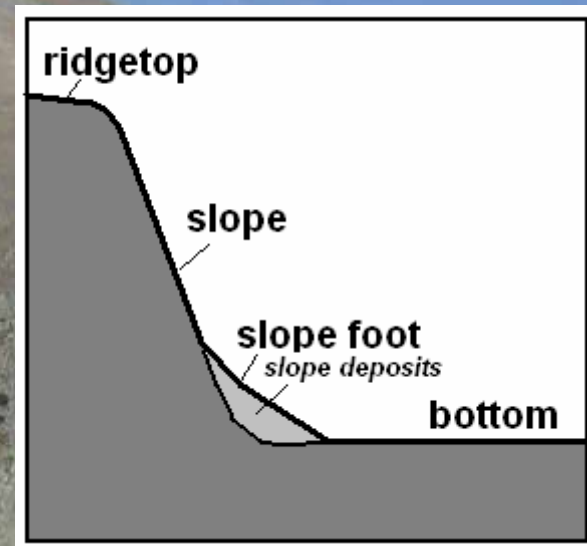




# Elements of Relief

- Elements at mezoscale

- Ridgetops
- Slopes
- Active slope feet
- Slope feet
- Bottoms





# Elements of Relief

- Importance of slope tilt

- Slope surfaces

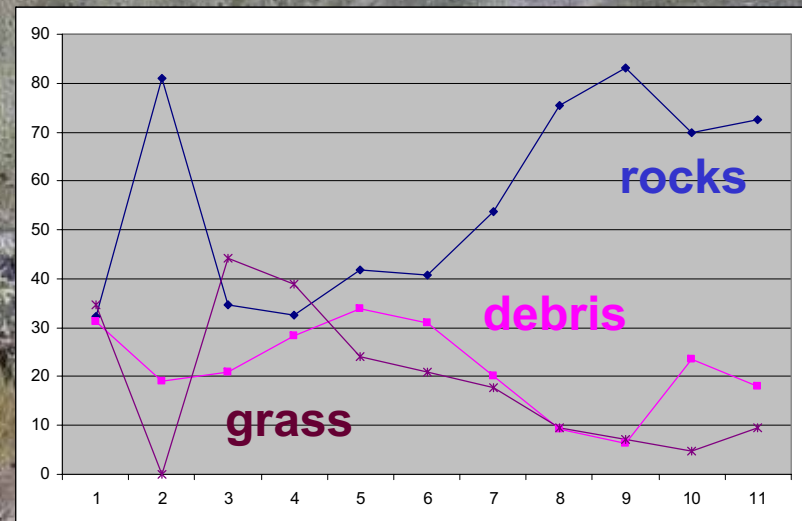
- steady slopes (5° to 23°)
- steep slopes (23° to 40°)
- very steep slopes (40° to 70°)
- rockwalls (70° to 90°)

- Gullies

- steady gullies (5° to 30°)
- steep gullies (steeper than 30°)

| No | Slope tilt value | Categories according to land cover specifics |   |
|----|------------------|--|---|
|    |                  | Subalpine slopes (2386 to 2575 m a. s. l.)   | Alpine slopes (2575 to 2925 m a. s. l.)     |
| 1  | 5 – 23°          | Grass-debris and debris                      | Grass-debris and rock-debris                |
| 2  | 23 – 40°         | Grass-debris, debris and rock-debris         | Grass-debris, debris, rock-debris and rocky |
| 3  | 40 – 70°         | Rock-debris-grassy                           | Rocky with debris and grasses               |
| 4  | 70 – 90°         | Rockwalls                                    | Rockwalls                                   |

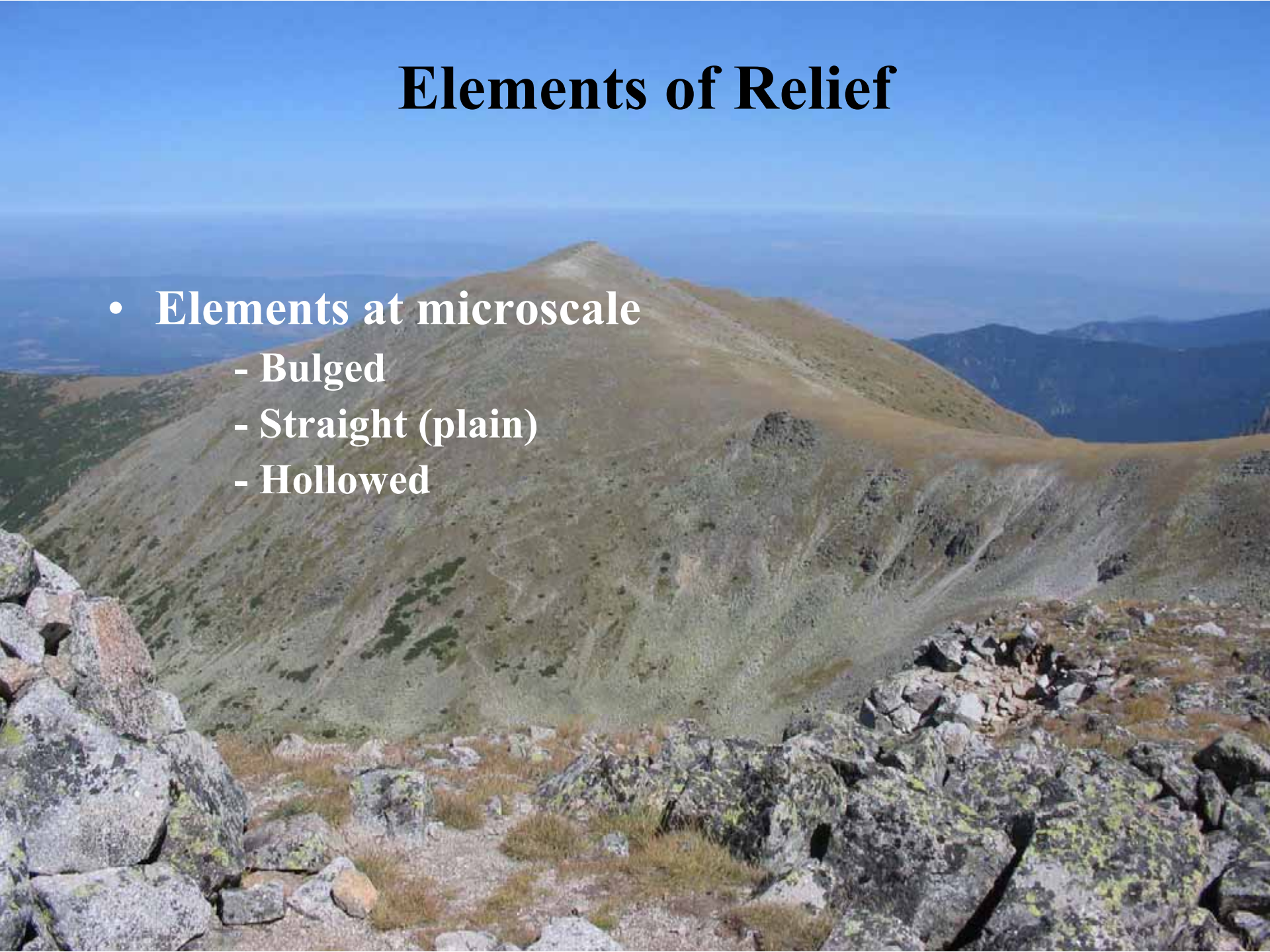
Percentage of basic land cover types - gullies





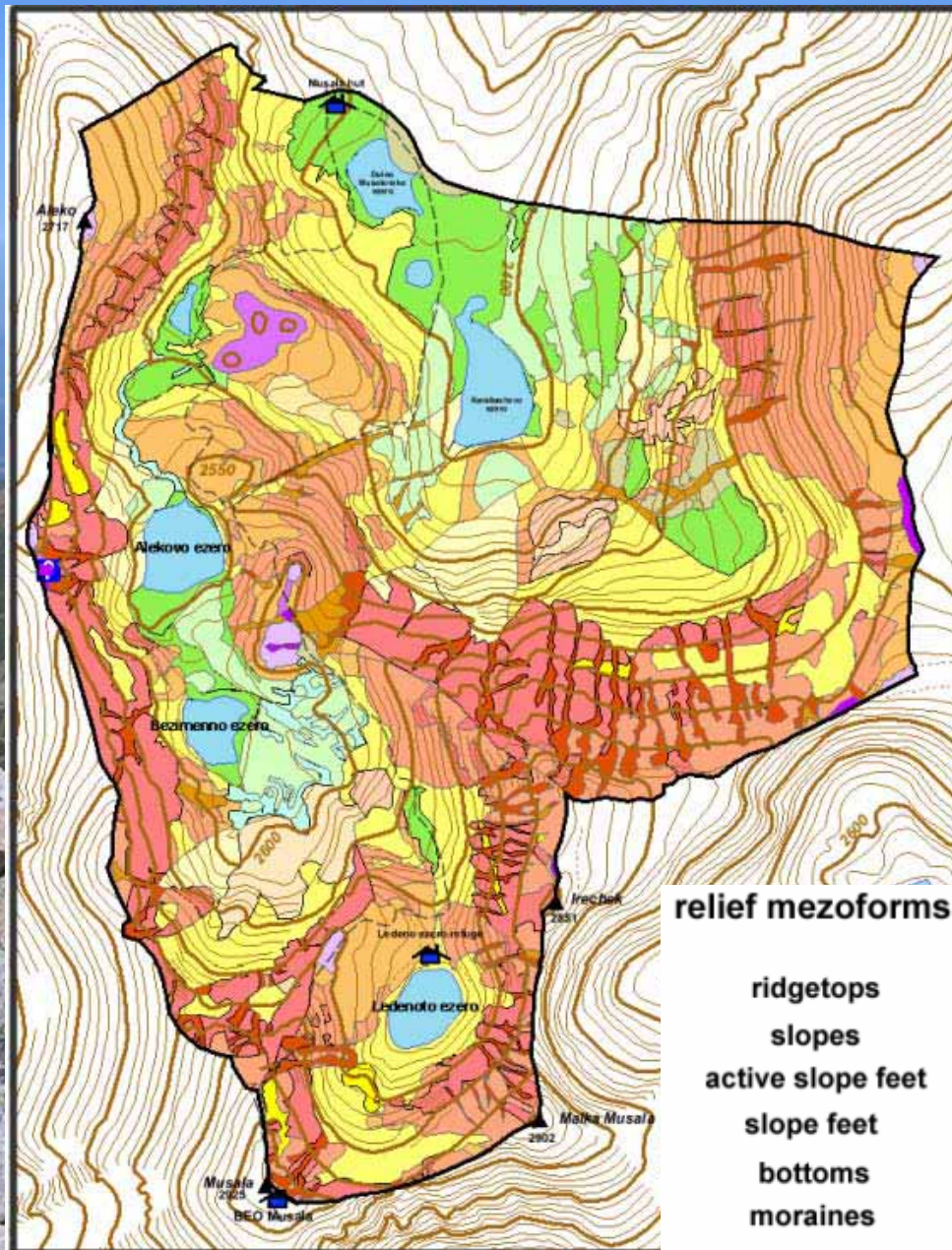
# Elements of Relief

- Elements at microscale
  - Bulged
  - Straight (plain)
  - Hollowed





# Map of relief elements



## relief mezoforms

ridgetops  
 slopes  
 active slope feet  
 slope feet  
 bottoms  
 moraines

## relief microforms

| bulged       |             | plain            |             | hollowed     |       |
|--------------|-------------|------------------|-------------|--------------|-------|
| summit       |             | ridgetop plain   |             | col          |       |
| slope ridges |             | slope surfaces   |             | gully slopes |       |
|              |             | 5-25             | 25-40 40-90 | 5-30         | 30-80 |
| rock glacier |             | active talus     |             |              |       |
| talus cone   |             | talus coverage   |             |              |       |
| rigel        | rigel col   | bottom (terrace) |             | gully        | lake  |
| moraine      | moraine col |                  |             |              |       |



# Land cover types

## homogeneous



Rocks



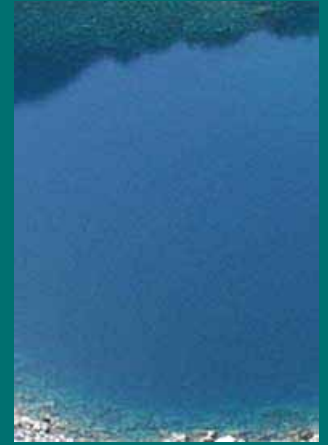
Debris



Grass



Barren ground



Water

## heterogeneous



Rocks and debris



Debris and grass



Rocks and grass



Rocks, debris & grass



# Land cover types

## Heterogeneous with mugo pine



Rocks  
& Pinus mugo



Debris  
& Pinus mugo



Grass  
& Pinus mugo



Rocks, debris  
& Pinus mugo



Debris, grass  
& Pinus mugo



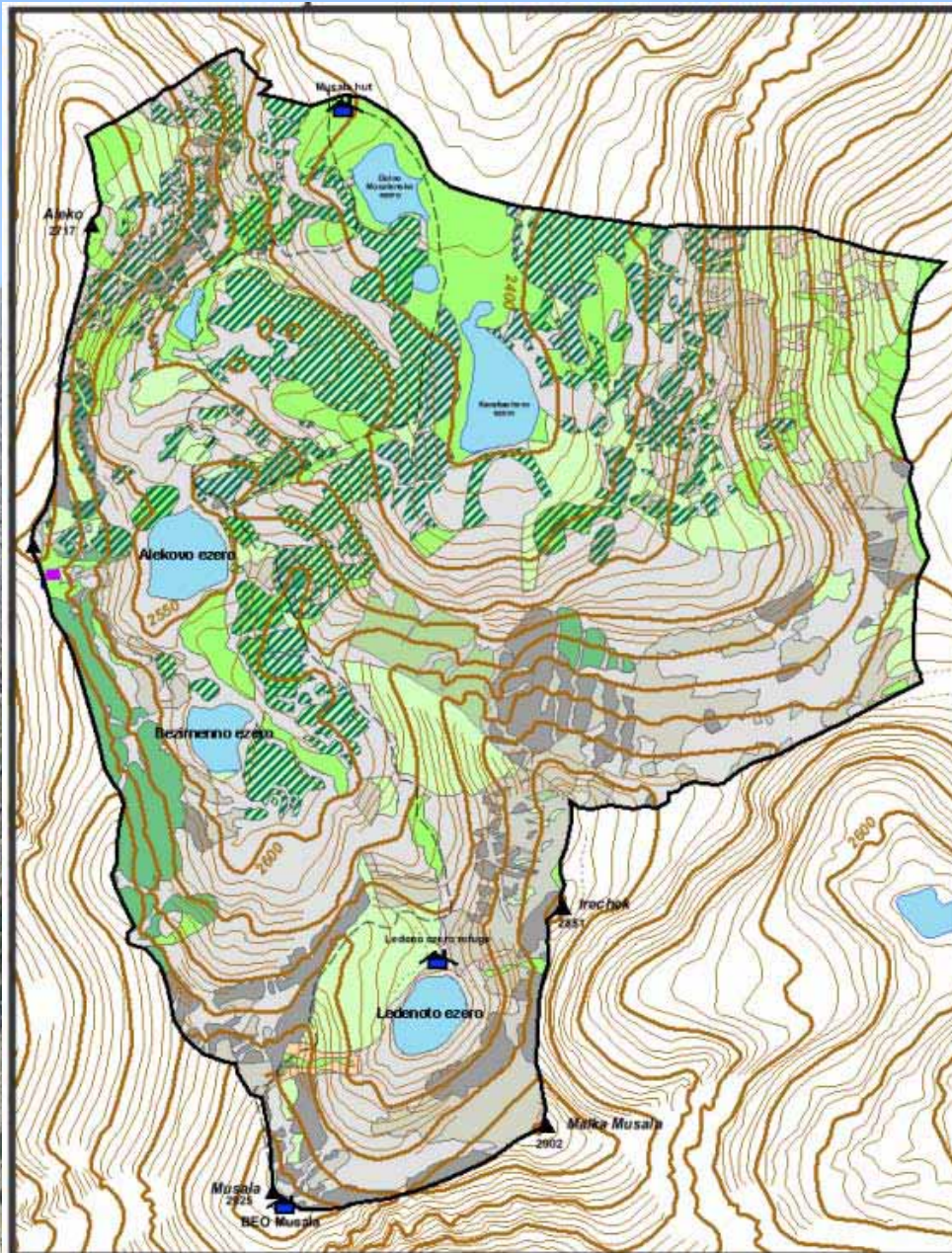
Rocks, grass  
& Pinus mugo



Rocks, debris, grass  
& Pinus mugo



# Map of land cover



land cover types

|   |                                   |
|---|-----------------------------------|
|    | rocks                             |
|    | debris                            |
|    | grass                             |
|    | barren ground                     |
|    | water                             |
|    | rocks & debris                    |
|    | debris & grass                    |
|    | rocks & grass                     |
|    | rocks, debris & grass             |
|    | rocks & pinus mugo                |
|    | debris & pinus mugo               |
|    | grass & pinus mugo                |
|   | rocks, debris & pinus mugo        |
|  | debris, grass & pinus mugo        |
|  | rocks, grass & pinus mugo         |
|  | rocks, debris, grass & pinus mugo |



# Map of landsystem units

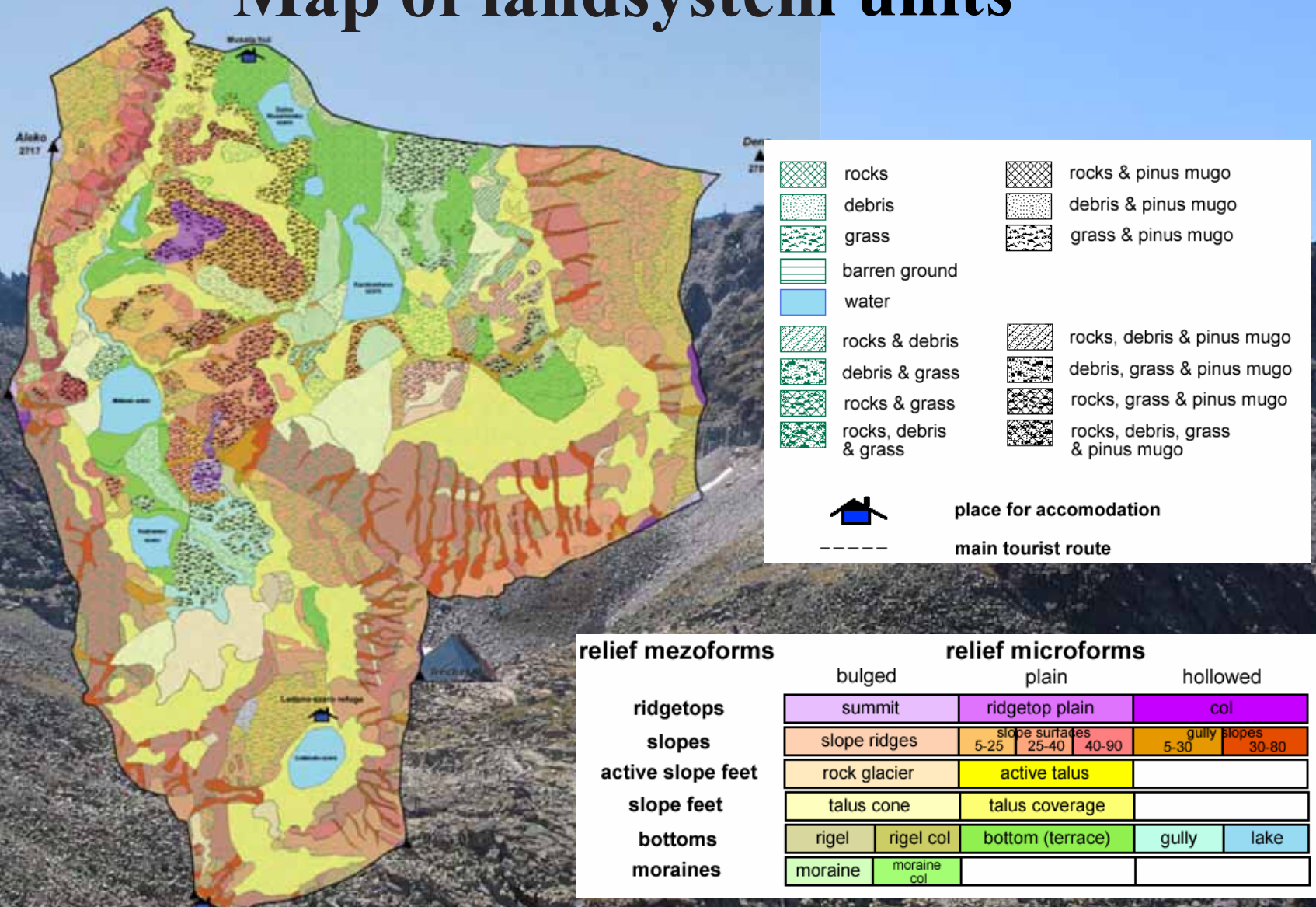
**Result of overlaying relief elements and land cover types**

**Each landsystem unit represents one type of surface in terms of land cover within one relief element**

**.... Typological landsystem units are defined on the territory researched**



# Map of landsystem units





# **Landsystem units and terrestrial processes**

**Each landsystem unit provides an environment for occurrence of specific combination of terrestrial processes**

**Depending on conditions these processes vary in quality and intensity**





# **Landsystem units and terrestrial processes**

- **Prevailing processes in different elements of relief**
  - **Ridgetops – strong weathering, weak transport**
  - **Slope surfaces – strong mass movement, weathering**
  - **Gullies – most intensive transport processes, avalanche and erosive mass movements prevail**
  - **Active slope feet – balance between transport and accumulation**
  - **Slope feet – prevailing accumulation, slow motion downslope**
  - **Bottoms – weathering, in situ soil formation, fluvial transport and redeposition**



# **Landsystem units and terrestrial processes**

- **Prevailing processes in basic land cover types**
  - Rocks – weathering, rockfalls
  - Debris – gravitational movement, additional fracturing
  - Grass – solifluction and creep of soil and grass cover, weathering and elluvial formation



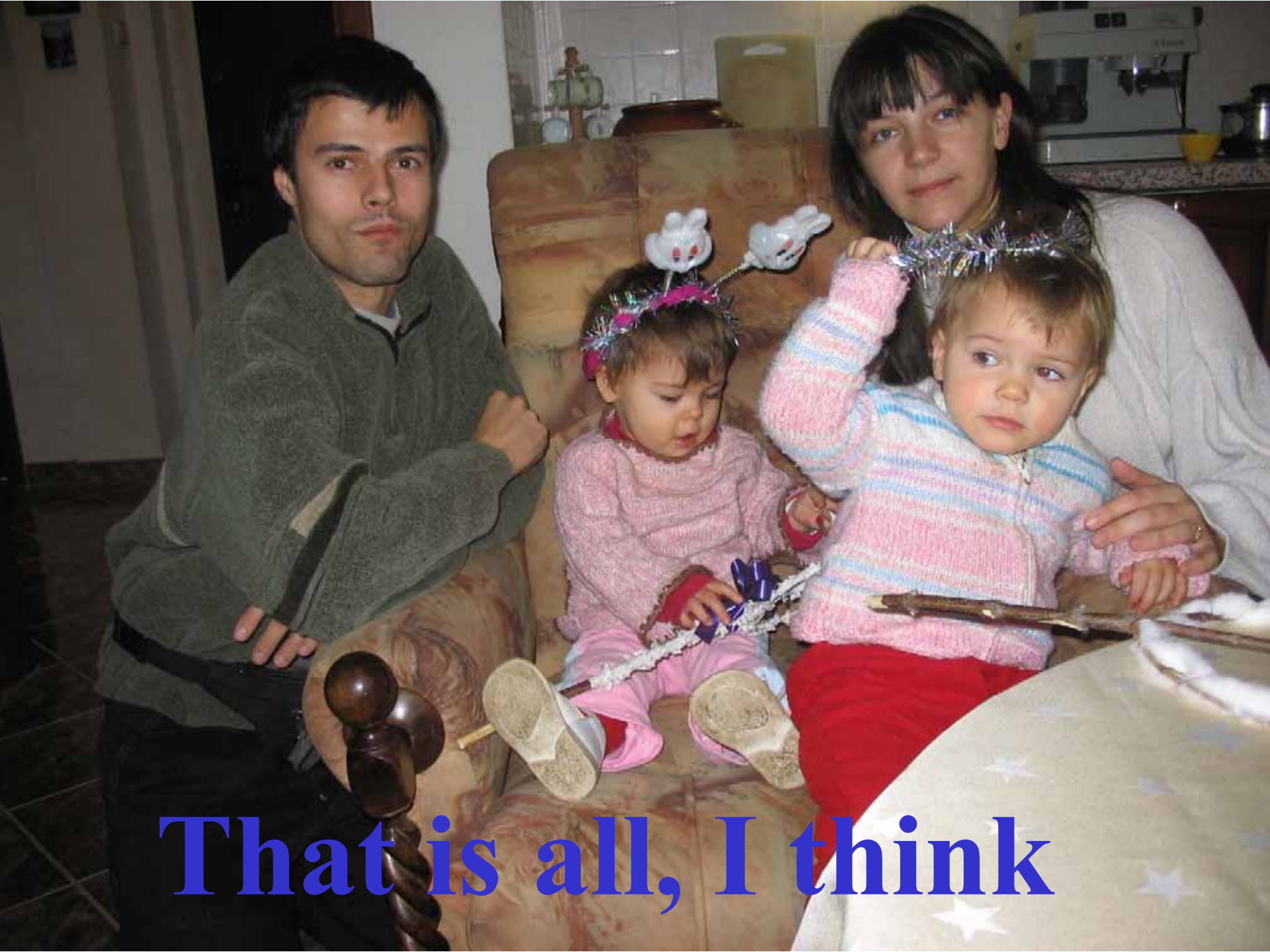
# Conclusions

Landsystem units are small scale elements of environmental differentiation that have internal Earth surface homogeneity

Landsystem units carry specific potential and ability for occurrence of contemporary terrestrial processes. Thus they can serve as basic units for qualitative evaluation of periglacial territories' geomorphic potential and preparation of assessment maps

Landsystem mapping of Musala cirque is a first stage in revealing the landscape structure of the site. Future researches should pay attention to climatic and hydrological conditions, which will allow not only to evaluate the range of processes for each place, but also the differences in processes regime.





**That is all, I think**