

Geomorphometric characteristics of the high mountains in North Macedonia

Ivica Milevski¹, Bojana Aleksova¹, Sonja
Lepitkova²

¹Institute of Geography, Faculty of Natural Sciences and
Mathematics, Skopje, North Macedonia

²UGD, Faculty of Natural and Technical Sciences, Štip
§ivica@pmf.ukim.mk

OBJECTIVES AND METHODS

- To analyze morphometric characteristics of the high mountains (above 2000 m) in North Macedonia, their similarities and differences;
- To classify high mountains in Macedonia according to the main morphometric elements;
- To understand correlation between structural basis of the mountains and its morphometry;
- For the geomorphometry analysis of the mountains, 15-m DEM (based on 5-m ARECNM/Agency of Real Estate and Cadaster of North Macedonia) is used;
- On the end, morphometric classification of the high mountains is made.

BASIC FACTS ABOUT THE RELIEF IN NORTH MACEDONIA

- Country area: 25 713 km²
- Average altitude 830 m (among the highest in Europe)
- Average slope 15.5° (among the steepest in Europe)
- 38 mountains; 13 higher than 2000 m
- 5 mountains higher than 2500 m
- Hilly-mountain area: 79%
- High mountain area: 29.3%

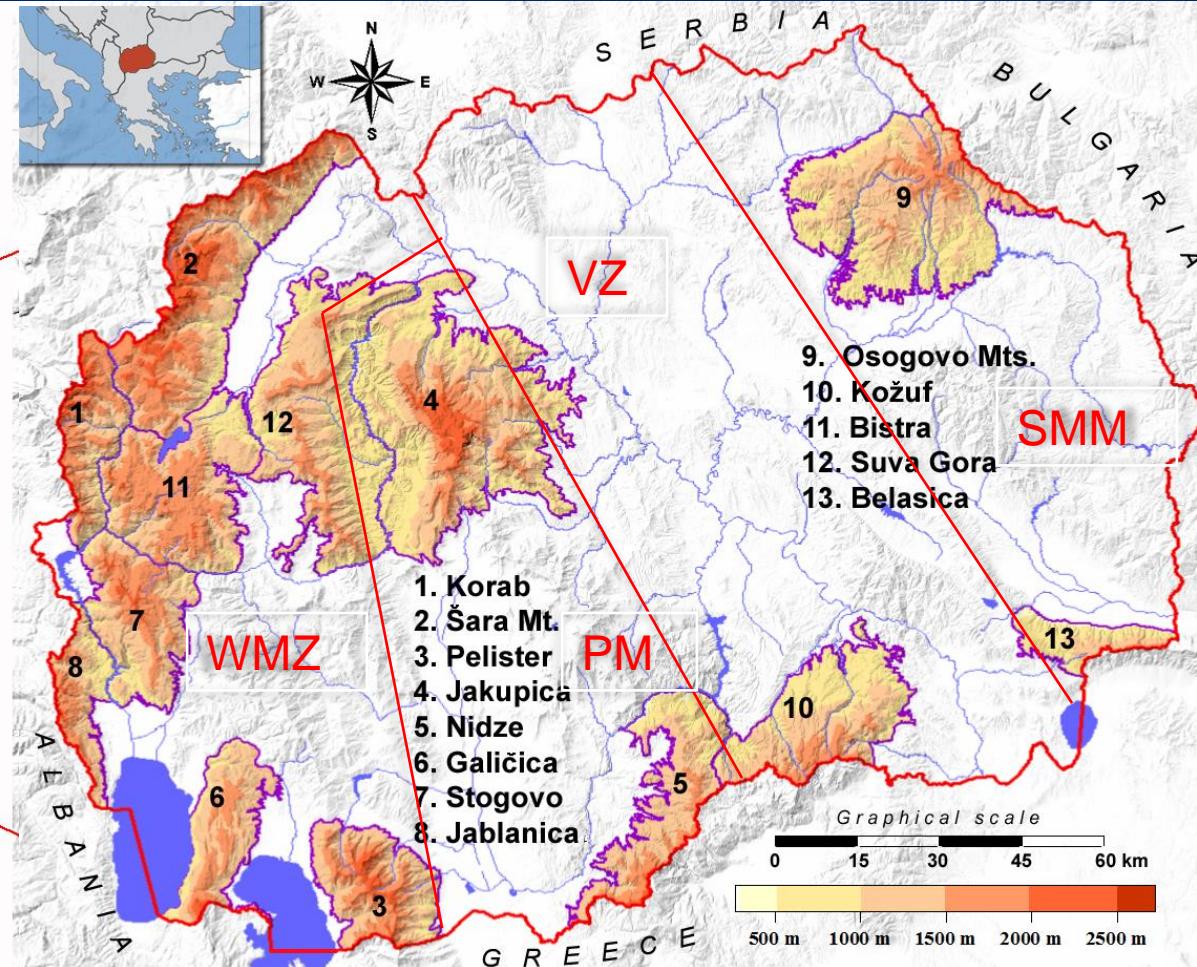


BASIC FACTS ABOUT HIGH MOUNTAINS IN NORTH MACEDONIA

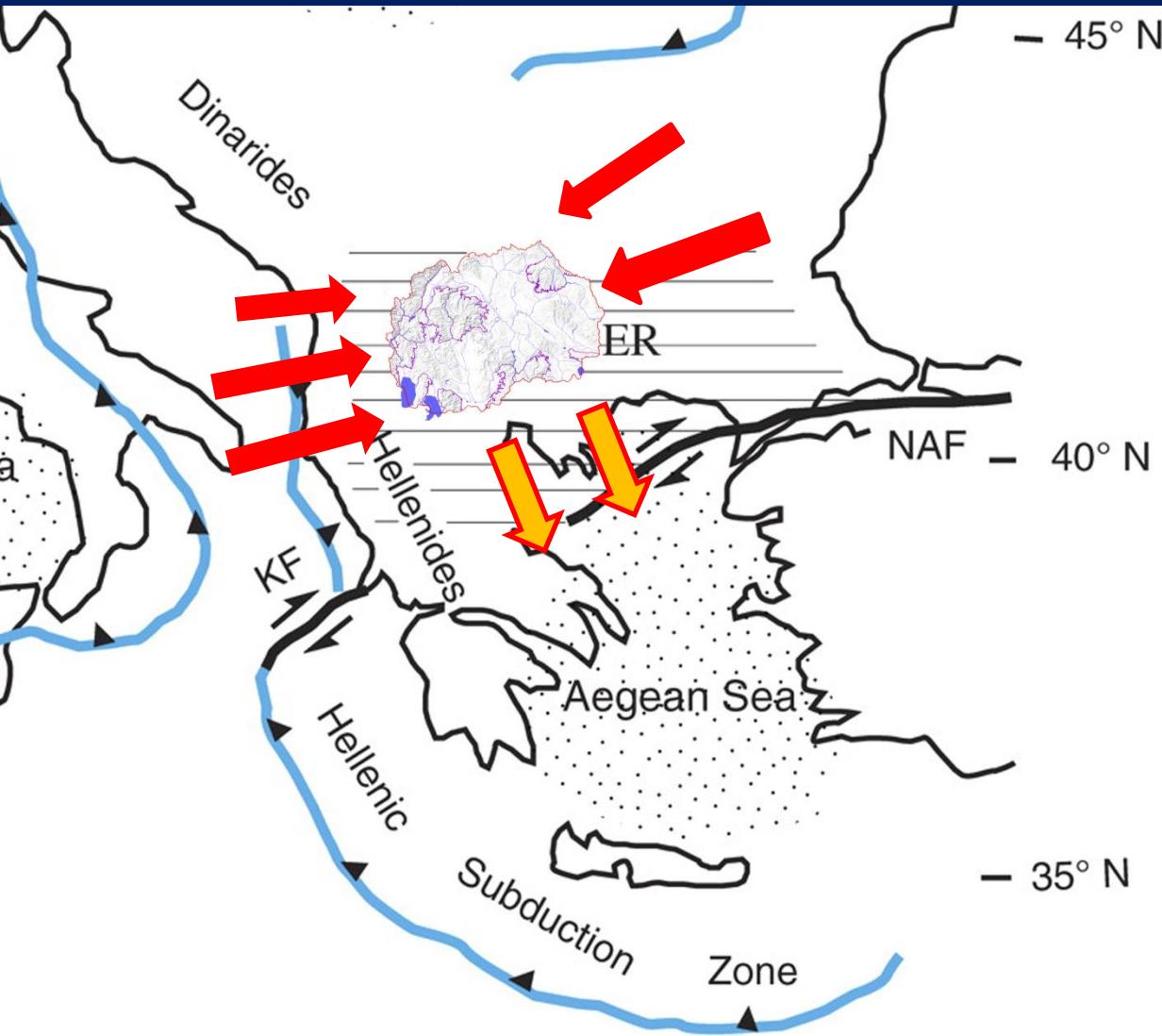
- Nationally, high mountains are defined as mountains higher than 2000 m.
- 11 high mountains in west/central part in the country built in schists, marbles and limestones (with karst, glacial, fluvial landscape...).
- 2 high mountains in the east part of the country built in gneiss, mica-schists, igneous rocks (fluvial, palaeovolcanic, denudation landscape...).
- On high mountains there are about 200 peaks above 2000 m.
- Very reach geodiversity: geologic, tectonic, fluvial, karst, periglacial, glacial, coastal, etc.

LOCATION OF HIGH MOUNTAINS IN NORTH MACEDONIA

Mostly in the west and central part of the country. Tectonically in West-Macedonian Zone and in Pelagonian Massif as a substructures of Dinarides-Helenides.

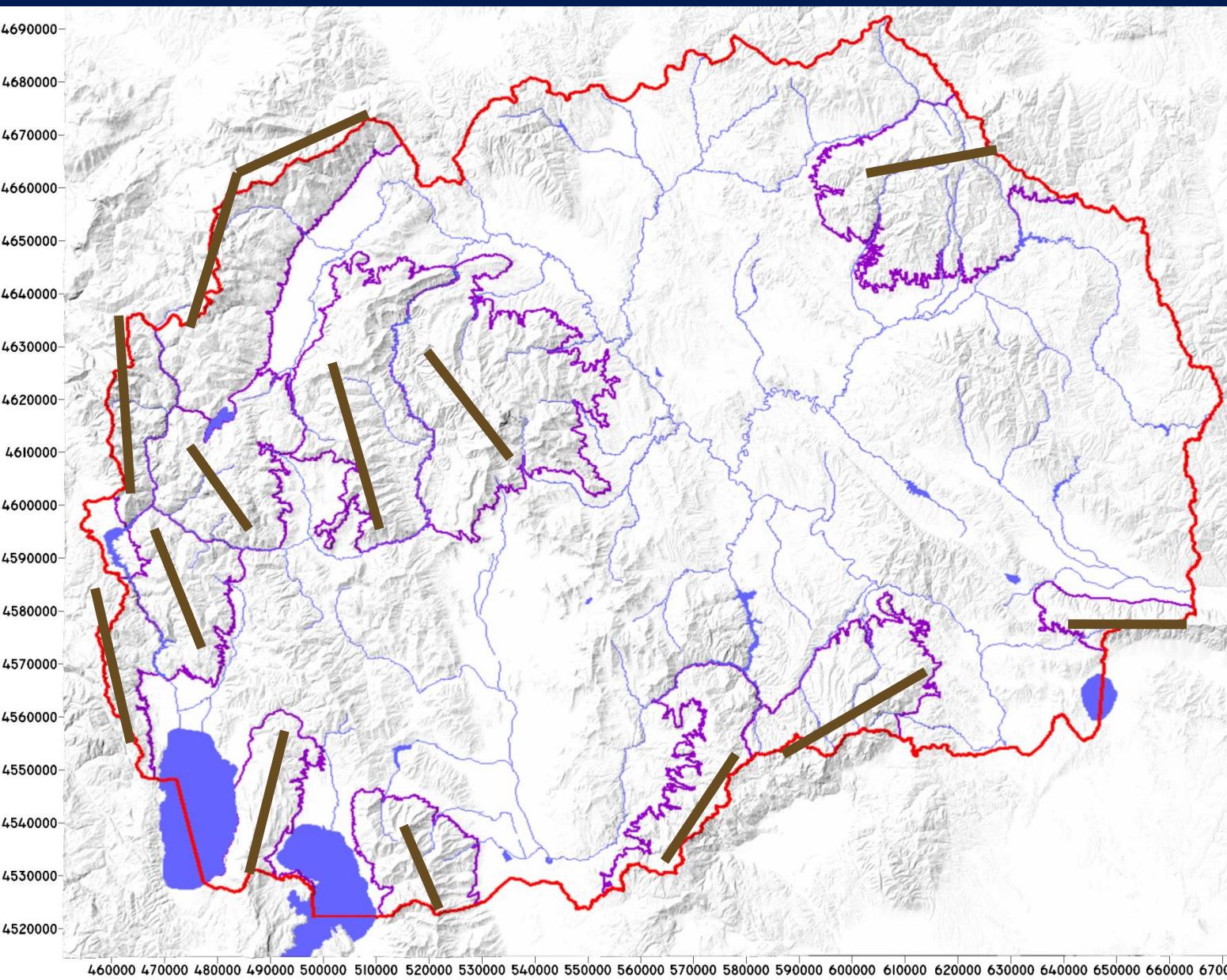


ABOUT HIGH MOUNTAIN GENESIS IN NORTH MACEDONIA



- Paleogene Cretaceous to Oligocene compression in east-west direction.
- Mountain range formation extended in NW-SE direction.
- Neogene and Quaternary north-south extension regime. Depression formation between mountains.

MOUNTAINS DIRECTION



NW-SE
(Dinaric)

E-W
(Exstensional)

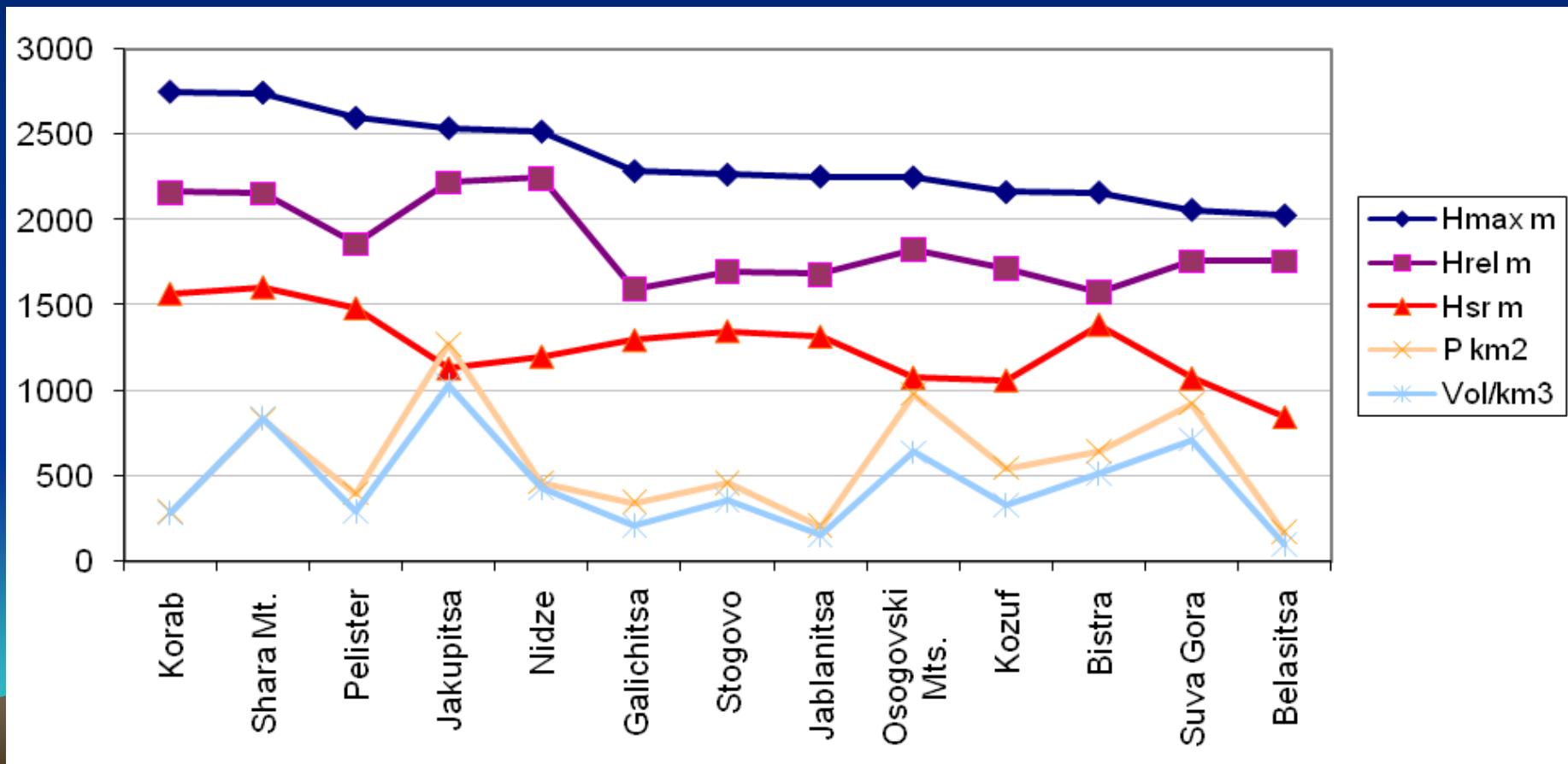
NE-SW
(Proextens.)

MORPHOMETRY OF THE HIGH MOUNTAINS IN NORTH MACEDONIA

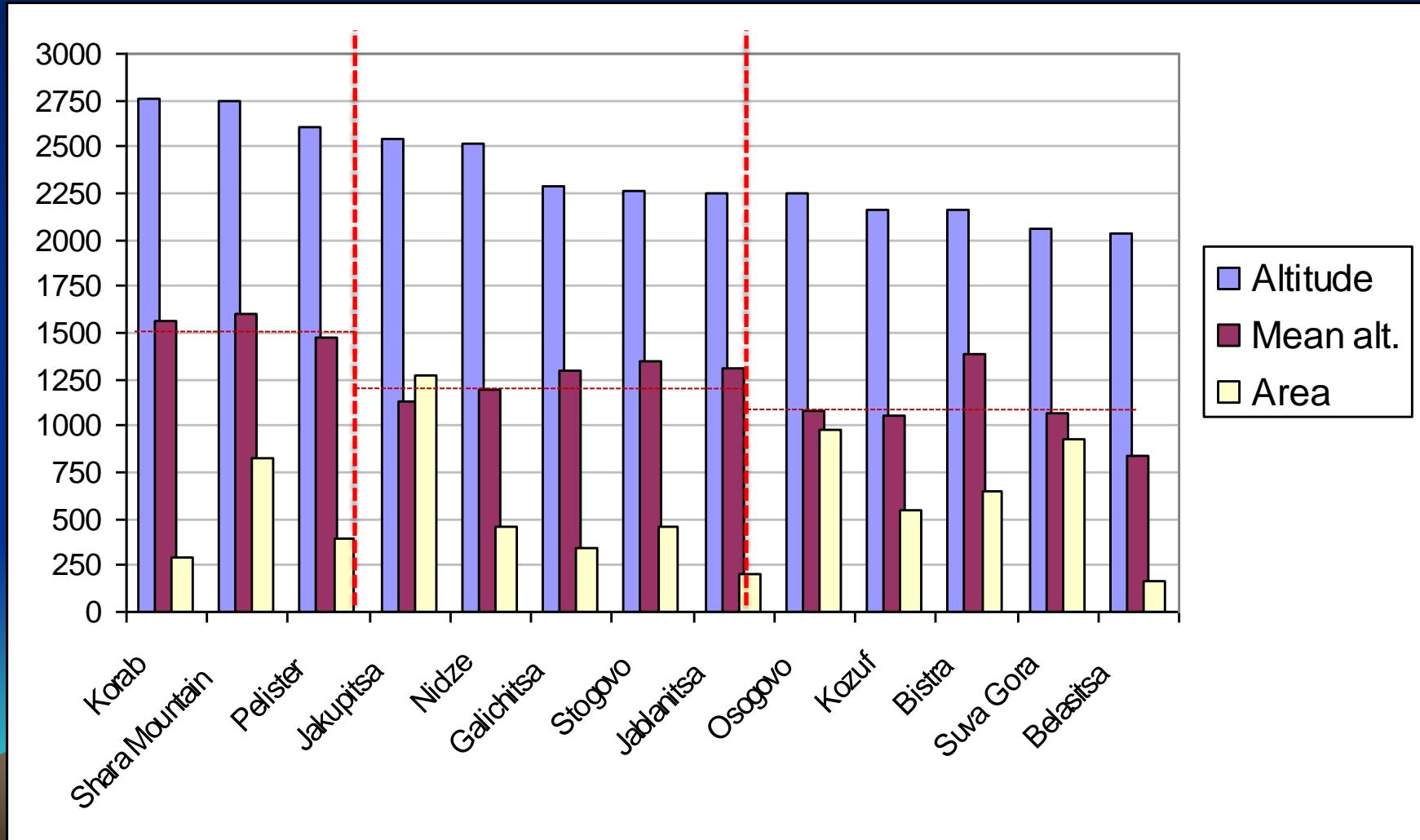
- 6 major morphometric parameters has analyzed:
 - Hypsometry;
 - Slope angle;
 - Length of slope (LS);
 - Slope curvature (planar and profile);
 - Aspects;
 - Vertical relief (terrain relief).



BASIC MORPHOMETRIC PARAMETERS FOR THE HIGH MOUNTAINS IN NORTH MACEDONIA: HYPSOMETRY, AREA AND VOLUME



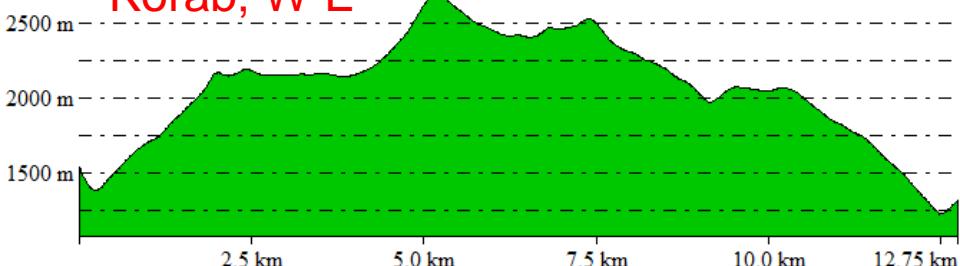
MAXIMAL, MEAN ALTITUDE AND AREA OF THE HIGH MOUNTAINS



From Pos: 457205.104, 4626936.765

To Pos: 469923.906, 4626114.935

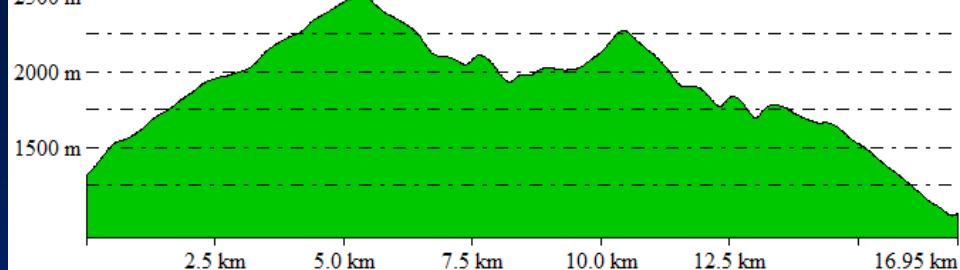
Korab; W-E



Nidze; SW-NE

To Pos: 568135.383, 4542894.067

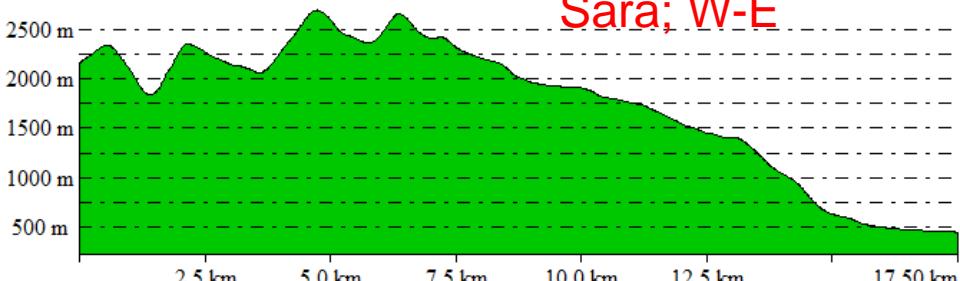
From Pos: 565040.983, 4526237.788



From Pos: 478690.096, 4650026.283

To Pos: 495713.724, 4645995.401

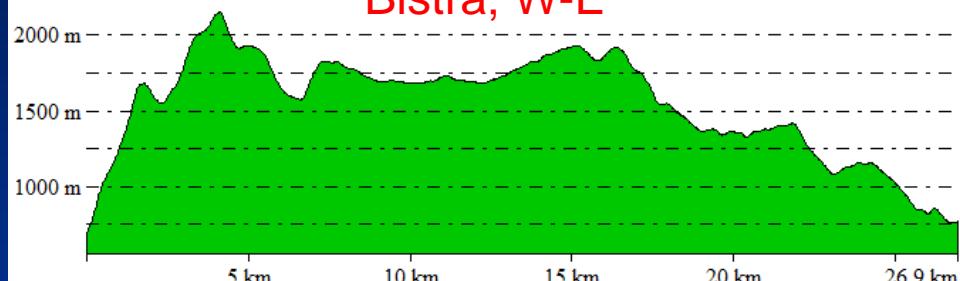
Sara; W-E



Bistra; W-E

To Pos: 494204.047, 4608029.283

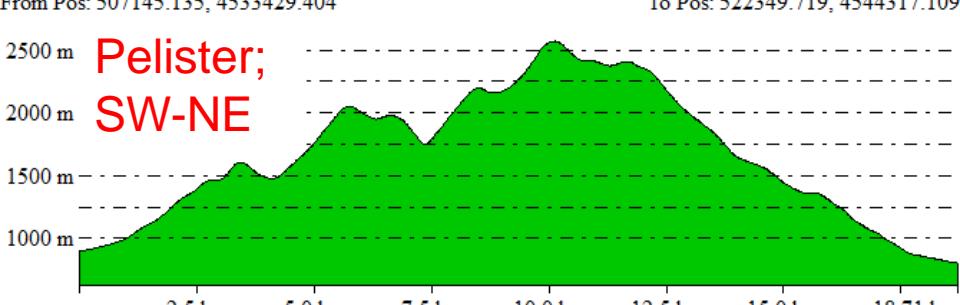
From Pos: 467271.304, 4607991.081



From Pos: 507145.135, 4533429.404

To Pos: 522349.719, 4544317.109

Pelister; SW-NE



Galichica; S-N

To Pos: 491696.813, 4557865.535

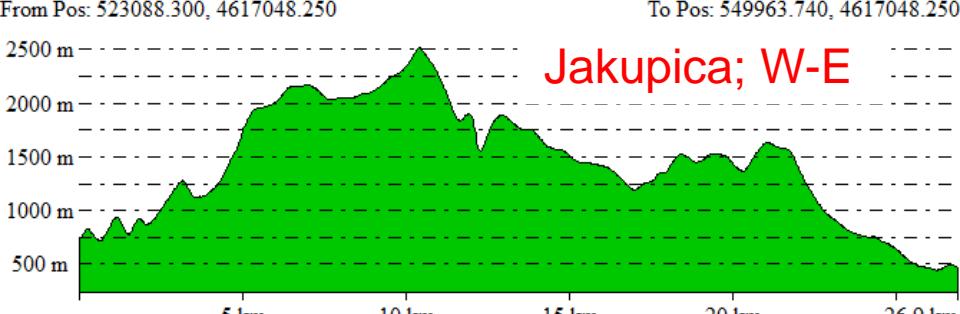
From Pos: 485075.528, 4528647.798



From Pos: 523088.300, 4617048.250

To Pos: 549963.740, 4617048.250

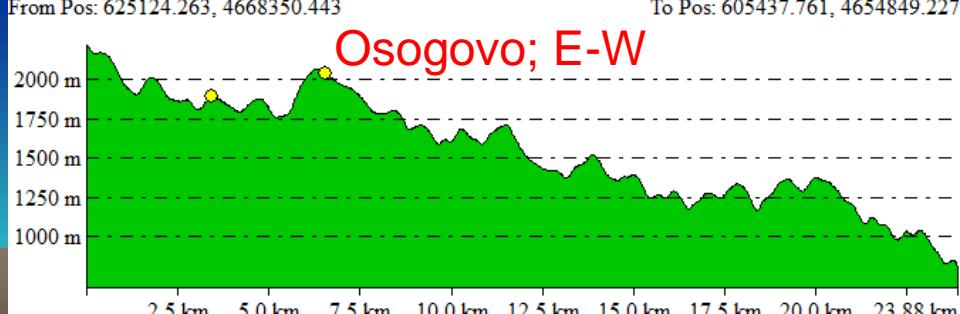
Jakupica; W-E



Osogovo; E-W

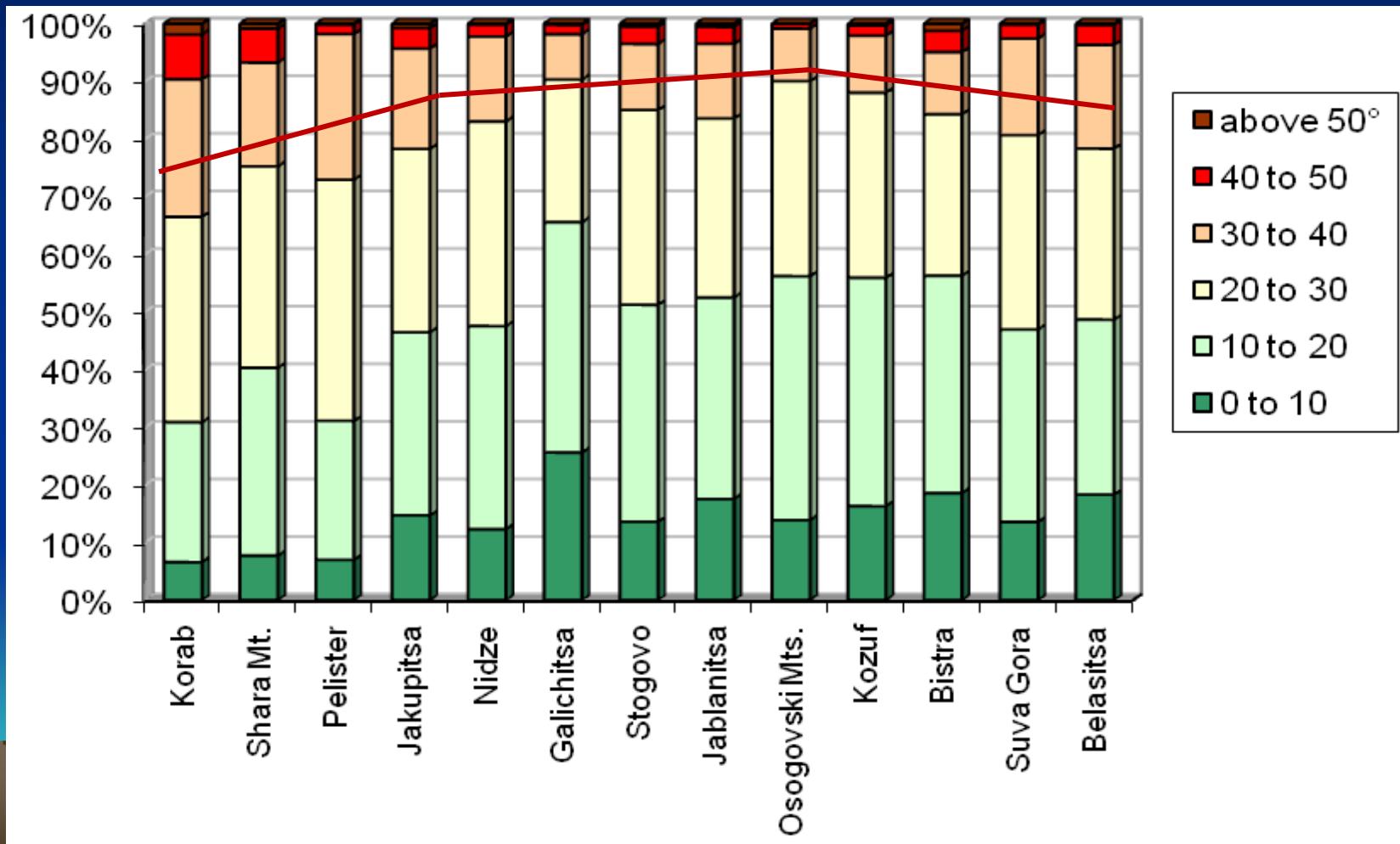
To Pos: 605437.761, 4654849.227

From Pos: 625124.263, 4668350.443

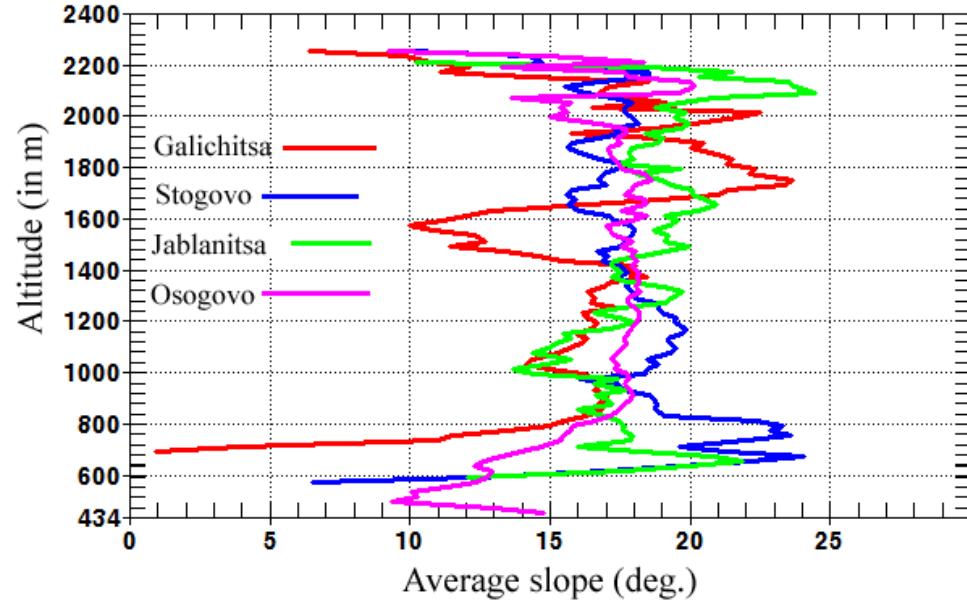
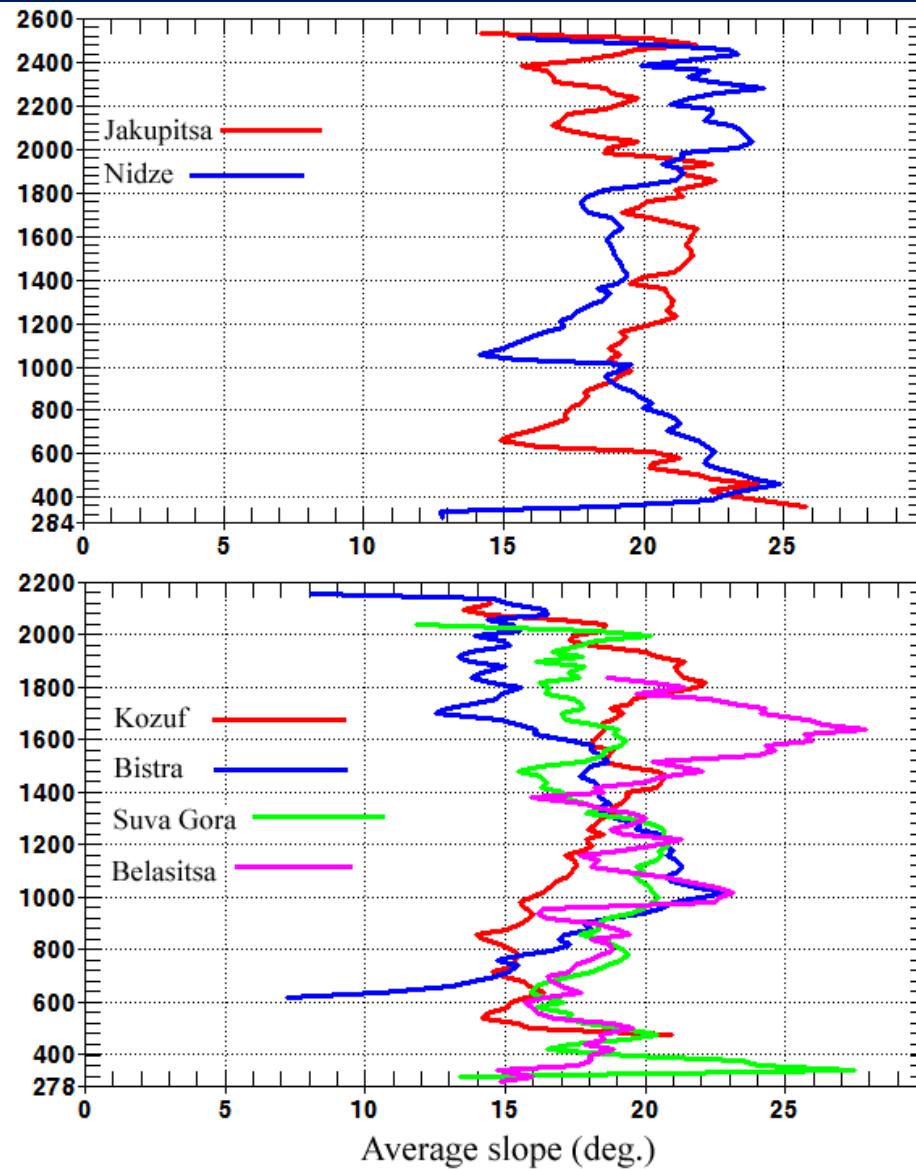
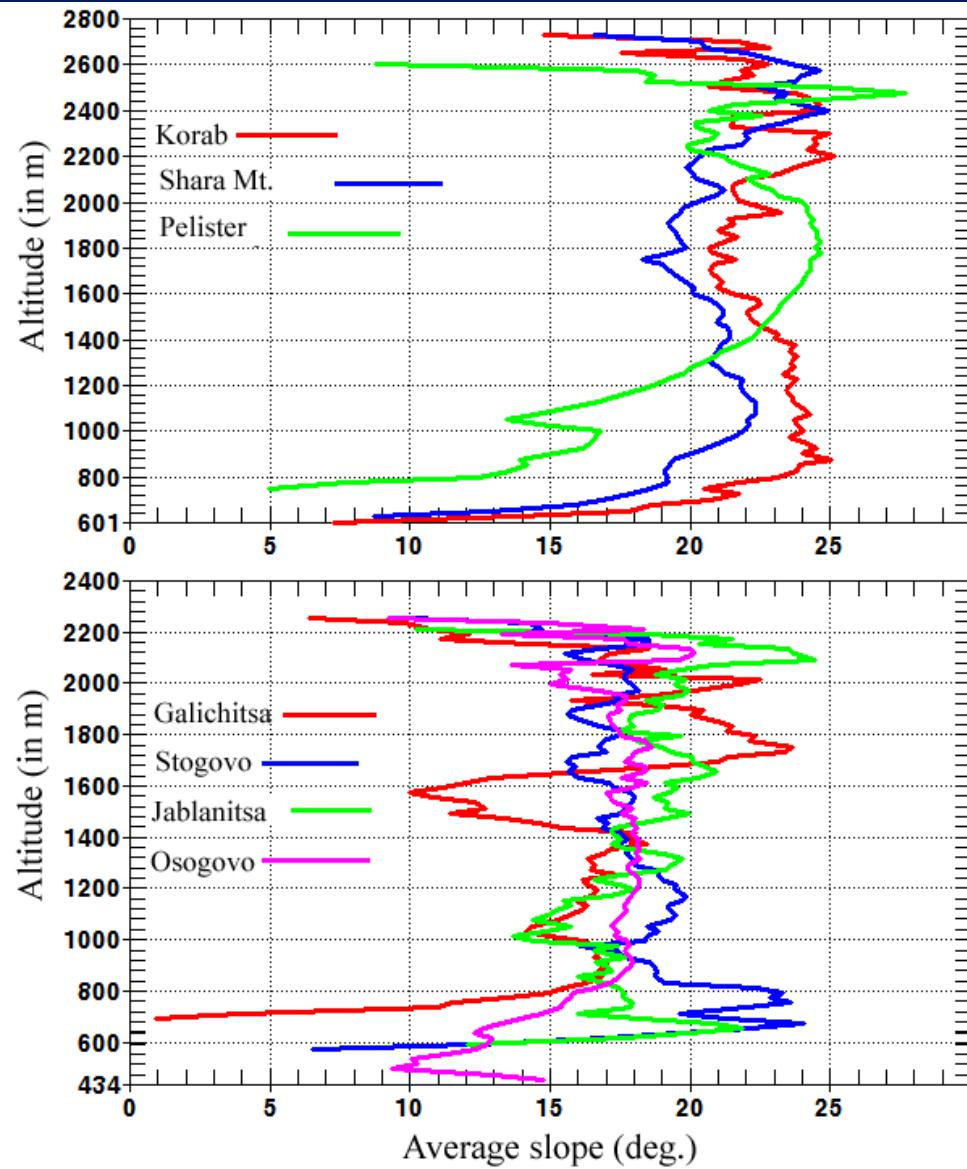


MOUNTAINS SLOPES

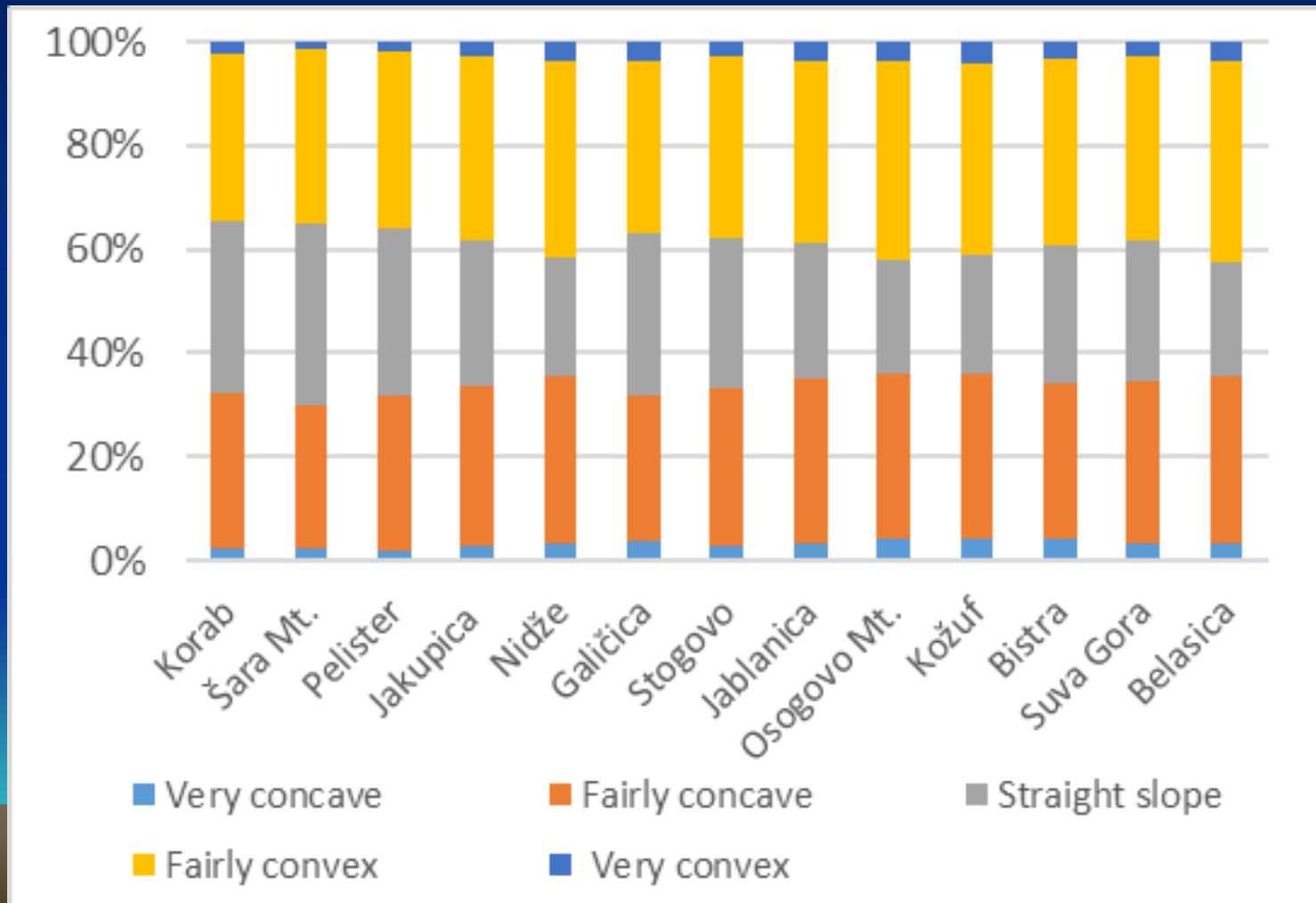
Average value: 20.9°



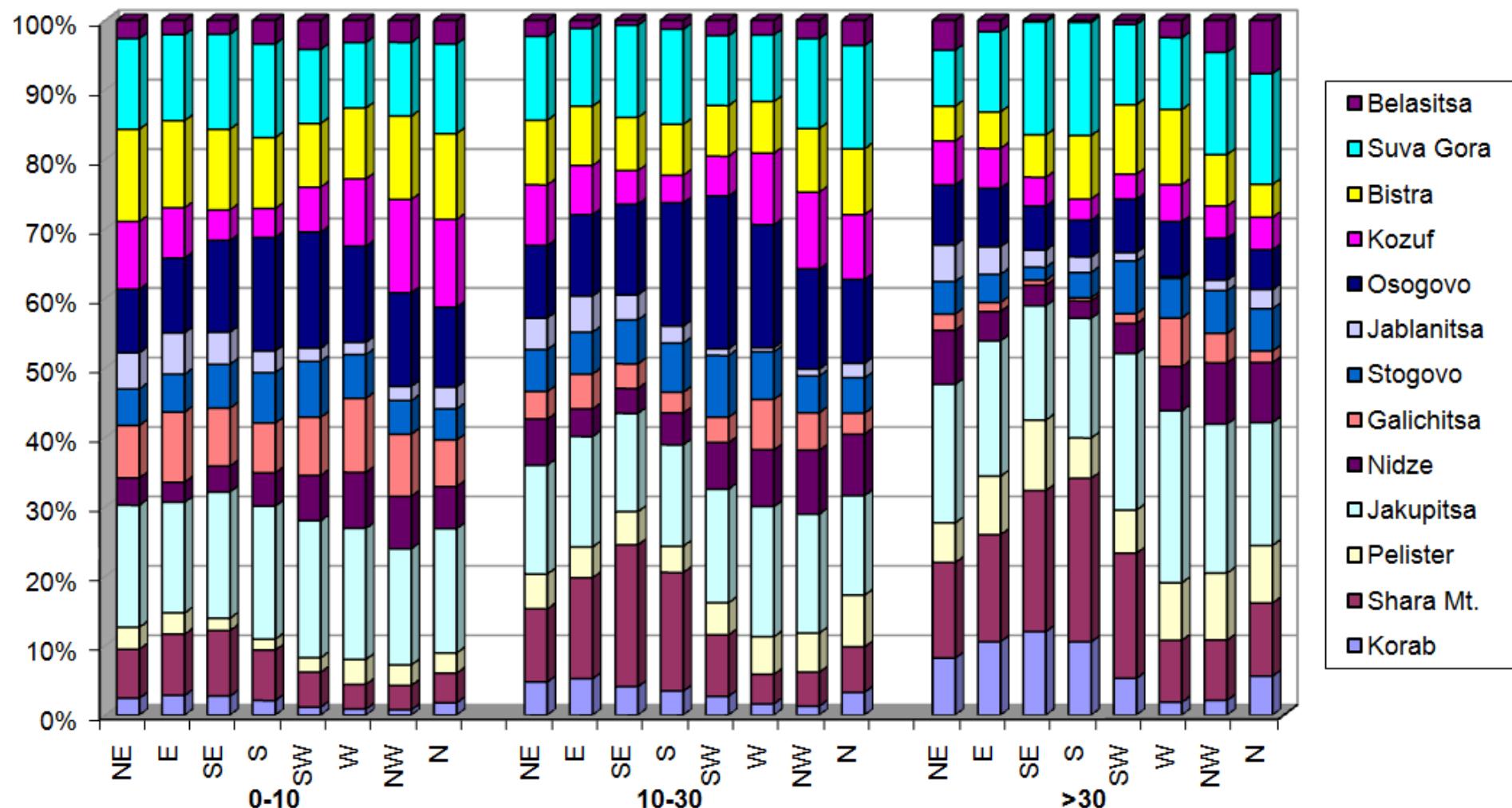
SLOPE WITH ALTITUDE



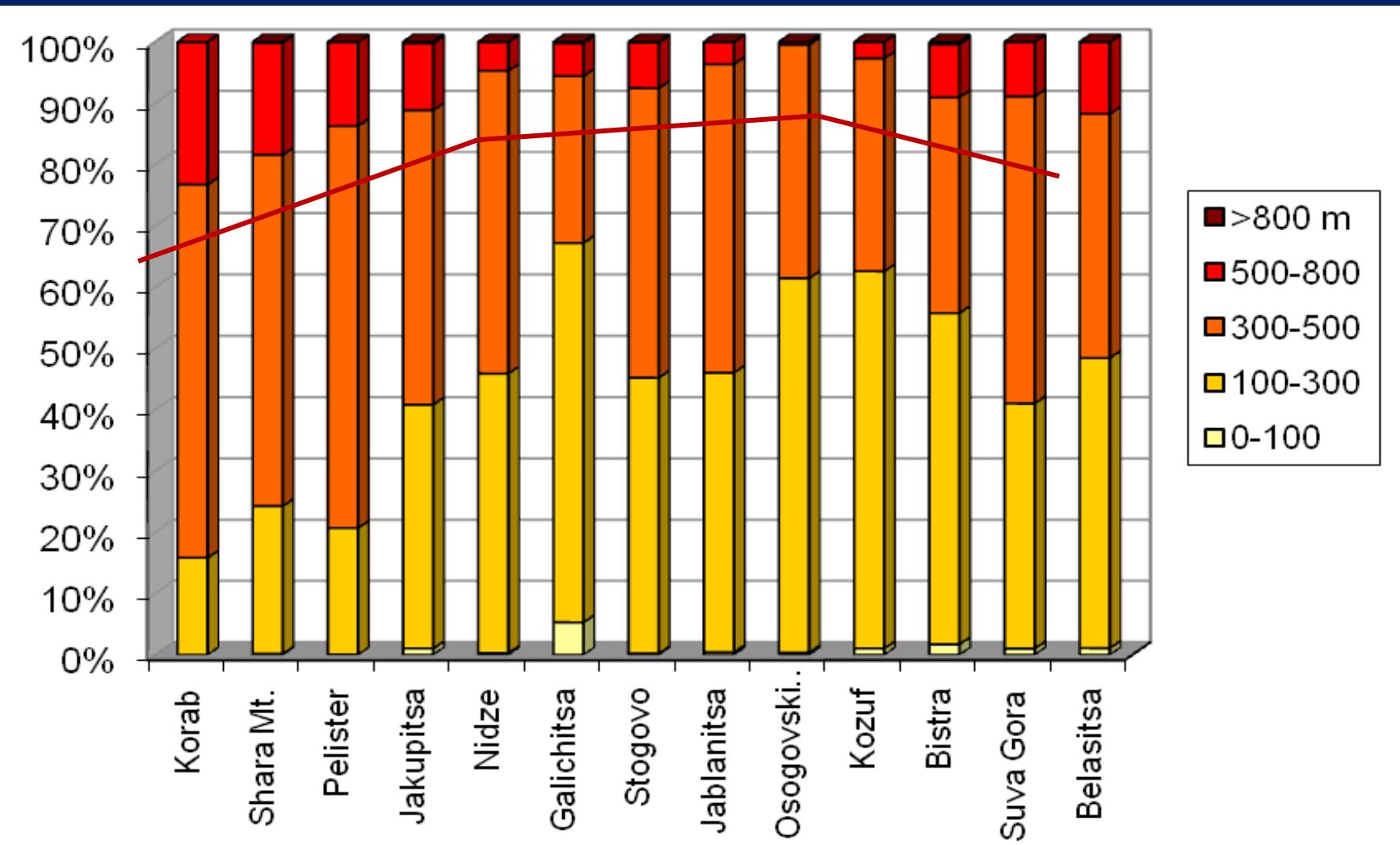
TERRAIN CURVATURE (CONVERGENCE INDEX) CLASSES OF THE HIGH MOUNTAINS IN NORTH MACEDONIA



MOUNTAIN ASPECTS



VERTICAL TERRAIN RELIEF IN M/KM²

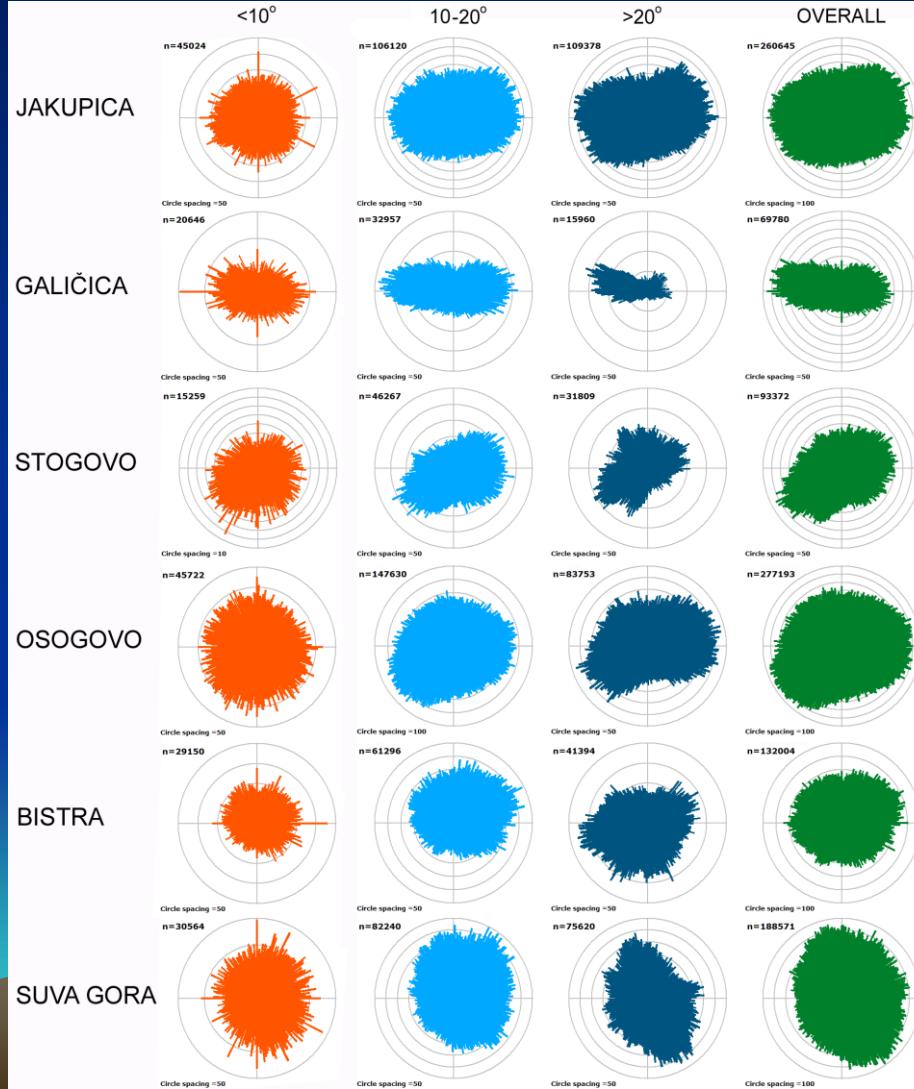


MORPHOMETRIC CLASSIFICATION ACCORDING TO THE HYPSOMETRY, SLOPES, TERRAIN RELIEF AND VOLUME INDEX

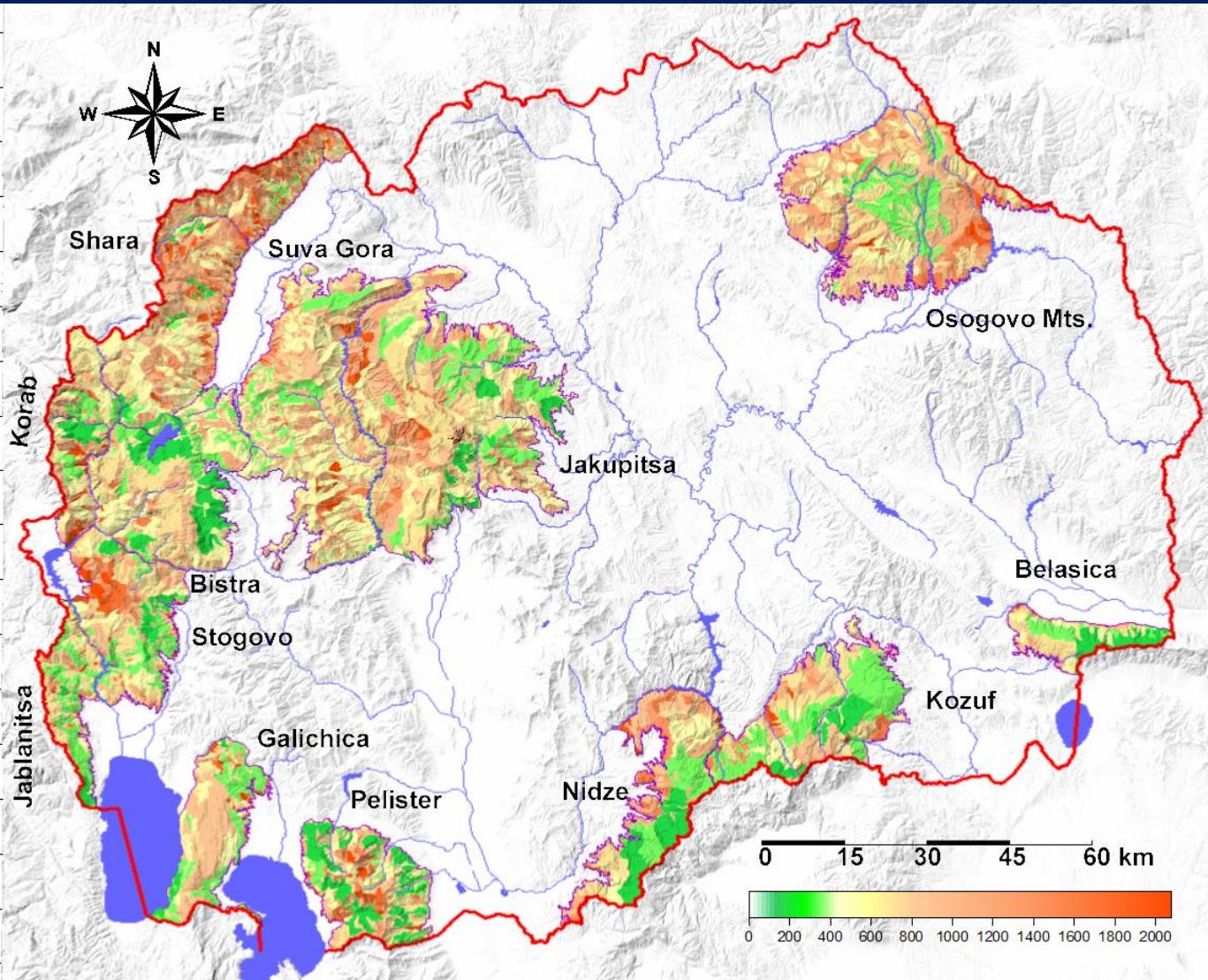
-cluster classification-

| Class | Mountain | Hmax m | Hsr m | Slope° | TR m/km ² | iV/P |
|-------|---------------|--------|--------|--------|----------------------|------|
| I | Korab | 2753 | 1564,9 | 25,8 | 415,8 | 0,98 |
| I | Sara Mountain | 2748 | 1602,7 | 23,5 | 390,0 | 1,01 |
| I | Pelister | 2601 | 1480,3 | 24,1 | 386,8 | 0,74 |
| II | Jakupica | 2540 | 1127,2 | 21,6 | 340,9 | 0,81 |
| II | Nidže | 2520 | 1197,3 | 20,4 | 316,4 | 0,93 |
| III | Galičica | 2288 | 1294,3 | 17,0 | 269,7 | 0,60 |
| II | Stogovo | 2268 | 1345,8 | 20,4 | 327,2 | 0,78 |
| II | Jablanica | 2256 | 1314,2 | 20,0 | 315,4 | 0,74 |
| III | Osogovo | 2252 | 1074,8 | 19,1 | 278,5 | 0,65 |
| III | Kožuf | 2165 | 1058,5 | 19,2 | 282,4 | 0,61 |
| III | Bistra | 2163 | 1384,9 | 19,7 | 306,8 | 0,80 |
| II | Suva Gora | 2061 | 1070,7 | 21,1 | 333,0 | 0,77 |
| II | Belasica* | 2029 | 843,6 | 20,9 | 322,0 | 0,57 |

Aspects vs slopes for selected high mountains in North Macedonia



MORPHOMETRY AND EROSION INTENSITY



Below 1000 m,

790 m³/km²/y

Above 1000 m,

650 m³/km²/y

S sides, 840 m³/km²/y

N sides, 625 m³/km²/y

Under 10 degree, 590
m³/km²/y

From 20-40 degree,
910 m³/km²/y

CONCLUSION

- According to the analyzed parameters, the high mountains in North Macedonia in morphometric terms can be separated into three groups:
 - ✓ First group of very high, steep slope mountains: Korab, Šar Planina and Pelister,
 - ✓ Second group of moderate altitude, slope and relief: Jakupica*, Nidze, Stogovo, Jablanica, Suva Gora and Belasica;
 - ✓ Third group, lower, gentle sloped with large planation surfaces: Galichica, Osogovo, Kozuf and Bistra.
- Morphometry and morphometric classification is closely connected with morphostructural shape, genesis and evolution stage.
- Morphometric type is changeable with time.

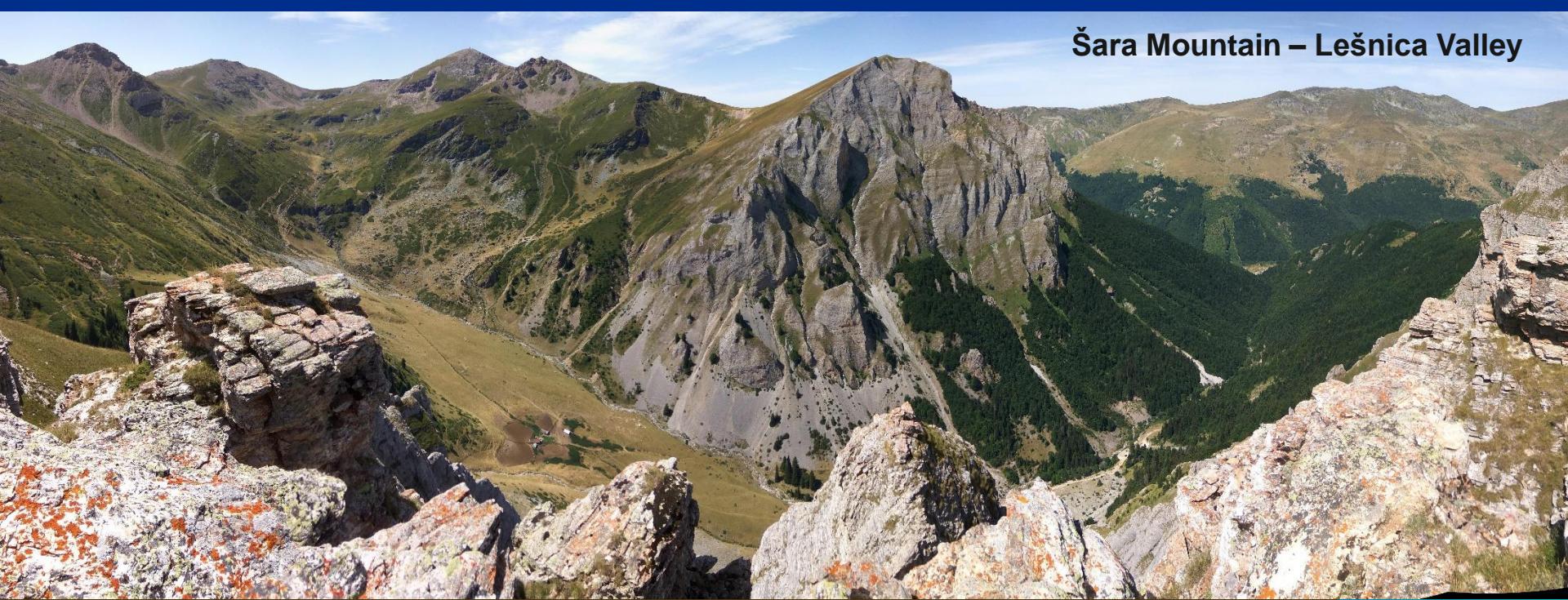
Korab Mountain-east slope



Korab Mountain-south ridge



Šara Mountain – Lešnica Valley



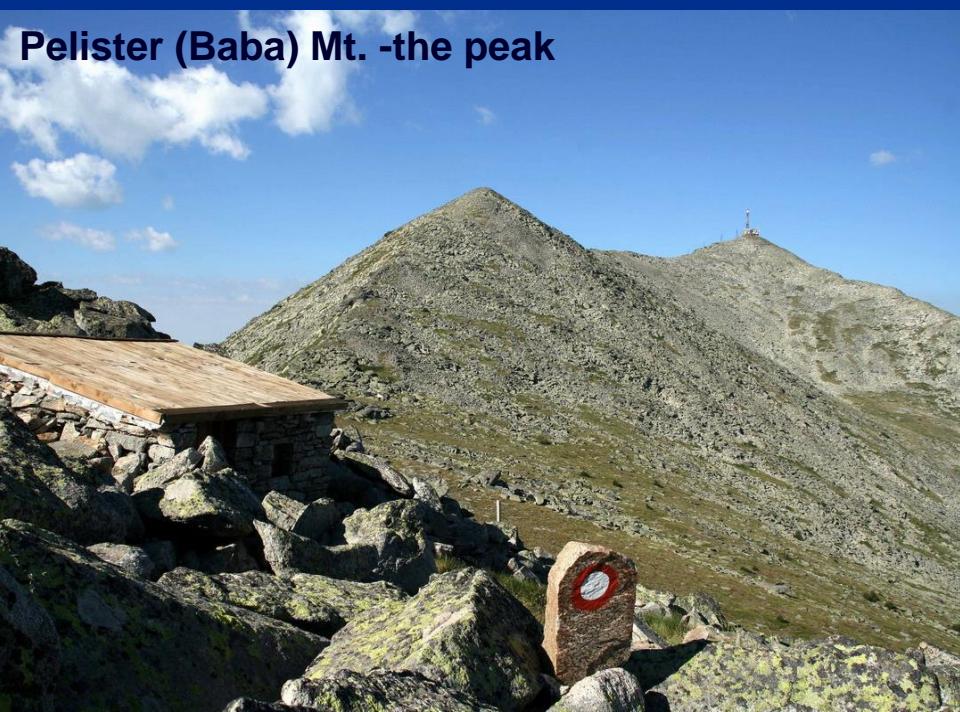
Jakupica-north side



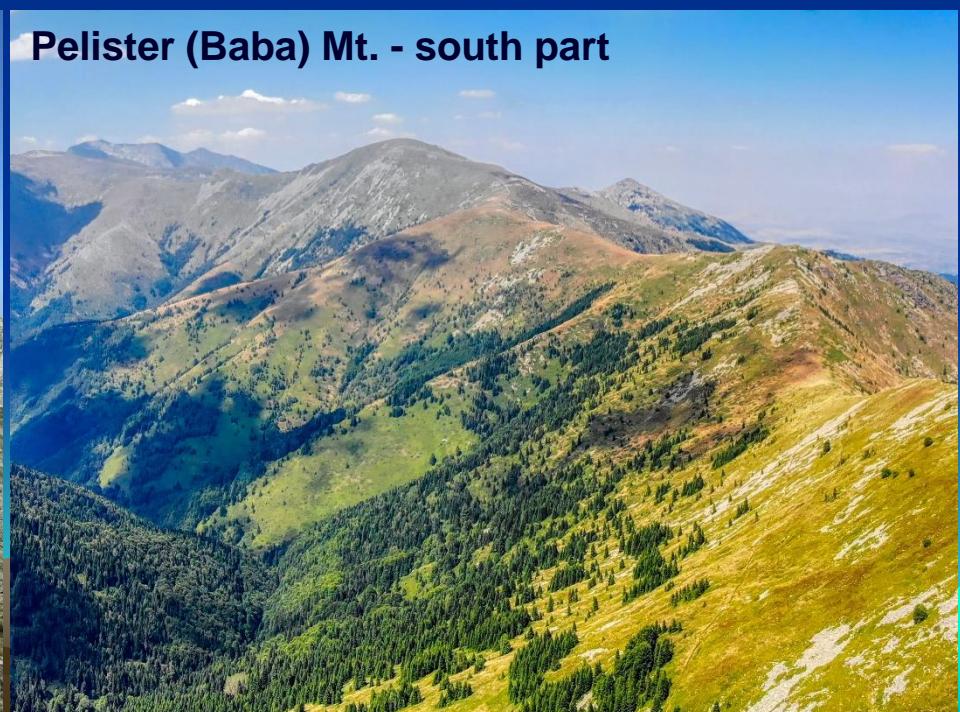
Jakupica-south side



Pelister (Baba) Mt. -the peak



Pelister (Baba) Mt. - south part



Nidze, east ridge



Nidze, north slope



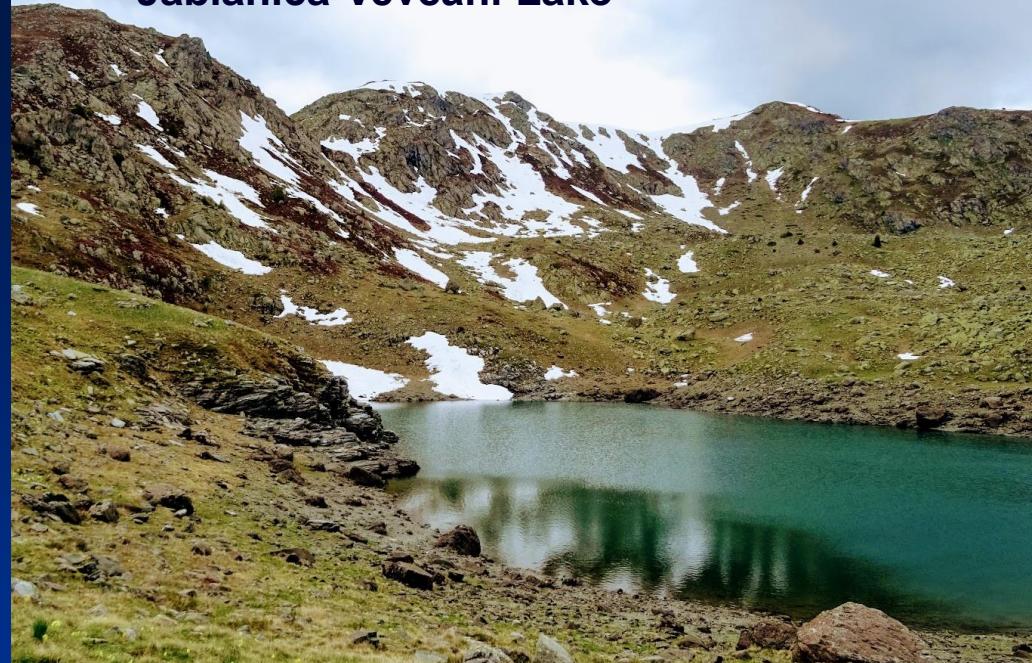
Galičica-highest part



Stogovo-highest ridge



Jablanica-Vevčani Lake



Osogovo-highest ridge



Bistra-west side



A wide-angle photograph of a mountainous landscape. In the foreground, there's a lush green meadow with some low-lying shrubs. Beyond the meadow, a dense forest of tall evergreen trees stretches across the middle ground. The background features several majestic, rugged mountains with rocky peaks and patches of snow or ice. The sky above is a vibrant blue, dotted with large, fluffy white clouds.

**THANK YOU FOR THE
ATTENTION!**