MORPHOMETRIC AND MORPHOLOGIC CHARACTERISTICS OF DOAMNEI RIVER MOUNTAIN BASIN (FĂGĂRAŞ MOUNTAINS)

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Abstract
This paper presents a detailed morphometric and morphographic analysis of Doamnei River mountain basin (Făgăraş Mountains), based on digital morphometric maps, field observations and surveys. The mountain basin of Doamnei River is characterized by a typical alpine, subalpine and mountainous morphology. The main morphometric and morphographic characteristics are: prevalence of high hypsometric steps that exceed 1,600m altitude (including 4 peaks over 2,500m and 18 peaks over 2,400m), high values of landform energy (400-600m, and locally over 1,000m for the areas adjacent to the glacial valleys), very high and steep slopes (predominant slopes of and over 30^0-50^0), high massiveness; well developed river network, with a characteristic river density of 2-4 km/ sq.km; slopes moderately (W, SE) and well (S, SW) exposed to solar radiation.

Keywords: morphometry, morphology, Doamnei River mountain basin, Făgăraş Mountains

1. INTRODUCTION

Doamnei River mountain basin is situated in the central part of Făgăraş-Iezer Mountains. The mountain unit represents 63% of the Doamnei River basin area, respectively 376 sq.km, and is made up the following subunits: Făgăraş Massif to the north and center (the central eastern part of the southern slope of the Făgăraş Massif); Iezer Massif for the central-eastern part (the north-west and west slopes of the Iezer Massif); the intra-mountain depression called Bahna Rusului to the south.

Within the Făgăraş Massif, Doamnei River has the largest basin area that exceeds that of its collector, Argeş River. The morphometric and morphologic characteristics of Doamnei River mountain basin are determined by morphogenesis and consequently, morphology. The mountain basin of Doamnei River is characterized by a typical alpine, subalpine and mountainous morphology. There are two distinct geomorphologic sectors: superior (glacial, high mountains) and inferior (lower mountains and intra-mountainous depression).

Geology is represented by the crystalline rocks (crystalline schists, micaschists, gneisses and intercalated parallel east-west stripes of harder rocks, crystalline limestones and amphibolites) of Argeş Nappe (Cumpăna Unit), and Moldoveanu Nappe (Supragetae Unit) for the main ridge.

2. MATERIAL AND METHOD

In order to represent and interpret better the morphometric characteristics of Doamnei River mountain basin, digital maps were made for each morphometric indicators, using the programs ArcView GIS 9 and CorelDraw 11. They are based on topographic maps (scale 1:25,000), satellite images (LANDSAT ETM+2000), field observations, surveys and photographs. The morphometric maps were completed adding toponyms, hydronyms, oronyms, altitudes and in some cases (the hypsometric, slope and slope aspect maps), a map of landform illumination was overlapped for a better expressiveness.

3. RESULTS AND DISCUSSION

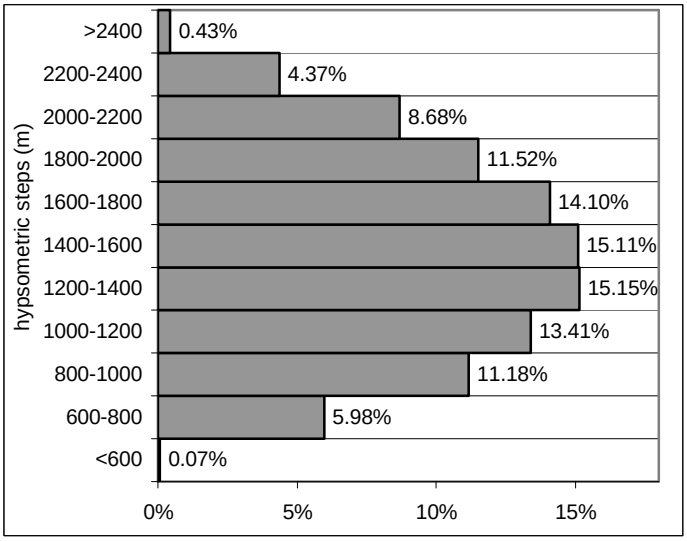
Apart the rest of Făgăraş Massif, Doamnei River basin preserves considerable fragments of all erosion Carpathian levels and surfaces that forms a unique combination with the relict glacial

landforms. The north-west mountain basin shows a typical alpine landscape: alpine ridges and sharp peaks that forms two distinct gipfelflur levels, separated by large glacial cirques and valleys. To the east and south there is gradual passing to "Borăscu glacial landscape", with a large extent of the Carpathian pediplaine, fragmented from place to place by smaller glacial landforms. Add to all of these the relict and actual periglacial landforms. In the southern half of the mountain basin, the alpine ridges separated by the tributaries of Doamnei River are replaced by rounded ridges that preserve the erosion surfaces Râu Șes and then Gornovița. The landscape is marked by the fluvial-normal erosion: the slopes are still steep, the valleys are narrow and deep, with many gorges and torrential tributary streams. Bahna Rusului (or Slatina-Nucșoara) Depression represents the eastern termination of the Central Făgăraș Couloir (or Central Făgăraș Depression), an intra-mountainous tectonic and erosive depression. The depression has the form of a symmetric amphitheater that descends slowly to Doamnei River's bed, with a series of landslides, accumulation and slope deposits glacises.

3.1. Hypsometry

The hypsometric steps of Doamnei River mountain basin descend from north, west and east to center (Doamnei River valley) and south (general direction of river flow). Doamnei River mountain basin extends between 2,544m altitude (Moldoveanu Peak, which is the maximum altitude in both Făgăraș Mountains and Romania) and 600m altitude (the limit between the mountain and hill basin). This high landform energy of 1,944m results in a high erosion potential and dynamics of geomorphologic processes.

The hypsometric map of Doamnei River mountain basin (figures 1, 2) separates 11 classes of hypsometric values at intervals of 200m, from 2,400 to 600m altitude, that succeed decreasingly from north to south (as the mountain altitude decreases), and from west and east to center (toward the valleys). Analyzing the hypsometric diagram of Doamnei River mountain basin, the highest share (377 sq.km) of total mountain basin belongs to the hypsometric steps between 1,000 and 1,800 m (almost 60%). The northern half of Doamnei River mountain basin belong to the category of high mountains, due to the high frequency and area of over 2,000m altitude: more than 50 sq.km are above 2,000m, that represents 13% of total mountain basin area.



Pos	*Hypsometric step*	*Area (sq.km)*	*% of mountain basin area*
1	above 2400 m	1.634465	0.43
2	2400 – 2200 m	16.44779	4.37
3	2200 – 2000 m	32.67243	8.68
4	2000 – 1800 m	43.36255	11.52
5	1800 – 1600 m	53.09080	14.10
6	1600 –1400 m	56.89401	15.11
7	1400 – 1200 m	57.05973	15.15
8	1200 – 1000 m	50.51073	13.41
9	1000 – 800 m	42.11863	11.18
10	800 – 600 m	22.50990	5.98
11	under 600 m	0.26898	0,07
Total mountain basin		*376.57*	*100.00*

Figure 1 . The hypsometric steps of Doamnei River mountain basin

3.2. River density

River density is a morphometric indicator that shows territorial differences regarding the evolution of river network, valley system, as well as their connection with the lithologic and structural support, the climatic, pedological and phyto-geographic particularities. The values of river density for Doamnei River mountain basin (figure 3) vary between 0 km/ sq.km (on interfluves and watersheds) and 6.2 km/ sq.km (on the slopes of main rivers, especially in the glacial sector).

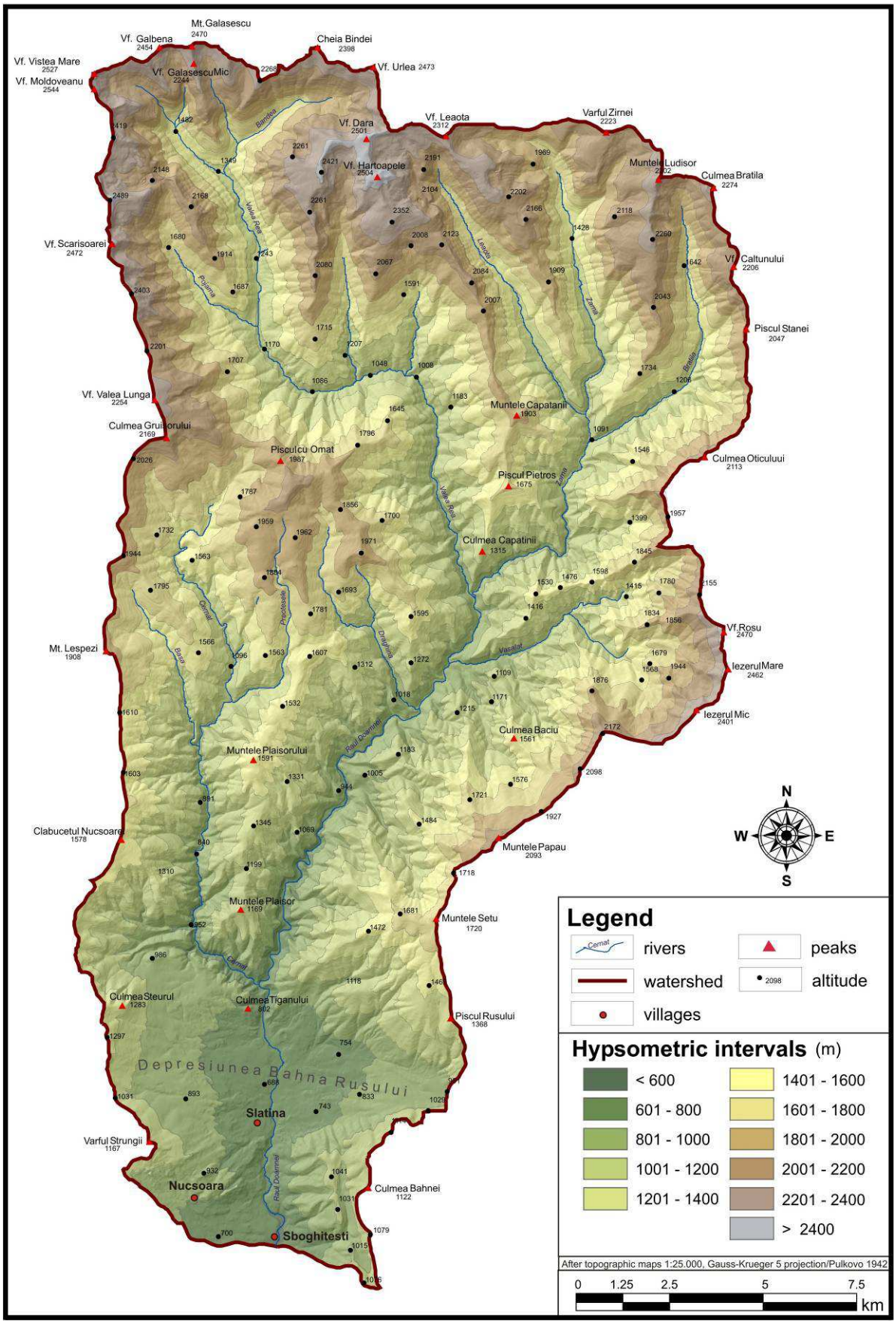
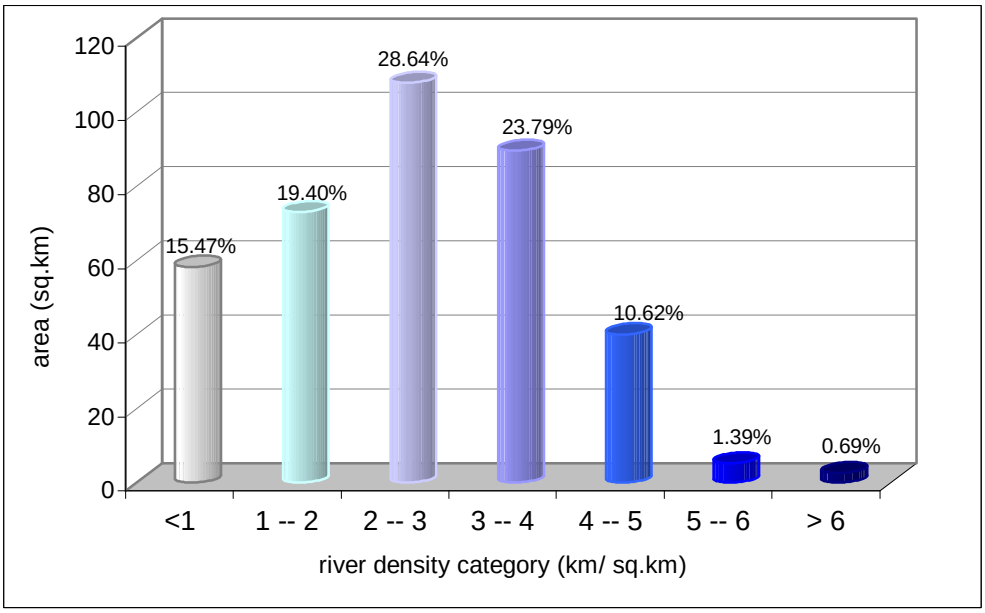


Figure 2 . The hypsometric map of Doamnei River mountain basin

The lowest values (under 1 km/ sq.km) of river density represent 15.47% of basin area, that is 58.27 sq.km, and characterize the interfluves of gipfelflur type or those preserving fragments of Borăscu erosion surface. Higher values of river density (4.1-5 km/ sq.km) represent 10.62% (40 sq.km) of mountain basin and characterize the steep slopes (striped by torrential valleys) of large rivers' gorges corresponding to tectonic lines (Valea Rea, Văsălat, Cernat, Leaota), as well as the sizable glacial cirques and thresholds of Valea Rea and Bândea glacial complexes. The highest values of river density (5.1-6 km/ sq.km, even more than 6 km/ sq.km) occur sporadically in the studied basin (an area of 7.83 sq.km, that is 2% of total) and only within the glacial sector of the valleys Valea Rea, Zârna, Brătila, and Gropile cirques in Iezer Massif; a dense network of springs and nival and fluvial torrents (feeding from rich precipitations or glacial lakes) developed here, on the fractures that stripe the walls of the above mentioned glacial cirques and valleys.



Pos.	*River density category (km/sq.km)*	*Area (sq.km)*	*% of mountain basin area*
1	under 1.00	58.27	15.47
2	1.01 – 2.00	73.05	19.40
3	2.01 – 3.00	107.84	28.64
4	3.01 – 4.00	89.58	23.69
5	4.01 – 5.00	40.01	10.62
6	5.01 –6.00	5.22	1.39
7	above 6.00	2.61	0.69
Total mountain basin		*376.57*	*100.00*

Figure 3 . River density of Doamnei River mountain basin

3.3. Landform energy

Landform energy or depth of landform fragmentation is the result of the complex relations between the erosion intensity (mainly the fluvial one) influenced by the local or general erosion base, and the lithologic and structural support.

The landform energy in Doamnei River mountain basin varies between 52m (centre of Bahna Rusului Depression) and 853m (Valea Rea in its glacial sector, below Dara Mountain), but the values of 400-600m are predominant (50% of total area), indicating a high erosion potential (figures 4, 5). The landform energy exceeds 1,000-1,500m for the large valleys and their basins.

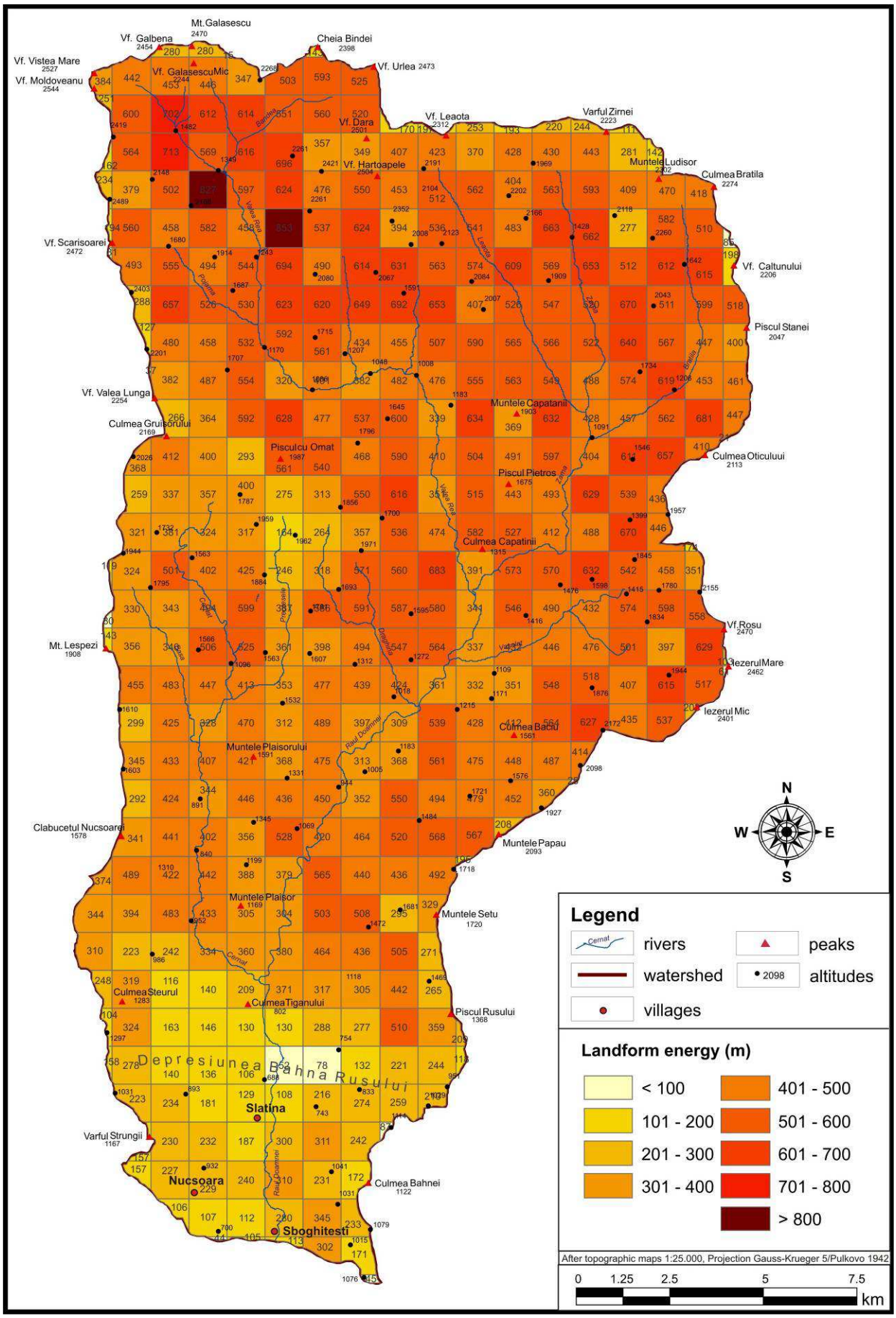
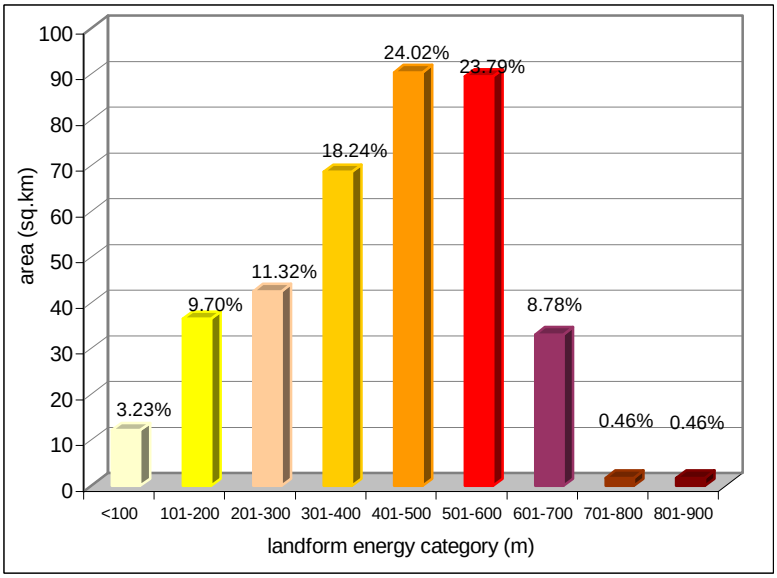


Figure 4. Doamnei River mountain basin - the map of landform energy



Pos	*Landform energy (m)*	*Area (sq.km)*	*%*
1	sub 100 m	12.18	3.23
2	101 – 200 m	36.53	9.70
3	201 – 300 m	42.61	11.32
4	301 – 400 m	68.70	18.24
5	401 – 500 m	90.45	24.02
6	501 – 600 m	89.58	23.79
7	601 – 700 m	33.05	8.78
8	701 – 800 m	1.74	0.46
9	801 – 900 m	1.74	0.46
Total mountain basin		*376.57*	*100.00*

Figure 5. Landform energy of Doamnei River mountain basin

3.4. Declivity (slopes)

Declivity of one of the most important morphometric parameters of a region from the geomorphologic point of view, as its values determine the type and intensity of geomorphologic processes (erosion, transport, accumulation) closely related to climatic, hydrologic, pedological and phyto-geographic factors. Slope (along with rock features, friction coefficient and vegetation) is one of the determinant factors of gravitational processes and landforms. The landforms of Doamnei River mountain basin are characterized by a complexity of slopes, from both genesis and value points of view (figures 6, 7).

The plane surfaces, with low gradients, correspond to: the center of Bahna Rusului Depression with Doamnei River waterside, the edges of this depression where Gornovița erosion surface extends, the floors of large glacial cirques, all the fragments of Borăscu and Râul Șes erosion surfaces, Baciu lake, and some small basinets along Doamnei and Cernat rivers.

Slopes of 10^{o}-20^{0} cover 17% of mountain basin area (66 sq.km) and represent the connection surfaces between the erosion surfaces and the steep slopes bordering them. Along the fluvial valley slopes, these values correspond to valley shoulders. These gradients are also characteristic to all floors of glacial cirques and valley.

High and very high values of slopes, respectively 28^{o}-35^{0} (108.34 sq.km) and 36^{o}-50^{0} (90.92 sq.km), form the most representative slope intervals in Doamnei River mountain basin, extending on 200 sq.km (meaning 53% of total mountain basin). These gradients characterize the steep slopes of all valleys (in both glacial and fluvial sectors), affected by intense gravitational processes, torrents, avalanches (that have increased during the last decade due to deforestation). The highest slope gradients (above 36^{o} and over 50^{0}-70^{0} here and there) correspond to the glacial thresholds, the walls of glacial cirques and alpine peaks and ridges, as well as to the numerous gorges (sometimes with vertical walls along faults) along the valleys Valea Rea, Cernat, Zârna, Dara, Leaota, Brătila, Boureț and Văsălat. In addition to this category, there are structural steep slopes, lithologic and structural thresholds along valleys and fault steep slopes. These impressive steep slopes are generally barren and affected by intense processes of weathering, rock falls, avalanche tracks, nival and fluvial torrents (often set on schistous plans, fissure and fractures).

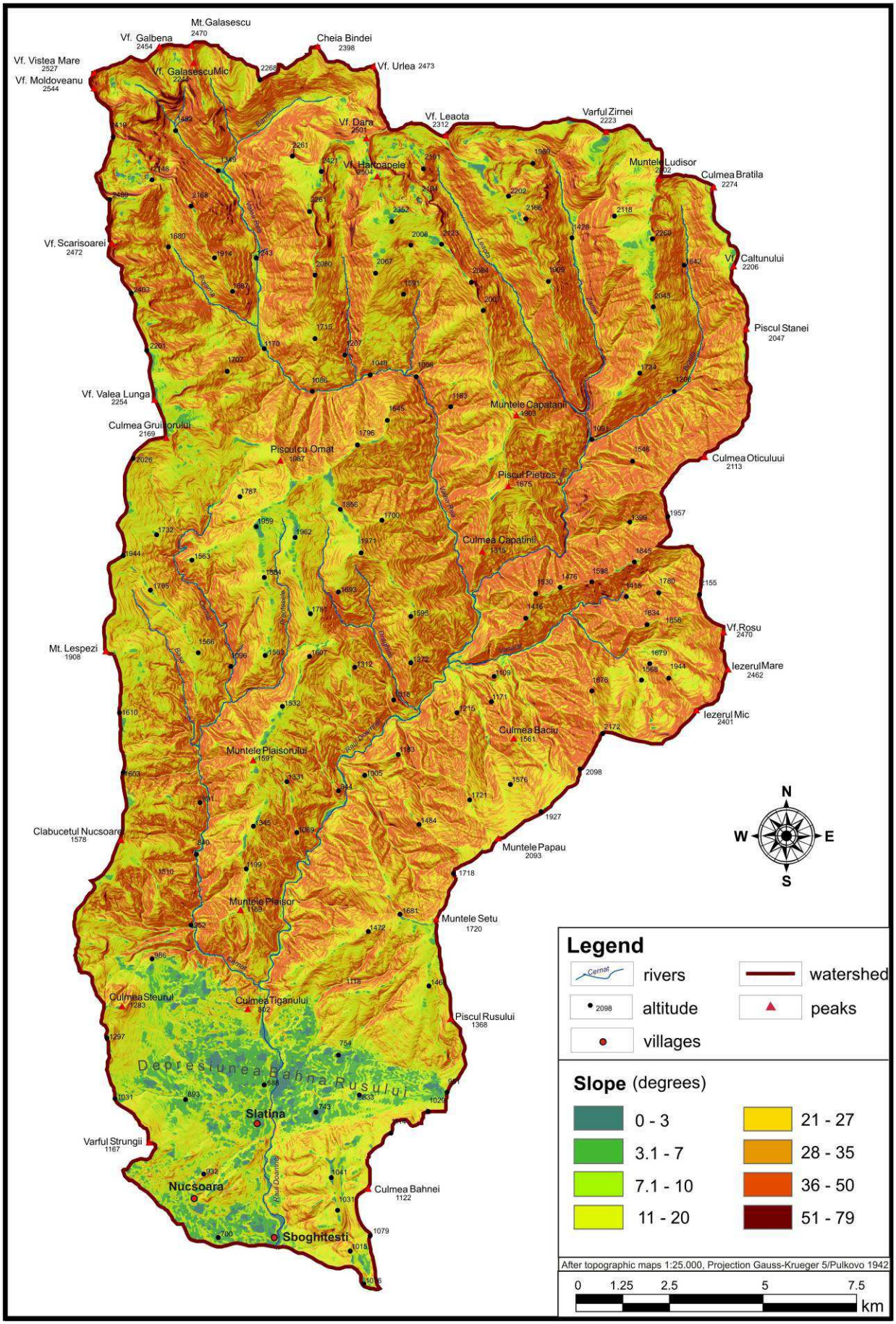
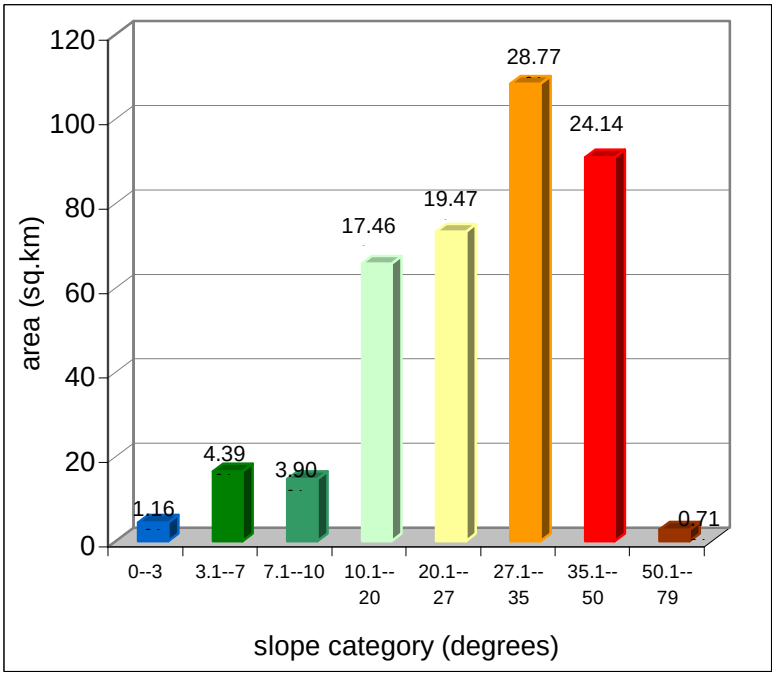


Figure 6 . The slope map of Doamnei River mountain basin



Pos	*Slope category (degrees)*	*Area (sq.km)*	*% of mountain basin area*
1	$0^o - 3^o$	4.36	1.16
2	$3.1^o - 7^o$	16.53	4.39
3	$7.1^o - 10^o$	14.70	3.90
4	$10.1^o - 20^o$	65.73	17.46
5	$20.1^o - 27^o$	73.32	19.47
6	$27.1^o - 35^o$	108.34	28.77
7	$35.1^o - 50^o$	90.92	24.14
8	$50.1^o - 79^o$	2.67	0.71
Total mountain basin		*376.57*	*100.00*

Figure 7 . Slopes of Doamnei River mountain basin

3.5. Slope aspect

Slope aspect is another important morphometric parameter, influencing the geomorphologic processes, topoclimates, soils, and vegetation. Slope aspect in Doamnei River mountain basin (figures 8, 9) is determined by the aspect of southern macro-side of Făgăraş Mountains, and within it, by the aspect of hydrographic basins, direction of main valleys, development and ramification of river network (river density and landform energy).

The main valleys head generally from north to south (Doamnei River, Pojarna, Dara, Boureţu, Leaota, Zârna, Brătila, Cernat, Drăghina), while their basins are large and ramified, so that their sides face mainly south-east and east, consequently south-west and west. The exception is Valea Rea because its basin is ramified in the glacial sector and the river turns twice with 90^0 in the fluvial sector; its sides have different aspects, including shadowed ones (north and north-east). The larger tributaries of Doamnei River from Iezer Massif direct from east to west, so their sides face mainly south and north.

In consequence, the highest shares belong to the sides with south-west 15.84% (59.73 sq.km), east 14.96% (56.35 sq.km), west 14.32% (53.91 sq.km) and south-east 13.34% (50.22 sq.km) aspects.

Depending on the quantity of energy received and slope (different incident angles of solar radiation), vegetation and geomorphologic processes differ in type and distribution. On sunny and semi-sunny slopes, the freeze-thaw cycles are more frequent, and weathering, pedogenesis and solifluction are more intense. In spring, the first wet snow avalanches occur here. These mountain sides are also called “summery mountains”, as the high nutritive alpine lawns are the first to be used for grazing; therefore the sheepfolds and winter stables are usually places on sunny slopes or on sunny plateaus and interfluves (quasi-horizontal surfaces). Also, the mixed forests (coniferous and deciduous) climb more in altitude (to almost 1,600 m) on the sunny and semi-sunny slopes: Căpăţânii Mountains, Dara and Boureţu valleys and the adjacent ridges (Dara, Plaiului, Strungii, Boureţu), Plăişoru Mountain, Cernat valley.

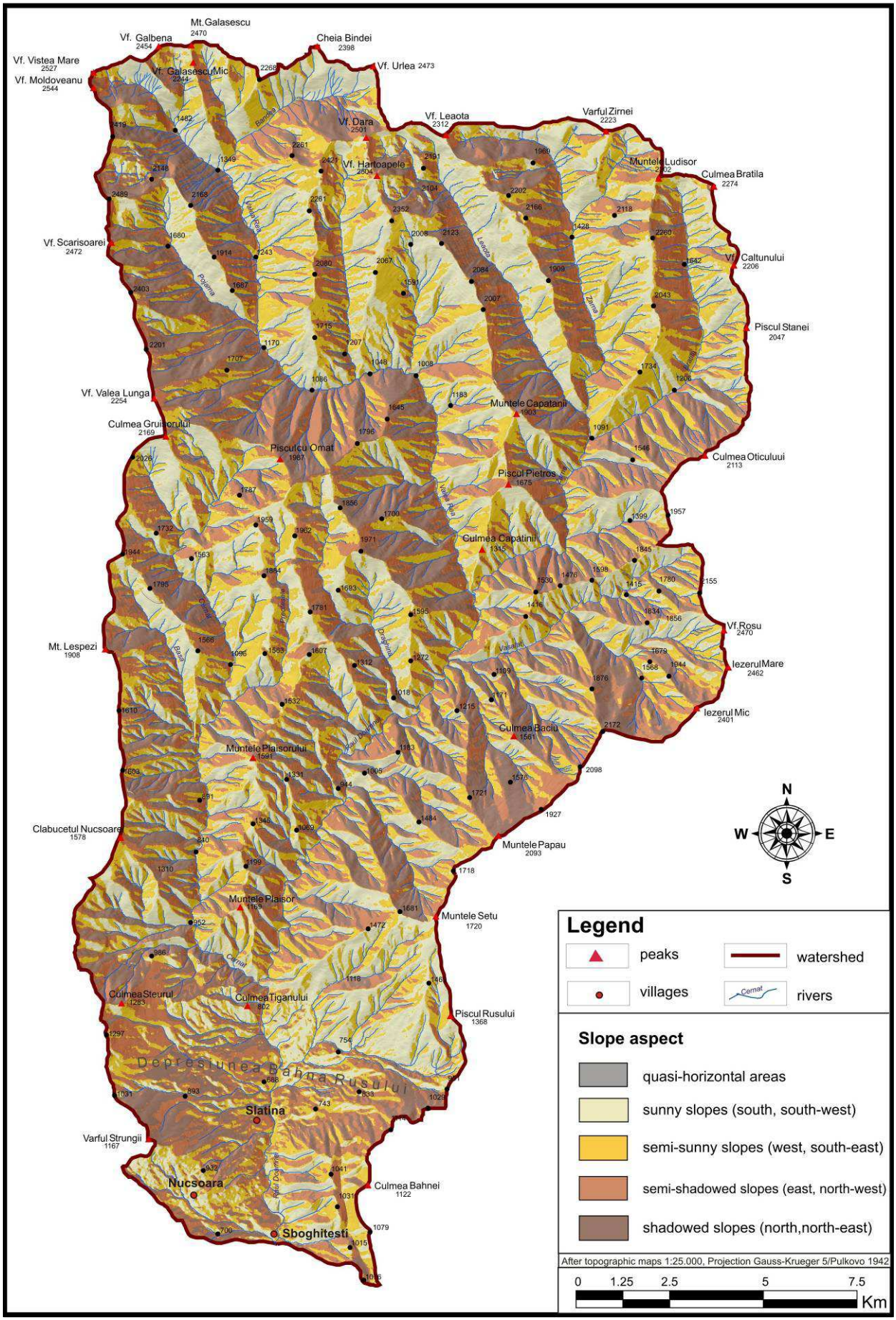
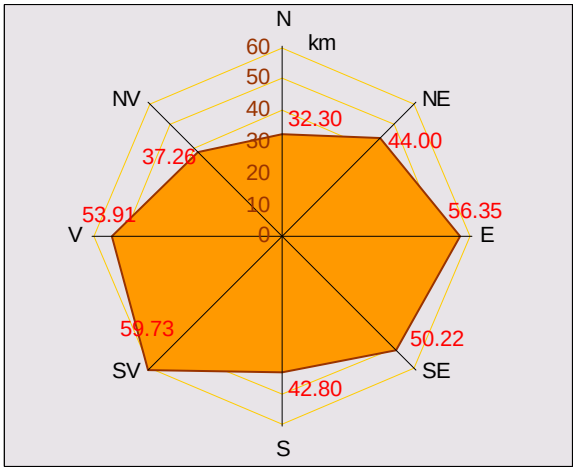
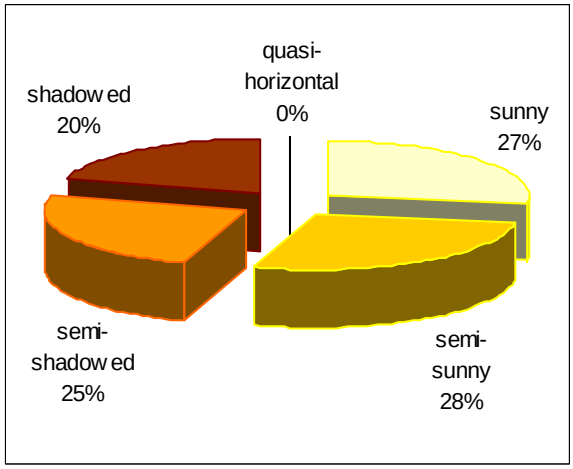


Figure 9. Doamnei River mountain basin - the map of slope aspect

On the other hand, the shadowed and semi-shadowed slopes are characterized by high humidity, longer duration of snow strata, more intense torrential erosion, longer period of soil freeze, shorter vegetation period. These slopes are better wooded with predominant coniferous species (a reason could be a smaller man intervention, at least on the upper part of the slopes, since there are no pastoral facilities).





Pos	*Aspect*	*Area (sq.km)*	*% of mountain basin area*	*Pos*	*Aspect category*	*Area (sq.km)*	*% of mountain basin area*
1	N	32.30	8.58	*1*	quasi-horizontal	0.07	0.01
2	NE	44.00	11.69	*2*	sunny	102.53	27.23
3	E	56.35	14.96	*3*	semi-sunny	104.13	27.65
4	SE	50.22	13.34	*4*	semi-shadowed	93.61	24.86
5	S	42.80	11.36	*5*	shadowed	76.23	20.24
6	SW	59.73	15.86	*Total mountain basin*		*376.57*	*100.00*
7	W	53.91	14.32				
8	NW	37.26	9.89				
Total mountain basin		*376,57*	*100.00*				

Figure 8 . Slope aspect in Doamnei River mountain basin

4. CONCLUSIONS

Doamnei River mountain basin is characterized by a typical alpine, subalpine and mountainous morphology. The main morphometric and morphologic characteristics of Doamnei River mountain basin are: prevalence of high hypsometric steps that exceed 1,600m altitude (including 4 peaks over 2,500m and 18 peaks over 2,400m); high values of landform energy (400-600m, exceeding 1,000m locally for the areas adjacent to glacial valleys); high and steep slopes (predominant slopes of and over 30^0-50^0); high massiveness; well developed river network, with a characteristic river density of 2-4 km/ sq.km; slopes moderately (W, SE) and well (S, SW) exposed to solar radiation. This analysis is based on digital morphometric maps, field observations and surveys.

5. REFERENCES

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