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DELINEATION OF MOUNTAINS AND MOUNTAIN AREAS IN EUROPE – A PLANNING APPROACH

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Abstract: Mountains are usually understood as high elevation areas, which are sparsely populated and where nature is preserved. The elevation above sea level is the most commonly taken as a criterion for mountain delineation, but the complexity of the task arises when definitions are compared in different national contexts, between projects and particularly when they are applied in decision-making process. Therefore, this paper aims to give a review of the existing palette of mountain definitions and mountain area delineations, to recognise some common criteria used in the definitions, as well as to review topics and situations in which the delineations are applied and used in spatial planning. Due to the diversity of cases, it was necessary to reduce scope of the topic; therefore the paper is limited to the European context and particularly to countries representing the largest European mountain massifs – Alps, Apennines, Pyrenees, Dinaric Alps and Carpathians.

Key words: mountains, mountain areas, delineation, spatial planning approach, European context

Introduction

The term “mountains” seems to be well known and understood, usually as high elevation areas with sparse population and preserved nature. However, any attempt to make an exact and universal definition would rather end with series of open questions than with a quick answer. This is particularly the case when geographically established delineation (based on topographic criterion) needs to be applied in governing particular administrative units.

Therefore, it is relevant to note that there is a difference between the terms “mountains” and “mountain areas”. While “mountains” basically represent geographically defined areas, “mountain areas” are a sum of the smallest administrative units encompassing “mountains” (mountain municipalities). In some cases, it can be decided that a mountain municipality is entirely or partially mountainous.

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Mountains in Europe occupy 19% of its territory (excluding Commonwealth of Independent States) (Copus & Price, 2002) and most of the European countries are mountainous at least partially. Actually, only five countries – Denmark, Netherlands, Estonia, Latvia, Lithuania and Malta – do not define, by any definition, a part of their territories mountainous (European Commission [EC], 2004). Other European countries share many mountain ranges among which the Alps, Apennines, Dinaric Alps, Carpathians, Scandinavian Mountain Range and Pyrenees are considered the largest.

The beginning of an exact and legally binding delineation of mountain areas occurred in the second half of the 20th century (Price, Lysenko, & Gloersen, 2004), starting with France in 1961, Italy in 1971 and Switzerland in 1974 (Castelein, Dinh, Mekouar, & Villeneuve, 2006).

Territorially, this paper focuses on European mountains and mountain areas. Their delineation is considered on a national and European level; however, this study also includes a review of some world-wide projects with regard to this topic.

Criteria for Delineation of Mountains

Mountains are delineated by either one-criterion or multiple-criteria methods. The one-criterion method is common for geographical definitions of mountains and in scientific research in countries with no specific policy towards mountains or mountain areas. Another common feature of the one-criterion definitions is that they are defined at a national level, instead of encompassing the entire European continent.

The only criterion used in the one-criterion delineations is elevation above sea level. Depending on the overall topography of the terrain – the highest point and the percentage of mountains within the total area of a country – the minimum elevation threshold significantly varies (Table 1). Thus, Ireland delineates its mountains at the 200 m contour line, while in the Czech Republic it is 700 m. Sometimes, the criterion values differ even within one country e.g. in Serbia where 500 m (Gavrilović & Gavrilović, 2002) was the commonly accepted contour line before the *Sustainable Development on Mountain Areas in Serbia* project (Institute of Architecture, Urban & Spatial Planning of Serbia [IAUS], 2002-2004), Milijić (2005) and Pantić (2014) changed this value to 600 m.

Table 1. Delineation criterion in the one-criterion method

Country	Minimum elevation (m)
Ireland	200
United Kingdom	240
Belgium	300
Bulgaria	420
Serbia	500/600
Norway	600
Albania	650
Croatia	650
Czech Republic	700

Source of data: Copus & Price, 2002; EC, 2004; in Galabov et. al., 1982 (as cited in Kenderova & Baltakova, 2013)

In multiple-criteria method for delineation of mountains, elevation is taken as a main criterion while other criteria are taken as additional. A choice of the additional criteria and their threshold values depend on the application aims. However, slope, elevation range, climate caused difficulties and their mutual combinations are the most common criteria choice (Table 2).

Table 2. Delineation criteria in the multiple-criteria method

Country	Minimum Elevation	Additional criteria
Austria	700 m	also above 500 m if slope >20%
Bulgaria	600m	also altitudinal difference/km ² >200m or slope >12°
Cyprus	800 m	also above 500 m if average slope >15%
France	700 m (generally) 600 m (Vosges) 800 m (Mediterranean)	slope >20% over >80% of area
Germany	700 m	climate difficulties
Greece	800 m	also 600 m if slope >16% below 600 m if slope >20%
Hungary	600 m	also above 400 m if average slope >10% or average slope >20%
Italy	600 m	altitudinal difference > 600 m
Poland	350 m	or >12° for >50% of agricultural land in a municipality
Portugal	700 m (north of the Tejo river) 800 m (south of the Tejo river)	slope >25%
Romania	600 m	also on slopes >20°
Slovakia	600 m	above 500 m on slopes >7° or average slope >12°
Slovenia	700 m	also above 500 m if more than half the farmland is on slopes of >15% or slope > 20%
Spain	1000 m	slope >20%, elevation gain 400 m

Source of data: Copus & Price, 2002; European Commission, 2004; European Observatory of Mountain Forests (2000)

In contrast to the diverse national delineations, the UNEP-World Conservation Monitoring Centre, led by Kapos, Rhind, Edwards, Price & Ravilious (2000), developed a significantly more detailed and the first worldwide delineation based on US Geological Survey’s database (Table 3) (Figure 1). The database was made in 1996, by mapping the altitude and slopes for each square km, called also a digital elevation model [DEM] for the whole of the Earth’s surface. The DEM was defined as 1 km resolution consisting of points; for each of the points was calculated standard deviation with the eight cardinal points (North – East – South – West) and ordinal points (North-East – South-East – South-West – North-West). For lower elevations (300-999 m), they used an additional criterion – local elevation range [LER] within 3 or 7 km radius.

Table 3. UNEP-WCMC criteria for delineation of mountains

Class (elevation in metres)	Additional Criteria
> 2,500	-
1,500-2,499	> 2° mean slope within 3 km radius
1,000-1,499	>5° mean slope within 3 km radius and/or LER >300 m within 7 km radius
300-999	LER >300 m within 7 km radius
0 – 299	standard deviation > 50 m for 8 surrounding points

Source of data: Kapos et al. (2000)

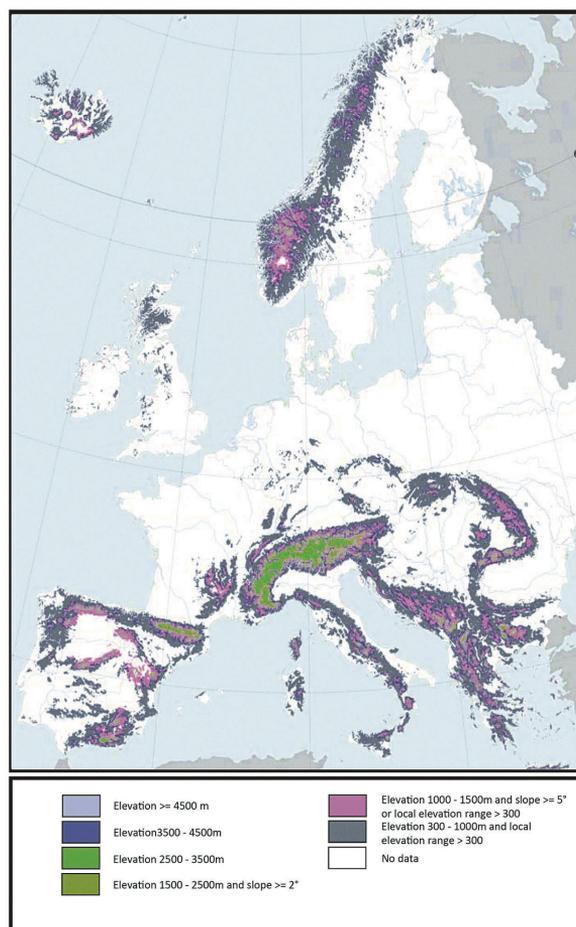


Figure 1. Mountains of Europe

Source of data: map originally prepared by S. Blyth using UNEP - World Conservation Monitoring Centre [WCMC] 2000 global delineation, taken from the NORDREGIO study (EC, 2004)

The EC has considered application of the UNEP's delineation criteria and adapted it for use in the European context by slight changes (Table 4). The most noticeable addition to the original criteria list is the temperature contrast index "K"² which is introduced to enable incorporation of lowland and coastal areas where climate conditions are similar to mountainous climate. The decision was

² "K" = $\{\Sigma(T_{max}^{\circ} > 0^{\circ}) - \Sigma(ABS[T_{min}^{\circ} < 0^{\circ}])\} / \{\Sigma(T_{max}^{\circ} > 0^{\circ}) + \Sigma(ABS[T_{min}^{\circ} < 0^{\circ}])\}$ where $\Sigma(T_{max}^{\circ} > 0^{\circ})$ is the sum of average monthly maximum temperatures $> 0^{\circ}C$, and $\Sigma(ABS[T_{min}^{\circ} < 0^{\circ}])$ is the sum of absolute values of average monthly minimum temperatures $< 0^{\circ}C$.

based on the fact that some European mountains (e.g. in British Isles, Iberian Peninsula and Scandinavia) extend down to the sea level and the costal climate conditions in the north are similar to those at high elevation in the south.

Table 4. The European Commission Criteria for Mountains

Main criteria (elevation in m)	Additional Criteria
> 2,500	-
1,500-2,500	Standard deviation of elevation with the 8 surrounding points > 50 m or LER within 7 km radius \geq 300 m and slope between each of 8 points is \geq 2°
1,000-1,500	Standard deviation of elevation > 50 m with the 8 surrounding points or LER within 7 km radius \geq 300 m and slope between each of 8 points is \geq 5°
300-1,000	Standard deviation of elevation with the 8 surrounding points > 50 m or LER within 7 km radius \geq 300 m
0 – 300	Standard deviation of elevation with the 8 surrounding points > 50 m and temperature contrast index “K” < 0.25

Source of data: EC (2004)

Meybeck, Green & Vörösmarty (2001) also used US Geological Survey’s database in creation of a relief patterns classification according to relief roughness – difference between maximum and minimum elevation per grid cell (1x1 m) divided by half the cell length in m/km. According to them, mountains are above 500 m mean elevation, differentiated from plateaus by relief roughness greater than 40 m/km.

Criteria for Delineation of Mountain Areas

As the UNEP-WCMC and other mentioned delineations define only mountains, the definitions were not applicable for data collection, data analyses and policy making. Therefore, an adjustment to administrative requirements (borders of municipalities and regions) was necessary to define mountain areas. So, the following step was to decide on sufficient proportion of mountains in a municipality to call it a mountain area municipality.

Based on this requirement, but also realising existence of small portions of non-mountainous land in midst of mountains, the EC made the decision to include non-mountainous areas into mountain areas if the former were less than 5 km² and exclude mountainous areas if they were less than 5 km². Finally, only municipalities with more than 50% of mountains are considered as part of a mountain area.

In case of one of the Italian regions - Lombardy, the choice of mountain area municipalities was expanded from topographical criteria to socio-economic criteria (Table 5). Each criterion was assigned three ranges of values – each bringing a different amount of points. The final point score for each municipality enabled their classification into three categories with regard to difficulty (European Academy of Bolzano [EURAC], 2006). This was a tool to separate municipalities that “deserve” to be part of the mountain area from those that do not, as well as to grade the amount of financial support and apply specific measures.

Table 5. Criteria for delineation of the mountain area in Lombardy (Italy)

Criteria	Ranges of values
Territory	$\leq 10 \text{ km}^2$; $> 10 \text{ km}^2$ and $\leq 40 \text{ km}^2$; $> 40 \text{ km}^2$.
Inhabitants	> 500 and $\leq 3,000$; ≤ 500 .
Depopulation	≥ 0 ; < 0 and $\geq -5\%$; $< -5\%$.
Slope	Plane areas (slope $< 9^\circ$) $> 20\%$ of total surface; Plane areas $< 20\%$ of total surface and areas less or non-usable (slope $> 30^\circ$) $< 50\%$ of total surface; Plane areas $< 20\%$ of total surface and areas less or non-usable $> 50\%$.
Elevation of communal territory	60% of total surface at level $< 600 \text{ m}$; $< 60\%$ of total surface level $< 600 \text{ m}$ and $< 60\%$ at level $> 900 \text{ m}$; $> 60\%$ of total surface at level $> 600 \text{ m}$.
Accessibility*	Total distance $\leq 45 \text{ km}$; Total distance $> 45 \text{ km}$ and $\leq 80 \text{ km}$; Total distance $> 80 \text{ km}$.
Overnight stays at tourist accommodation	$> 50,000$; $> 5,000$ and $\leq 50,000$; $\leq 5,000$.
Extra-agricultural activities**	$> 95\%$; $> 85\%$ and $\leq 95\%$; $\leq 85\%$.
Elevation of the main communal city	≤ 450 above sea level; $> 450 \text{ m}$ and $\leq 800 \text{ m}$ above sea level; $> 800 \text{ m}$ above sea level.

*This is the total distance between the main city of the municipality and the main city of the province.

**Percentage of employees in sectors outside of agriculture to the total percentage of employees.

Source of data: EURAC, 2006

Even though based on the same delineation of mountains, some scientific projects in Serbia have used slightly different delineation for the mountain areas. The *Sustainable Development on Mountain Areas in Serbia* project (IAUS, 2002-2004) initiated the use of 600 m as a delineation criterion for mountains, adding administrative-political units to define mountain areas. These decisions were later used by the participants of the project and projects that followed. However, Dželebdžić and Jokić (2003)³ analysed mountain areas on the level of 78 mountain municipalities (2,068 cadastral municipalities). The criterion for the inclusion of a municipality was the presence of mountains in its territory, regardless of their share of the total area. Malobabić & Bakić (2003) considered only cadastral municipalities that have more than 50% of their area over 600 m as a mountain area, which makes a total of 1,522 cadastral municipalities distributed in 67 municipalities. Analysing the economic capacities of mountain meadows and pastures, Nikolić (2003) defined mountain areas as above an elevation of 800 m.

None of these projects included Vršacke Planine (614 m) and Kosmaj (626 m) mountains due to their territorial “isolation” from other mountains and/or their insignificant elevation above 600 m. It was the case in two doctoral theses by Milijić (2005) and Pantić (2014), too (Figure 2). In addition, they both defined mountain areas by summing municipalities include mountains in their territory regardless of their areal proportion.

³ All examples of Serbia in this paper refer to Serbia without Kosovo (as it is defined by the UN Resolution 1244).

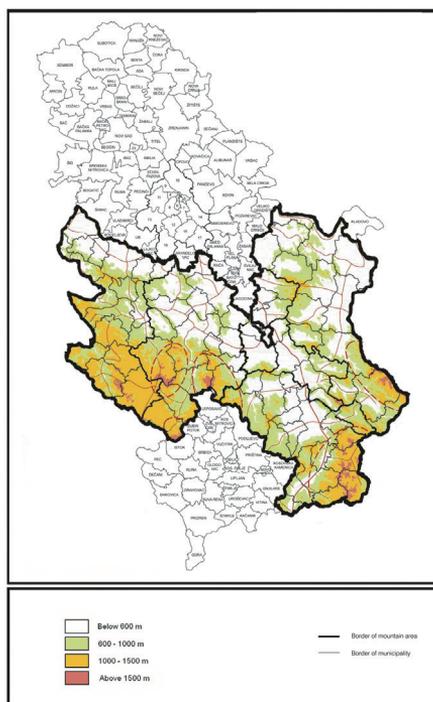


Figure 2. Mountains and mountain area of Serbia

Source of data: elaborated by the author in Pantić 2014, based on the Spatial Plan of the Republic of Serbia (2010)

In case of the Carpathian Convention (2003), Serbia, as a member state, defined its Carpathian area, as did the rest of the member states. According to the definition, the Serbian Carpathian area was limited to the borders of the Djerdap National Park and its vicinity (EURAC, 2006). Thus, this simplified delineation excluded a large part of the Carpathians in Serbia, which is in contrast to Poland where the area was widened to the highest extent by including every district where the majority of terrain is above 300 m elevation.

Applications of the Delineations

As it is noted in the previous sections, definitions of mountains and mountain areas are often not universal and not unique even within the same country. Some European mountain countries have more than one definition even of the same mountain area, as it is the case with the Alpine area within the German state of Bavaria and with Lombardy in Italy (EURAC, 2006). However, this should not

be taken as a mistake because it is legitimate to adjust definition to project scope and aims. In other words, delineation depends on application purpose.

A topographic definition of mountains might be the easiest solution in delineation, but in practice it is not applicable without delineation of mountain areas. The purpose for having clearly defined mountain area is to collect statistical data which can be used in research and application of an explicit mountain policy, regionally, nationally and internationally.

In order to apply an explicit mountain policy, European mountain countries assign a special status to their mountain areas. The policy application can also be related to national budget expenditures, so a precise and clear definition of a mountain area is of utmost relevance for avoiding waste of resources or, on the other hand, negligence of areas with a mountainous character. A tool to assign their special status is legislation, where France (1961), Italy (1971) and Switzerland (1974) have been among the firsts and Greece (1990), Bulgaria (1993), Ukraine (1995), Spain (2002) and Romania (2002) followed (Castelein et al., 2006).

In the legislative acts, countries usually define mountain areas as a list of mountain ranges (France), municipalities (Bulgaria, Italy, Romania) or zoning of agricultural land on the level of parcels (Austria, Switzerland). Agriculture is a commonly present topic in European legislation on mountain areas, but also on the European Union level. Therefore, the Directive 75/268/EEC on Mountain and Hill-Farming in Less-Favoured Areas (Council Directive, 1975) gave the first definition on a European scale. The same definition was used in Article 18 of the European Council regulation No 1257/1999 for rural development support (Council Regulation, 1999). In Serbia, the Ministry of Agriculture, Forestry and Water Management at that time (2009), used the elevation of 500 m as a limitation of mountains in order to facilitate certain forms of support in marginalised areas⁴.

The second group of topics involved in the legislation on mountain areas is linked to different aspects of living: from technical and social infrastructure, education, medical services to housing. Diverse aspects on protection represent the third group addressing the issues of cultural heritage, waters, soils, forests and landscapes. With this regard, even though not being an explicit mountain law, the Spatial Plan of the Republic of Serbia (Republic Agency for Spatial

⁴ According to an interview with the Consultant for rural development, Sector for Rural Development, Ministry of Agriculture, Forestry and Water Management, conducted in June 2009.

Planning [RASP], 2010), takes into consideration mountain areas (particularly high mountain areas) in one of its sections for the first time in Serbia.

For the countries that chose explicit policy towards mountain areas, legislative platform is a tool for regulation of responsible institutions and bodies and constitution of financial support. The support is a part of the governmental budget the legislative acts define the rules under which this budget is going to be spent. The examples are France, Romania and Bulgaria. Great deals of countries that have mountain laws also arrange explicit funds for the development of mountain areas such as Austria, France, Italy, Switzerland and Bulgarian (Castelein et. al., 2006).

In addition to the topics that regulate life quality and economic activities in mountain areas, some countries use their legal acts to influence governing matters as well. In order to improve the bottom-up approach in governing and improve cooperation, Romania obliges establishment of regional institution responsible to implement development programs and encourage regional relations by cooperating with other mountain regions (Ibid.). In Italy, cooperating communities must belong to the same province, they must comprise at least 5,000 inhabitants and municipalities not larger than 40,000 inhabitants; and partially mountainous municipalities have to comprise at least 15% of their population within mountain areas (Ibid). The communes are embodied – consisting of representatives of each member municipality and an executive body. They play a role in the implementation of socio-economic development and establishment of information offices for inhabitants (Food and Agriculture Organisation [FAO], 2002).

In Bulgaria and France, the establishment of associations of mountain municipalities is not mandatory, but it is supported. In case of Bulgaria, grouping of local authorities is encouraged by a set of measures which are mainly economic incentives, but at the same time by providing advantage for each municipality to have a representative in the National Board for Mountain Regions. In France, beside added values of cooperation, communes are willing to group in order to get additional financial resources from the central government (Castelein et al., 2006).

Discussion

Reviewing diverse cases of mountain and mountain area delineation in Europe, several discussion points emerge: the difference in territorial and demographic size between mountain and mountain areas; superficiality of some definitions; applicative use of mountain area definitions.

Transition process from delineation of mountains to delineation of their mountain areas means to make a decision on percentage of mountains the smallest administrative unit needs to involve. The problem in the process can be significant difference in size between the mountains and their mountain area in case of large local administrative units. Thus, Serbia mountain areas comprise 78 municipalities, where each has at least one cadastral municipality covering mountains and mountains of Serbia occupy 20,500 km², whereas its mountain areas 45,131 km², which makes them twice as large (Table 6). When their demographic size is compared, the difference is even more pronounced.

Table 6. Serbian mountains and mountain areas - comparison of territorial and demographic size

Comparison criterion	Mountains		Mountain areas	
	Value	%	Value	%
Area (km ²)	20,500	26.5	45,131	58.2
Population	721,453	9.6	3,099,014	41.3

Source of data: Malobabić & Bakić, 2003; Statistical Office of the Republic of Serbia, 2003

The other potential problem is the superficiality in setting a definition. As the cases of Lombardy and EC show, precise delineations require more than one criterion and some mathematical models, in contrast to the superficial approach e.g. the approach chosen by the authors of the delineation of the Serbian Carpathians. This definition is stated to be based on geological diversity and biodiversity, thus neglecting the administrative-political division and excluding the larger part of the Carpathian massif in Serbia outside of the Djerdap National Park. Officially, the reason is the unclear border between the Carpathian and Balkan Mountains (EURAC, 2006), which indeed is an issue, but it is required to be resolved because of the size of the left-out area. Indicative for the magnitude of the territory left out is the fact that Serbian Carpathian area for the Carpathian Convention covers only 732 km², whereas Pantić (2014) delineates Serbian Carpathian region as an area of 6,833 km².

Applicative use of mountain area delineation appears to be directly related to an assignment of a special status to them. This principle is supported by the European countries with constituted legislative framework for mountain areas - Bulgaria, France, Greece, Italy, Romania, Switzerland and Ukraine. Through persistent application of its mountain policy, Austria also belongs to this group of countries, in accordance with the EU's Less Favoured Areas Scheme. The Carpathian Convention (2003) also advocates this principal.

Stojanović (1990) and Milošević, Milivojević & Čalić (2010) argue that demographic structures depend on the physical geographic factors (e.g. geomorphology); Pantić & Živanović Miljković (2010) highlight difference in

population aging between lowland and mountain municipalities in Serbia; and the whole range of strategies and studies address hilly and mountain areas as areas of specific geographic conditions and a higher extent of social, infrastructural and economic problems (Pantić, 2014). The evident specificity of mountains and mountain areas, regarding inherent conditions and challenges, needs to be treated and governed in a specific manner. The precondition for this is a clear definition on mountains and delineation of mountain areas that are to be assigned a special status (Ibid.).

Finally, differences in territorial sprawl and deficiencies of mountain and mountain area delineations need to be accepted, but should be reduced to the smallest scale if possible. Choice of delineation criteria and decision about their border values depend on the delineation goal and purpose, but crucial topographic preconditions need to be taken in a thorough consideration before some parts of a territory are involved or left out from the target area. In order to meet specific characteristics and needs of ecosystems and population in mountains, an exact delineation is the main requirement because “there is no implementation of chosen responses if mountain areas are not previously defined” (Pantić, 2014, p. 141).

Conclusions

This paper shows the relevance in understanding the difference between terms “mountains” and “mountain areas”. Definition on the mountains is the precondition for delineation of their mountain areas, and in the delineation process can be used one-criterion or multi-criteria method. The choice of delineation method depends on the aim and planned application of the delineation itself. Therefore, the same mountain and its mountain area may have several delineations.

According to reviewed cases, the applicability of delineations in governing and spatial planning is diverse. It includes use in collecting statistical data, practicing agricultural policies, nature protection, taking care of social equity (living standard), inter-municipal cooperation, etc. Finally, the delineation is recommended to serve in establishing mountain areas as areas with a special status on an international and national level, while taking care to diminish area size between the mountains and their mountain areas as much as possible.

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