4. Terrain, climate and land covers/uses in mountain areas

Key characteristics of the physical environment of mountain areas – altitude, slope, and climate – were used to develop the delineation presented in Chapter 3. These are also key factors affecting land covers/uses, economic activities, settlement patterns, and infrastructure development.

4.1 Terrain and climate

The mean altitude of mountainous municipalities is presented in Figure 3.5. The same data were used to produce Figure 4.1, which shows the mean altitude of the national massifs. This clearly reveals the great differences between the high mountains – Alps, Pyrenees and many other mountains of the Iberian Peninsula, the Romanian Carpathians, southern Bulgaria and Southern Fennoscandia – and the lower ‘middle’ mountains that account for a much greater proportion of the total area of the mountains of the study area; even when some have high peaks such as those of the Apennines and the Polish/Slovak Tatras. The roughness of the terrain is also a critical factor in many regards. To evaluate this, the standard deviation of altitudes and average slope angles in both municipalities and massifs were calculated. Figures 4.2 and 4.3 show the high relief and steep slopes of many municipalities in the Alps, Pyrenees, southern Romanian Carpathians, the Spanish Sierra Nevada, and the Balkans of southern Bulgaria and Greece. The roughness of the terrain at this scale is a critical constraint on local economic activities. Particularly for the development of transport infrastructure, terrain roughness at the regional scale is more important. Figure 4.4 shows a number of massifs with high relief, including those mentioned above, but also others such as the central and southern Apennines, Cantabrian mountains, Corsica, and southwestern Norway.

Climatic conditions provide both opportunities and constraints for economic activities in mountains. Figures 4.5 and 4.6 show the tendency for temperature to decrease as altitude and latitude increase; and also the oceanic-continental gradient from north/west to east, leading to a greater range of temperatures across the year.
Figure 4.1. Mean altitude of national massifs

Mean altitude of national massifs

in meters a.s.l.

- 0 - 250
- 251 - 500
- 501 - 750
- 751 - 1000
- 1001 < ...

Data not available
Study area
Other countries

Source: Eurostat/GISCOC, GTOPO30 DEM
Figure 4.2. Municipalities: standard deviation of altitude

Municipalities: Standard deviation of altitude

Source: Eurostat/GISCO, GTOP00 DEM
Figure 4.3. Municipalities: average slope angle

Municipalities: Average slope angle

in percent

<table>
<thead>
<tr>
<th>Slope Angle</th>
<th>Legend</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 2.5</td>
<td>Data not available</td>
</tr>
<tr>
<td>2.5 - 5.0</td>
<td>Study area</td>
</tr>
<tr>
<td>5.0 - 7.5</td>
<td>Other countries</td>
</tr>
<tr>
<td>7.5 - 10</td>
<td></td>
</tr>
<tr>
<td>10 &lt; ...</td>
<td></td>
</tr>
</tbody>
</table>

Source: Eurostat/EGISCO, GTOPO30 DEM
Figure 4.4. Standard deviation of altitude within massifs

Standard deviation of altitude within massifs

- 0 - 200
- 201 - 400
- 401 - 600
- 601 - 800
- 800 < ...

Data not available
Study area
Other countries

Source: Eurostat/GISCO, GTOP090 DEM

Mountain Areas in Europe – Final Report
Figure 4.5. Lowest monthly average temperature in massifs

Lowest monthly average temperature in massifs

lowest value for spatial unit in Celsius

-20 to -15
-14 to -10
-9 to -5
-4 to 0
1 to ...

Source: Eurostat/GISCO

Data not available
Study area
Other countries

Source: Eurostat/GISCO
Figure 4.6. Highest monthly average temperature in massifs

Highest monthly average temperature in massifs

Highest value for spatial unit in Celsius

- 13 - 20
- 21 - 25
- 26 - 30
- 31 - 35
- 36 - 40

Data not available
Study area
Other countries

Source: Eurostat/GISCO
4.2 Land covers/uses

As described in section 2.4, data from PELCOM were used to characterise land cover and uses across Europe. These were then analysed at both municipality and massif level. A considerable number of maps were produced, of which only a relatively small number are shown here, with two emphases: first, to show the ways in which mountains are different from other parts of Europe and, second, to highlight characteristics of specific massifs both individually and in relation to other massifs.

4.3 Agricultural land

Figure 4.7 shows the proportion of arable land for all municipalities within the study area. On this map, with very few exceptions – most notably Sicily which has a high proportion of arable land and the Nordic countries, where there is very little – the mountains clearly stand out as areas with relatively low proportions of arable land: for instance, the Alps, Carpathians, Pyrenees and other mountains of the northern and western parts of the Iberian peninsula can clearly be discerned. At the massif scale, these ranges, as well as those of the British Isles and the Nordic countries, are seen to have less the 20% arable land. Nevertheless, there are many mountain municipalities and massifs in which arable land covers a significant proportion of the area, particularly at lower altitudes around the edges of massifs, as shown in Figure 4.8. Thus, in Sicily the average proportion of arable land is within the 61-80% class; arable land accounts for about half the land in the middle-mountain massifs of the Sudetes and most other parts of the Czech Republic; and many of the massifs surrounding the Mediterranean, as well as the Swiss Mittelland and the middle mountains of Germany, fall within the 21-40% class.

One particular type of agriculture is permanent agriculture, such as vineyards, olive groves, and orchards. As can be seen from Figure 4.9, these cover significant proportions of the mountains of Andalucia (Spain). Both the Betic Systems massif, which includes these mountains, and Crete have between 21 and 40% of their area under permanent crops; and they are also important at lower altitudes around the Mediterranean, in other parts of Greece and Italy, and in Portugal.

A third type of agricultural land use is grazing on permanent grassland, a key element of many mountain cultures, often serving as a link between mountain areas, where animals graze in summer, and lowland areas, where they graze in winter. While grassland is important in terms of area in some lowland areas in northern Europe (e.g., Belgium, France, Ireland, Netherlands, UK), there are also some massifs where it is important either at the scale of the massif or more locally, as shown in Figure 4.10. The highest proportions are in the mountains of northern England and Northern Ireland, and Morvan (France); the overall proportion is 61-80%. Within the mountains of Wales and parts of the Norwegian mountains, the overall proportion is 41-60%; and it is 21-40% in the Massif Central (France), the western Carpathians of Romania, and Crete. Grassland is also of more local importance in other parts of Greece, Romania, and the Nordic countries, as well as the Apennines, the Central System and Pyrenees of Spain, the pre-Alps of France, and Sardinia.
Figure 4.7. Proportion of arable land within municipalities

Proportion of arable land within municipalities

in percent

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 20</td>
<td>Light yellow</td>
</tr>
<tr>
<td>21 - 40</td>
<td>Yellow</td>
</tr>
<tr>
<td>41 - 60</td>
<td>Orange</td>
</tr>
<tr>
<td>61 - 80</td>
<td>Dark orange</td>
</tr>
<tr>
<td>81 - 100</td>
<td>Red</td>
</tr>
</tbody>
</table>

Data not available: Grey
Study area: Light grey
Other countries: Light grey

Source: PEEROM

Administrative borders: EuroGeographics, EUROMED, Office, Nordic Statistical Office, Eurostat, OOSD.
Figure 4.8. Proportion of arable land in mountain municipalities

Proportion of arable land in mountain municipalities

in percent

- 0 - 20
- 21 - 40
- 41 - 60
- 61 - 80
- 81 - 100

Source: PELCOM

Data not available
Study area
Other countries
Figure 4.9. Proportion of permanent crops in mountain municipalities

Proportion of permanent crops in mountain municipalities

in percent

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

Data not available
Study area
Other countries

Source: PELXCM
Figure 4.10. Proportion of grassland in mountain municipalities

Proportion of grassland in mountain municipalities

in percent

- 0 - 20
- 21 - 40
- 41 - 60
- 61 - 80
- 81 - 100
- Data not available
- Study area
- Other countries

Source: FELOOM
4.4 Forest land

Contrasting with the distribution of arable land shown in Figure 4.7, Figure 4.11 shows the importance of Europe’s mountains in terms of forests; although there are also large forested lowland areas, especially in the Baltic states, France, Finland, Germany, Norway, Poland and Sweden. The relatively easier terrain of these areas, which means that the costs of forestry infrastructure, harvesting, and transport to markets are significantly lower than in mountain areas, is a major reason why forestry in mountain areas is often not very profitable, if at all. Typically, mountain forests have a far high societal value for the protection of watersheds and against natural hazards; and for tourism and recreation, including hunting.

Figure 4.12 shows the importance of forests in terms of the land cover in many massifs. Forests cover over 80 percent of the Jura and Vosges (France) and the Dinaric mountains (Slovenia). In the Pyrenees and Cantabrian mountains, the mountains of Germany, the eastern Alps, the Apennines, much of the Carpathians and Bulgarian Balkans, and the Bothnian Arc (Finland), they cover between 61 and 80 percent. Only in very few mountains, such as those of western Norway, northern England, western Ireland, Greece and Sicily, does the average cover drop below 20 percent.

4.5 Summary of land covers

The predominant land cover in mountain municipalities across the study area is shown in Figure 4.13, while Figure 4.14 summarises the relative proportions of land cover in each massif. The dominance of forest cover in most massifs – except for those of Sicily, southern Greece, Ireland and the UK – can be seen. In northern Europe, grassland is proportionately more important, as is barren land and permanent ice and snow in the mountains of Scandinavia. An important component of the ‘other’ land covers in the Highlands of Scotland and other parts of the British Isles is moorland, typical of this oceanic climate, and shown as ‘scrubland’ in Figure 4.13. ‘Scrubland’ is also important in Greece and the Iberian peninsula, but here it is of a Mediterranean type. In central and southern Europe, arable land is of far greater importance than grassland, which is rather limited in extent except for the Massif Central, Crete, the Carpathians, and the Apennines. This great diversity of land covers reflects both natural settings and centuries, if not millennia, of human use of the cultural landscapes which occupy most of the mountains of Europe.
Figure 4.11. Proportion of forests within municipalities
Figure 4.12. Proportion of forests within massifs

Proportion of forests within massifs

in percent

<table>
<thead>
<tr>
<th>Percentage Range</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 20</td>
<td>Dark gray</td>
</tr>
<tr>
<td>21 - 40</td>
<td>Gray</td>
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<tr>
<td>41 - 60</td>
<td>Medium gray</td>
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<tr>
<td>61 - 80</td>
<td>Light gray</td>
</tr>
<tr>
<td>81 - 100</td>
<td>Green</td>
</tr>
</tbody>
</table>

Data not available
Study area
Other countries

Source: PELOOM
Figure 4.13. Predominant land cover in mountain municipalities
Figure 4.14. Proportion of land covers in massifs

Proportion of land covers in massifs

in percent

- Forest area
- Arable land
- Grassland
- Permanent ice and snow area
- Other areas

Data not available
Massif area
Study area
Other countries

Source: PELCOM