

## What is a mountain? - Background Paper to definition of mountains and mountain regions

### **Introduction**

Is there a globally accepted definition of a mountain? The answer, currently, is no. Numerous definitions of what constitutes a mountain have been proposed. Mountains are very diverse landforms and there appears to be little consistency in definition, description and analysis. The definition of a single mountain might also differ from that of a mountainous area or region. A mountain region is usually more than the sum of individual mountains. Thus, the geographical scale is probably an important part of the definition of a mountain region. Many of these issues have been discussed by Veyret and Veyret (1962), Gerrard (1990) and Bandyopadhyay (1992).

The criteria most often used in defining mountains are elevation, volume or size, relative relief, steepness, ruggedness or density of dissection, as well as spacing and continuity. The *Oxford English Dictionary* defines a mountain as ‘a natural elevation of the earth surface rising more or less abruptly from the surrounding level and attaining an elevation which, relative to adjacent elevation, is impressive or notable’. In *Webster’s Dictionary* a mountain is ‘any part of a land mass which projects conspicuously above its surroundings.’ Such definitions convey an image of what a mountain is but are of little use in demarcating mountain areas from non-mountain areas. Peattie (1936), even more subjectively, suggests that mountains should be impressive, possess individuality and should enter into the imagination of the people who live near them. In fact, in a recent paper, Debarbieux (1992) argues that most definitions, however scientific, arise from *a posteriori* reasoning and rely heavily on intuition in the first instance.

As mountains enter more into the political agenda, definitions have been produced to suit particular purposes. In Italy, *communita montane* are defined as areas above 600m (Rommano, 1995). In the 1975 European Community Less Favoured Areas scheme, a mountain has been defined as an area above 600m with slopes over 15%. Also, Thorsell and Harrison (1992) and Thorsell (1997) have summarised the characteristics that have been adopted to form the basis for including or excluding mountains in categories for conservation. To be designated mountainous, a landscape must have relative relief higher than 1500m and cover an area larger than 10,000 km<sup>2</sup>. This definition excludes many European mountain areas, including the Pyrenees.

Some of the issues and inconsistencies raised by these definitions have been discussed by Strahler (1946). Most early writers used the term to emphasise the rugged nature of mountain terrain. According to Preston James (1935) a mountain should possess sufficient relief to produce a marked vertical zonation of vegetation and Finch and Trewartha (1936) saw mountains as being characterised by steep slopes, small summit areas and strong relief. These definitions are still essentially subjective and it is necessary to try to define what is meant by high elevation, steep slopes and relief. It is also clear that a single criteria is not sufficient to define a mountain. Mountains need to be defined by a combination of these characteristics.

Elevation is clearly an important characteristic. In their recent book, Messerli and Ives (1997) include a map showing that 48% of the Earth's surface lies above 500m, 11% exceeds 2,000m and 2% lies above 4,000m. But, altitude alone is not sufficient to define mountains. The high plateaus of Bolivia and Peru and the high interior Tibetan Plateau are not mountains or mountainous terrain. The Colorado Plateau of the southwestern United States of America and the East African Plateau are other examples. Mountains rise above these plateaus but the plateaus themselves could not

be defined as mountain areas even though those in Bolivia and Peru occur within the Andes Mountain Range. Thus, it is generally agreed that any definition should include relative relief and perhaps also slope steepness and land volume. Some have argued that an isolated mountain or inselberg (island mountain) might not be a mountain but a hill (e.g. Waldbaur, 1952; Rutkis, 1971). The question arises as to what value of relative relief to use. This needs careful consideration as too high a value may exclude some areas that most people would consider as mountains. As Price (1981) has noted, using a relative value of 900m would include the European Alps, Pyrenees, Caucasus, Himalayas, Andes, Rockies, Cascades and the Sierra Nevada but not the Appalachians or the old, degraded mountains of Scandinavia and the British Isles.

Relative relief itself, as a criteria, has to be qualified by the horizontal distance over which it is measured. The horizontal distances between ridges and valleys are just as important to the definition of mountains as are the vertical distributions that establish the relief. These ideas prompted Price (1981, p. 5) to define a mountain as 'an elevated landform of high local relief e.g. 300m with much of its surface in steep slopes, usually displaying distinct variations in climate and associated biological phenomena from its base to its summit'. This figure of 300m seems on the low side and most scientists working in mountain areas would argue that relative relief should be larger than this. A figure of 700m has been widely suggested (e.g. Derrau, 1968; Temple, 1972; Brunnsden and Allison, 1986).

More confusion is created by attempts to distinguish high mountains (the German *Hochgebirge*), with altitudes over 1500m and relative relief over 1000m from lower and intermediate mountains (*Mittelgebirge*). The only areas in western Europe with relative reliefs greater than 1500m are the Alps and the central Pyrenees. Areas such

as the Scandinavian and Carpathian Mountains would be excluded. Hammond (1954, 1964) separated high and low mountains in North and South America also on the basis of relative relief. High mountains possessed a local relief of 3000 feet whereas low mountains were defined as possessing a local relief of 1000-3000 feet. Low mountains included the Appalachian Mountains, the Guyana Highlands and coastal mountains of Brazil. Except for very specific purposes, there seems little reason for distinguishing high from low mountains.

As mountains exhibit vertical zonation of processes, climate and vegetation and the upper parts of high mountains possess a distinctive suite of features, a geoecological approach to defining mountains has been suggested. Thus high mountains should rise above the Pleistocene snow line, should extend above the regional timber line and should display processes characterised by ice and snow (Troll, 1973b; Hollermann, 1973a). This has often been called the 'Alpine' zone, but it is a term and a concept that has been criticised (e.g. Love, 1970; Ives and Barry, 1974; Barsch and Caine, 1984; Ives, 1985, 1987). The major problem with this definition is that it varies with latitude as the lower limit for snow and ice processes is 4000m in the southern Rocky Mountains and European Alps and 700m in Alaska, Iceland, northern Scandinavia and Iceland. Using the height of the timberline suffers from the same problems. The upper timberline on mountains in arid areas is different to the timberline in other climatic environments. The highest elevation at which trees grow anywhere in the world is 30<sup>0</sup>N and 30<sup>0</sup>S in the arid zones of the Andes and the Himalayas and not in the humid tropics as might be expected (Troll, 1973a). Thus, although it appears that it may be possible to define mountains in particular areas on the basis of ecology, it is not possible to produce an ecological definition that will be consistent in all areas of the world. There seems to be no other solution than to define

mountains on the basis of some combination of elevation, relative relief and horizontal scale.

### **Criteria**

On the basis of the previous discussion and practical experience of a wide variety of mountains in many countries and continents the mountain area percentages of specific countries were assessed using the following criteria:

- a general minimum altitude of 1000m was required although small proportions of defined mountain areas could be below this minimum value to take account of very deep incision by rivers.
- One of the characteristics of mountain areas are deeply cut river valleys. Thus, large valleys have been included in the definition of a mountain area where they are clearly part of that mountain area. Large rivers that clearly separate two distinct mountain areas were excluded and the two areas treated as separate mountain areas. For the same reason, large intermontane basins have been excluded from the definition; the mountain ranges surrounding the basins have been measured separately.
- A minimum relative relief of 500m was required to differentiate mountain areas from high, level plateaus.
- The emphasis was on the definition of mountain areas rather than individual mountains. Thus, single isolated volcanic peaks were excluded from the definition unless they covered a minimum area of 100 km<sup>2</sup> and/or were intensely dissected to produce mountain landscapes rather than individual peaks. In reality, there were very few instances of such isolated peaks.

These three criteria of elevation, relative relief and area enabled the mountain areas to be identified.

### **Methodology**

A consistent methodology was required that could be applied to all countries. It was necessary to obtain the information from topographic maps as there was no reliable and consistent data base available. A map scale was required that could be used with large and small countries alike. It was thought that a 1:1 million scale was the most appropriate and was the scale adopted in this analysis. The mountain areas of each country were defined from 1:1M maps using the criteria outlined above. The areas were obtained by grid sampling at a scale of 5km. To overcome the problem of the orientation of the grid corresponding to lineations in the topography the grid was rotated three times and the average value obtained. The total area of the countries was obtained in the same way and the proportions covered by mountains calculated. It is believed that this methodology provides a consistent indication of the proportion of a country that is mountainous according to the criteria defined earlier.

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References

- Bandyopadhyay, J. 1992 On the perceptions of mountain characteristics, *World Mountain Network Newsletter*, 7, 5-7.
- Barsch, D. and Caine, N. 1984 The nature of mountain geomorphology, *Mountain Research and Development*, 4, 287-298.
- Brunsdon, D. and Allison, R.J. 1986 Mountains and highlands, in Fookes, P.G. and Vaughan, P.R. (eds.), *A Handbook of Engineering Geomorphology*, Surrey University Press, Guildford, 150-165.
- Debarbieux, B. 1993 Du haut en général et du Mont Blanc en particulier, *L'Espace Géographie*, 1, 5-13.
- Derrau, M. 1968 Mountains, in Fairbridge, R.W. (ed.), *The Encyclopedia of Geomorphology*, Reinhold, New York, 737-739.
- Finch, V.C. and Trewartha, G.T. 1936 *Elements of Geography*, McGraw-Hill, New York.
- Gerrard, A.J. 1990 *Mountain Environments*, Belhaven, London and MIT, Boston.
- Hammond, E.H. 1954 Small-scale continental landform maps, *Annals of the Association of American Geographers*, 44, 33-42.
- Hammond, E.H. 1964 Classes of land-surface form in the forty eight states, USA, *Annals of the Association of American Geographers*, 54, Map supp. 4.
- Hollermann, P. 1973 Some reflections on the nature of high mountains with special reference to the western United States, *Arctic and Alpine Research*, 5, 149-160.
- Ives, J.D. 1985 Mountain environments, *Progress in Physical Geography*, 9, 425-433.
- Ives, J.D. 1987 The mountain lands, in Clark, M.J., Gregory, K.J. and Gurnell, A.M. (eds.), *Horizons in Physical Geography*, Macmillan, London, 232-249.
- Ives, J.D. and Barry, R.G. (eds.) 1974 *Arctic and Alpine Environments*, Methuen, London.

- Love, D. 1970 Subarctic and subalpine: where and what? *Arctic and Alpine Research*, 2, 63-73.
- Messerli, B. and Ives J.D (eds.) 1997 *Mountains of the World: A Global Priority*, London, Parthenon.
- Peattie, R. 1936 *Mountain Geography*, Harvard University Press, Cambridge, MA.
- Preston James 1935 *An Outline of Geography*, Ginn and Co., Boston.
- Price, L.W. 1981 *Mountains and Man*, University of California Press, Berkeley.
- Rommano, B. 1995 National Parks policy and mountain depopulation: A case study in the Abruzzo region of the Central Apennines, *Mountain Research and Development*, 15, 121-132.
- Rutkis, J. 1971 *Tables on Relative Relief in Middle and Western Europe*, Uppsala University Naturgeografisk Institut, report no. 9.
- Strahler, A.N. 1946 Geomorphic terminology and classification of land masses, *Journal of Geology*, 54, 32-42.
- Temple, P.H. 1972 Mountains, in Brunnsden, B. and Doornkamp, J. (eds.), *The Unquiet Landscape*, David and Charles, Newton Abbot, 15-20.
- Thorsell, J.W. 1997 Protection of nature in mountains, in Messerli, B. and Ives, J.D. (eds.), *Mountains of the World: A Global Priority*, London, parthenon, 237-248.
- Thorsell, J.W. and Harrison, J. 1992 National Parks and nature reserves in mountain environments and development, *GeoJournal*, 27, 113-126.
- Troll, C. 1973a The upper timberlines in different climatic zones, *Arctic and Alpine Research*, 5, 3-18.
- Troll, C. 1973b High mountain belts between the polar caps and the equator: their definition and lower limit, *Arctic and Alpine Research*, 5, 19-28.
- Veyret, P. and Veyret, G. 1962 Essai de definition de la montagne, *Revue de*



*Géographie Alpine*, 50, 5-35.

Waldbaur, H. 1952 Die Reliefenergie in der morphographischen Karte, *Petermanns Geographische Mitteilungen*, 96, 156-167.