

Mountain geography: a review

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Introduction

Geographers have long had a fascination with mountains, from earlier exploratory accounts to contemporary geomorphological and geophysical research, using the latest scientific techniques. Many early physical geography books contained significant chapters on mountains (Lake 1915; Holmes 1965; Miller 1953). For human geographers, Peattie's *Mountain geography* of 1936 establishes some of the basic concepts of the human geography of mountains. Interestingly, in the subsequent half century there have been relatively few systematic texts in English. Most material on mountains has been subsumed in more general regional studies (e.g. Veit 2002; Ehlers and Kreuzmann 2000; Stevens 1993) or thematic volumes, both broad (Messerli and Ives 1997; Price and Butt 2000) and more specific (e.g. Barry 1992; Körner and Spehn 2002; Whiteman 2000; Wielgolaski 1997; and others cited below). The textbooks by Price (1981) and Gerrard (1990) have been important volumes of synthesis, although with a distinct environmental bias. More recently, Funnell and Parish (2001) and Parish (2002) attempted to bring together the diverse range of material that now plays a crucial role in current mountain research. Interestingly, these volumes stimulated criticism partly because of a somewhat esoteric interpretation of the political economy now surrounding debates on mountains (Ives 2002). However, this does not mean to say there has been limited interest in mountains, as is plainly indicated in the account of research between 1973 and 1989 reported by Ives and Messerli (1990) and discussed in more detail below.

The significance of mountain research within the broader canon of geographical work is sometimes hidden both by the problems of definition and by the different traditions of physical and human geography. In many cases, physical geographers directly acknowledge their work as being set in a mountain context. In contrast, many studies in

human geography, especially of agricultural change or demography, barely comment on their location within a mountain area. Equally some writers adhere to a strict, usually attitudinally based definition of mountains, but Peattie's work presages the current attempts to embrace a more inclusive understanding when he writes:

to a large extent then, a mountain is a mountain because of the part it plays in popular imagination. It may be hardly more than a hill but if it has distinct individuality, or plays a more or less symbolic role to the people, it is likely to be rated a mountain by those who live at its base

Peattie 1936, 4

In addition, Messerli and Ives also resist the temptation to be prescriptive about defining mountains when they state:

the world's mountains do not lend themselves to unifying definition and classification that goes beyond the simple combination of 'steepness of slope' and 'altitude' . . . The search for a unitary definition of 'mountain' is to chase a chimera. It follows that several definitions, which are region-specific, are needed

Messerli and Ives 1997, 8

However, the circumstances in which mountain research occurs have changed dramatically in the last decade or so. Since the Rio 'Earth Summit' in 1992, mountains have become much more politically and scientifically significant in their own right. From being a small, highly localized focus of research, with the advent of the Mountain Agenda and the inclusion of a specific chapter (Chapter 13) in *Agenda 21* (Stone 2002), mountains now have a global role in the debates on environment and development. Linked to this trend has been the publication of substantial works explicitly linked to Chapter 13 and the International Year of Mountains, 2002, all edited by, and with many contributions from, geographers (Messerli and Ives

1997; Price and Butt 2000; Stone 1992). This has meant that it is increasingly difficult to separate attempts to advance our understanding of mountain areas and the processes at work within them from purely managerial type plans and programmes. One way forward is to provide a brief historical analysis of mountain research and then examine how this has progressed in the last decade, both in its own terms and through links with policy agendas.

Long-term themes in mountain research

It is well known that much of the early work on mountains stems from the research of Alexander von Humboldt in the nineteenth century. Of course, geologists and others were already developing theories about mountain formation, both through ideas about structure and later through studies of glaciation. However, it was von Humboldt's work that began to link the elevation of mountains to other phenomena, in particular climate and vegetation. Later, Carl Troll developed this into the highly influential school of Geocology which, much more recently, has introduced the rather ugly term 'verticality' (Troll 1972; Forman 1988). German geographers distinguished between 'Hochgebirge' and 'Mittelgebirge', the former meaning high mountains – largely an arena in which only physical processes operated; the latter where the human modification of the landscape became relevant. Models of mountain environments were predominantly based upon the 'Alpine' concept, with the physical characteristics of this area becoming a standard point of reference for mountain ranges around the world.

In 1968, Troll established the IGU Commission on High Altitude Geocology that led to the influential UNESCO Man and Biosphere research programme (MAB 6) in the 1970s and beyond. Ives and Messerli (1990) and Price (1995) describe the MAB 6 research projects, which focussed on the relationship between socio-economic activities and the natural environment. In particular, the first studies in the Austrian Alps looked at the impacts of tourism, and whilst the modelling structures remained relatively simplistic, the research employed 'participatory techniques' long before this became the *sine qua non* of much socio-economic investigation. Later studies in the Swiss Alps introduced more sophisticated modelling, including GIS, particularly at Grindelwald and Davos. The Grindelwald study, some results of which are available on a website (<http://www.cde.unibe.ch/griwa/>) is currently being revisited. The ideas embodied in these studies were also explored in other parts of the world, such as China and Kenya, with mixed success. In Kenya, the economic behav-

our of households has been hard to assimilate in the models used (Wiesmann 1992) despite the fact that pluri-activity is commonplace in many Alpine locations.

The research under the MAB programme developed both a cognitive model of the relation between mountain populations and their environment and also policy prescriptions for those authorities charged with the well-being and development of those areas. This became particularly apparent with the publication in 1989 of Ives and Messerli's book *The Himalayan dilemma: reconciling development and conservation*, where they critically evaluated what was called a Theory of Himalayan Environmental Degradation. This placed mountain issues at the forefront of regional and global development policy discussions, focussing particularly on the claims for excessive loss of forest cover and reduction in water resources in mountain areas. In turn, the debates about degradation in the Himalayas fed into the Mountain Agenda initiative, leading to the development of Chapter 13 of *Agenda 21*.

One of the key challenges of mountain research concerns its interdisciplinarity. This has been magnified in recent years by the increase in 'problem focussed' research that is not defined by the needs of existing disciplinary interests. The issue is demonstrated by the changing emphasis of work published in the journal *Mountain Research and Development* (MRD). When introduced in 1981, it provided the first English language journal with a specific mountain focus (the French *Revue de Géographie Alpine* is, of course, much older, having been founded in 1913). Since its inception in 1981, MRD has been a key influence on the direction of mountain research. During much of the 1980s and early 1990s, MRD included substantial papers addressing typical geographical problems such as glaciation, climate change and settlement patterns. Since that time, however, an increasing number of contributions have been focussed on specific policy issues and associated with 'development' and, in 2000, MRD introduced a specific 'development' section. In turn, this has emphasized the 'transdisciplinarity' of mountain issues.

Llambi (2001) suggests that, faced with the diversity of geographical localities and also cultural influences, mountain research cannot be pigeon-holed into simple categories or methodologies and must embrace a wide range of approaches. Therefore, one way of summarizing the last decade in mountain research would be to suggest that, whilst traditional academic studies continued, a much higher level of policy-focussed research (often funded by agencies) has taken place. Chapter 13 of

Agenda 21 called both for acceleration in research into the fundamental science of mountain environments and for an expanded programme of investigation into the livelihoods and development options of mountain communities. However, this interpretation is too simple. A detailed examination of the various bibliographic sources on mountain research suggests that, whilst there has been some degree of refocused attention, much work continues in the older tradition but relabelled to fit in with the new 'priorities'. In part this relates to the fact that the very notion of transdisciplinarity is not something that is well understood. Balsinger (2000), examining the work of the Autrans Conference on Mountain Research, noted a continuing tension between development agency appeals to a largely non-existent interdisciplinary (supra disciplinary) framework and the practice of much research that still remains effectively designed by reference to the approaches of particular disciplines. Geography remains an important contributor precisely because it embraces a broad spectrum of relevant subject matter; and this has been recognized, *inter alia*, by the establishment of specific mountain geography groups within both the RGS-IBG and the Association of American Geographers in the late 1990s.

Research output: 1990–2002

Without doubt mountain research, measured by the number of publications of all types, is still dominated by the natural science community. An examination of the bibliographic database GEOBASE for the years 1990–2002 using a very general keyword 'mountains' revealed 9912 'hits'. In most years, the percentage of 'human geography' did not exceed 15% and was heavily dependent upon the work published in MRD and the *Revue de Géographie Alpine*. For a more comprehensive analysis of the input of social sciences, other databases need examination – particularly those available for anthropological writing. While many of the 'keywords' used for papers resulting from these studies omit any reference to mountains, further investigation shows that, indeed, they were undertaken in mountain locations. Nonetheless, although a little crude, the bibliographic search does highlight clearly the balance of work within geography.

Physical geography

Geological studies, geomorphological (especially erosion and weathering), climatological (climate change), hydrological and biogeographical research comprise a substantial proportion of the literature

published in the last decade. The perspective followed in these studies varies markedly, with some remaining very 'scientific' and others examining the physical environment through the perspectives of hazards or risks.

Climate change In line with the concerns expressed at Rio, perhaps the most important work relating to mountains has concerned climate change. Mountain environments are not only very sensitive to this; its recorded and potential impacts on vegetation and hydrology with consequent downstream effects are well recognized. In addition to the specific chapter on mountain regions in the second report of the Inter-governmental Panel on Climate Change (IPCC 1996), work by Beniston (1994 2000), and Beniston and Bradley (1997) in a special issue of *Climate Change* provide overviews of the debates on the impact of a dynamic climate on mountain regions. Price and Barry (1997) review the implications of some of these processes for managing mountain environments. Shifts in the tree line and associated species composition, the impact of changes in the extent of glaciers, the problems faced by cloud forests and the technical issues associated with downscaling of general circulation models (GCMs) continue to dominate a research agenda which is then linked to the debates on biodiversity, water supply, hazards, and denudation. A number of projects have been developed to gather the data at high altitude which are critical for the fine-scale tuning of the global models. At the same time, the reconstruction of past environments using historical data has enhanced our understanding of the dynamics of climate change. Examples of this include the work of Lamb *et al.* (1991) in the Atlas Mountains, in African mountains (Messerli and Winiger 1992) and in the Andes (Kull and Grosjean 1998; Nunez *et al.* 2002). In contrast, relatively few studies have tried to link the notion of climate change with the mental constructs of farmers. A study by Vedwan and Rhoades (2001) in the Indian Himalayas suggests that few mountain farmers actually perceive climate change to be a significant factor in the long-term process of altering crop calendars.

Hydrology and geomorphology Geographers have been heavily involved in the extensive work on mountain hydrology, which itself has generated the use of the powerfully symbolic term of 'watertowers' in the current lexicon of the mountain debate (e.g. Mountain Agenda 1998). Such work is closely linked to the large numbers of studies of catchment erosion and mass wasting, for example that of Gerrard and Gardner (2000) in Nepal and hazards (Kreutzmann 1994; Hewitt 1997). Moreover, any

study of water explicitly involves the close linkages between the highlands and lowlands. Current research includes a very broad agenda from the detailed study of specific catchments (Anderton *et al.* 2002; Hooper 2001) to large-scale runoff studies and discussions of cooperative management (Grosjean *et al.* 1995). Important work on linkages between runoff regimes and conservation plays a significant role in discussions of mountain conservation (Johnson and Thompson 2002).

GIS and remote sensing The last decade has also seen considerable developments in the use of GIS and remote sensing in mountain areas. The techniques have been used in many research areas, some of which are discussed in Price and Heywood (1994). Work on water catchment analysis (Aspinall and Pearson 2001), estimating forest cover in the hotly contested arena of the Himalayan deforestation debate (Schreier 1994), and the planning of new community developments (Millette *et al.* 1995) has to be considered against the background of a global programme of improvement in terrain data. The recently developed global mountain map (Kapos *et al.* 2000) now serves as the point of reference for new research at the regional scale and is currently being used for a study of the mountains of the European Union (EU) and the candidate countries within the context of defining future regional policy within the expanded EU. However, local studies need more appropriately developed geo-spatial data.

While GIS is applicable to many management problems, there is an increasing awareness of the limitation of conventional techniques in mountainous terrain. The inaccuracies introduced by slope are well documented, but it is quite another matter to apply a uniformly appropriate correction algorithm precisely because the terrain conditions in mountains are so heterogeneous. Displacement of buffer limits, for example, can result in highly inaccurate estimates of forest cover which, as noted earlier, has become a contentious issue in the mountain debate. Dealing with complex topographies, in which the generalization algorithms may produce misleading results, is one of the principal demands in the work on virtual GIS, where imagery draped over terrain is increasingly providing a major input to the use of GIS for problem solving. In turn, this raises questions over data standards and availability, and as might be expected many mountain regions have, as yet, limited high-resolution cover. The recent Shuttle Topographic Mapping Mission of much of the globe will be a step forward, but there remains some uncertainty about the public availability of the high-resolution data. GIS research is therefore a major contributor to our knowledge of mountains

(Kimoto *et al.* 2002; Riddle and Duguay 1998; Gratton *et al.* 1993).

Human geography

Whilst research in purely physical science has been prominent in mountains, the contribution of human geography and other social sciences has been very diffuse, varying in emphasis from place to place. In all mountain regions, work on the relations between environment and society has been important, although increasingly moving away from the Troll mode noted above and also, with few exceptions, not expanding the MAB modelling approach. Many of the more traditional themes in mountain research are now being re-addressed through the framework of sustainability and especially sustainable livelihoods (Berkes *et al.* 2000; Sinclair and Ham 2000). Extensive research in all areas seeks to explore whether existing systems of water, forest, land or tourist management meets the criteria of sustainability. In the Andes and the Himalayas, studies now focus on the implications of deforestation but increasingly emphasize the heterogeneity of the situation and the degree to which various stakeholders play conflicting or complementary roles (Dubois 2000; Scherr and Templeton 2000).

Ecotourism and sustainable development Tourism, and ecotourism in particular, has been a major focus of research in the Alps, the Himalayas and many other ranges, because of the alleged benefits to rural areas (special edition of MRD 2002, vol. 22 no. 2; Price *et al.* 1997; Godde *et al.* 1999). Price *et al.* (1997) illustrate the range of stakeholders involved with tourist activity and the challenge of resolving conflicts between conservation and economic development. In mountain regions, one special attraction of ecotourism lies in the combination of nature and culture which, in turn, poses unresolved clashes of values. Many studies attempt to appraise the success or failure of projects to develop tourism (Bellaoui 1996; Sharma 1998; Leung and Marion 1999; Baron *et al.* 2000; Carroll *et al.* 2001), but an adequate evaluative framework embracing the often widely differing value systems of those involved remains elusive.

More generally, claims for sustainable development in mountains often reduce to no more than checklists or more general accounts of supposed linkages between the natural and social realms (Jodha 1997; Gurung 1992; Price and Kim 1999). The problem is that the sustainability argument itself is full of difficulties and cannot escape the longstanding issue of the relations between man and nature (Forsyth 1998). With few exceptions, for

example the work of Durand (1997), which attempts to extend a functional model of sustainability to some Alpine locations, most studies of sustainability in mountains remain theoretically very limited.

The plethora of studies responding to agency demands (and funding) has certainly put mountain research 'on the map' but it has drawbacks. At the present time, the demand for policy-orientated research is outstripping the capability of our conceptual equipment to provide adequate solutions. One of the interesting outcomes of the Conference at Autrans (2000) was the Latin American questioning of the 'western' universalism embedded in much of this research for sustainability. This appears in a number of guises, one of the most obvious being the drive for 'indicators' which, in the field of social science, have very little meaning outside of a very specific context. Much of the work on sustainability remains dangerously close to the 'carrying capacity' concept long ago discredited but recently revived under the notion of 'ecological footprint' (Cole and Sinclair 2002). This is an appealing idea for mountain research but has yet to be subject to a full-scale critique (Levett 1998; Rees 1996).

Culture and governance Whilst the bulk of social science contributions to mountain research have increasingly fulfilled the demand to be 'problem orientated', there are some important (and often overlooked) studies designed to capture a different perspective on mountain communities. From the viewpoint of late twentieth century geography, these have arisen through work in what may be loosely called Cultural Geography, and often suggest a strongly critical analysis of contemporary social science. For example, the work of Bozonnet (1992) and Debarbieux (1993 2001) which, in turn, has links with earlier discussions of Tobias (1986), explores the problems posed by the concept of mountain in different cultural settings, and emphasizes the fact that much of the scientific knowledge gathered in mountain research is far from the clear cut 'reality' it seeks to portray. In many cases, it is a 'construction' that provides agencies and decision-makers with a misleadingly simplified framework for policy analysis. The production and communication of scientific knowledge on mountains is itself now an area of debate (Barkin and Dominy 2000; Thompson *et al.* 1986). This latter study *Uncertainty on a Himalyan scale* has had important repercussions on both policy and research agenda well beyond the confines of mountain studies.

In the last decade, there has been a notable increase in research which examines the politics of mountains at all scales. The debates surrounding the creation of the state of Uttarakhand formed the basis for much of the work of Mawdsley (1997

1999), whilst Linder (1994) provides an interesting interpretation of the position of the mountain cantons in the Swiss federation. More generally, mountains have, throughout history, provided refuges for politically marginalized groups and are often the springboard for 'revolutionary' political activity. In Mexico, the EZLN/Zapatista movement in Chiapas has built its political constituency from a highland stronghold (Harvey 1995). The Panos Institute has recently brought 'participation' to the public eye by highlighting the results of a survey of many mountain communities using personal testimonies of mountain life (Panos 2002).

All this suggests that mountains are geographically complex, with considerable diversity contingent upon the nature of the terrain that, in turn, has a direct bearing on the efficacy of governance in which mountain communities operate. Price and Thompson (1997) and Funnell and Parish (1999) argue that these issues may be recast within the framework of 'complexity', which attempts to move away from more rigidly defined concepts and has important implications for management. Many geographers are claiming that the most appropriate management framework should be the catchment unit which Bellaoui (1996) argues traditionally characterized the High Atlas and allowed a hierarchy of administrative divisions which built upon the interactions between the mountains and lowlands. On a wider scale, the Alpine Convention has opened up new ways of tackling cross-national issues (Price 1999), and various initiatives are developing to learn from this experience and transfer it to other mountain ranges around the world (Angelini *et al.* 2002). More generally there is now a recognition that the way in which mountains are governed and the nature of legal provision for these areas requires more research (Villeneuve *et al.* 2002).

Mountain geography and the global agenda

Geographical research in mountains during the last decade has continued to provide new knowledge and insight into both environmental and social processes, but is now becoming increasingly directed towards a policy agenda. This becomes increasingly evident if we examine the proceedings of the Global Mountain Summit held in Bishkek, Kyrgyzstan near the end of the International Year of Mountains, 2002. This conference endorsed the policy of the World Summit on Sustainable Development at Johannesburg which argued for 'partnerships' in research and policy agendas, and widened the brief under which such partnerships should operate to include a greater social and political agenda. A distinctive feature of this conference was that the draft versions of background papers

describing our understanding of key mountain issues were circulated for discussion on the World Wide Web. It is interesting to compare the main themes of these papers with the position papers used at the 1992 Earth Summit. At Rio, where the mountain initiatives first became part of global policy, while general issues of poverty were noted, the main thrust of discussion centred around the significance of mountain environments for global sustainability. This emphasized physical processes and their management, particularly with reference to denudation processes and climate change. The subsequent decade has seen the increasing prominence of a myriad of connected social and political questions. In particular, poverty, livelihoods, and governance are seen to be equally as important as the environmental framework of mountain landscapes, especially as mountain zones are often centres of political conflict. Interestingly, as the analysis of research output above suggests, the wider socio-economic agenda remains an important future area of investigation in the mountain context.

Over the last 25 years mountain research has moved dramatically from being the pursuit of a few dedicated physical and social scientists to a process involving global agencies. Whilst mainstream research would no doubt have continued as before, the significant 'leap forward' owes its success to a group of determined scholars, including Professors Bruno Messerli and Jack Ives, both geographers, and thence to others who were able to mobilize resources to promote what became Chapter 13 of *Agenda 21*. The influence of geography has been considerable.

The papers in this issue provide an insight into the state of research into mountain environments and communities at the beginning of the twenty-first century. They are drawn from high mountain regions on three continents and use a wide range of approaches from various areas of geography. Given the theme of this special issue, all the papers consider the interactions of people and their biophysical and institutional environments, but in rather different settings. Danby *et al.* consider the various phases of science, management and development in the glaciated and sparsely populated St Elias mountains of North America – a saga that reflects many of the historical trends discussed above. Almost at the other end of the American mountains, Tanner addresses the implications of recent economic and political change in the dry eastern Andes of Argentina. In contrast to this area, where urban–rural interactions, agro-industrialization, and the declaration of protected areas are key issues, the Pamirs considered by Kreuzmann are still largely inhabited by pastoralists who live far from the urban centres of the four countries

between which this region is shared. Marginalization is also a theme for Timsina, but in the forested middle hills of Nepal, one of many mountain areas around the world where community forestry has been (re)introduced. Further work based in Nepal by Olsen and Larsen shows how the livelihood of some forest users depends upon the exploitation of medicinal plants which enter a multimillion dollar trade flow to India and beyond. Fittingly, on the 50th anniversary of the first ascent of Mount Everest – also known locally as Chomolungma and Sagarmatha – Stevens examines the relationships between tourism and deforestation around the world's highest mountain. Collectively, these papers indicate that geographical research continues to confront many of the issues that face policymakers in mountain regions, and continues to offer an all important scientific and critical perspective on the conduct of the global mountain debate.

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