Pirineos.Revista de Ecología de Montaña
Vol. 167, 15-27
Jaca, Enero-Diciembre, 2012
ISSN: 0373-2568
eISSN: 1988-4281
doi: 10.3989/Pirineos.2012.167002

THE ORIGINS OF MOUNTAIN GEOECOLOGY[1]

El origen de la geoecología de las áreas de montaña

JACK D. IVES

Honorary Research Professor, Carleton University, Ottawa, Canada

ABSTRACT.– Mountain geoecology, as a sub-discipline of Geography, stems from the life and work of Carl Troll who, in turn, was inspired by the philosophy and mountain travels of Alexander von Humboldt. As founding chair of the IGU Commission on High-Altitude Geoecology (1968), Troll laid the foundations for inter-disciplinary and international mountain research. The paper traces the evolution of the Commission and its close links with the UNESCO Man and Biosphere Programme (1972-) and the United Nations University's mountain Project (1978-). This facilitated the formation of a major force for inclusion of a mountain chapter in AGENDA 21 during the 1992 Rio de Janeiro Herat Summit (UNCED) and the related designation by the United Nations of 2002 as the International Year of Mountains. In this way, mountain geoecology not only contributed to worldwide mountain research but also entered the political arena in the struggle for sustainable mountain development and the well-being of mountain people.

Keywords: Mountain Geoecology, Carl Troll, Internacional Mountain Society, mountain development.

RESUMEN.– La geoecología de montaña, como sub-disciplina de la Geografía, entronca con la vida y trabajo de Carl Troll, quien, a su vez, fue inspirado por la filosofía y viajes de Alexander von Humboldt. Como presidente fundador de la comisión de la UGI sobre High Altitude Geoecology (1968), Troll colocó las bases para la investigación interdisciplinar e internacional de las montañas. Este trabajo presenta la evolución de la Comisión y sus estrechas relaciones con el Programa Hombre y Biosfera de UNESCO (1972-) y con el Proyecto de montaña de la Universidad de Naciones Unidas (1978-). Esto facilitó la inclusión de un capítulo sobre la montaña en AGENDA 21 durante la Cumbre de la Tierra de Río de Janeiro (UNCED), y la

1 This paper is a modified version of the first part of an on-line UNESCO publication (Ives, J. D. and Messerli, B, 2003: EOLSS).

Recibido: 09, 15, 2011. Aceptado: 12, 19, 2011.

consiguiente designación de 2002 como el Año Internacional de las Montañas por parte de Naciones Unidas. En este sentido, la geoecología de montaña no sólo contribuyó a la investigación de las montañas del mundo sino que también empujó a la política en el esfuerzo por un desarrollo sostenible de la montaña y el bienestar de los habitantes de la montaña.

Palabras clave: Geoecología de montaña, Carl Troll, International Mountain Society, desarrollo de las áreas de montaña.

The term *mountain geoecology* and the early principles that helped to establish it as a sub-discipline of Geography are inevitably associated with the life and work of Carl Troll (1899-1975). However, in a broader context, Troll drew much of his inspiration from Alexander von Humboldt, the great German cosmographer and philosopher. This involved his own extensive travels in the Andes, following the steps of Humboldt in the 1930s and his adaptation of Humboldt's formalization of life zones and altitudinal climatic belts. Furthermore, in a 1972 paper he provides additional antecedence: to *ökologie*, that he attributes to Ernst Haeckel in 1866; to terms *landschaftsgeographie* (Passarge, 1913) and *landschaftskunde* (Passarge, 1921-1930); to Tansley's 1935 introduction and definition of *ecosystem*, together with his own *ökotop* [ecotope] (Troll, 1939); finally to *landschaftsökologie* and hence *geoecology* (Troll, 1966). Troll also acknowledges his debt to trends in Russian botanical research (Sukachev, 1944) and the concept of *biogeocoenology* that seeks to explore the succession of plant communities through a pioneer stage to a climatic climax. Thus Troll's *landschaftsökologie* broadens the Russian plant succession concept to embrace soil development and associated abiotic transformations on newly exposed substrates-those, for instance, exposed by the retreat of glaciers. This progression of thought is also related to the work of the American botanist F. E. Clements.[2] Troll (1972) makes the pointed statement: "Landschaftsökologie, Geoecology, and Biogeocoenology are completely synonymous."

With the exception of his famous monograph published in 1944, and translated by the United States Army Corps of Engineers, Snow, Ice and Permafrost Research Establishment, as *Structure Soils, Solifluction, and Frost Climates of the Earth* (1958), Troll's early publications had little immediate impact on mainstream English and American geographical thought. Rather, it was the 1966 Mexico symposium on the *Geoecology of the Mountainous Regions of the Tropical Americas*, supported by Unesco, that led to rapid development

2 Other early American 'Humboldtians' include J.N. Reynolds, Clarence King, the first director of the U.S. Geological Survey, and John Muir, founder of the Sierra Club (see Sachs, A. 2006: *The Humboldt Current*).

 (Pirineos, 2012, Vol. 167, 17-00, ISSN 0373-2568, eISSN: 1988-4281, doi: 10.3989/Pirineos.2012.167002)

of interest in mountain geoecology. Several of its practitioners continue to claim a direct link to Humboldt and in December, 1998, a plaque was mounted high on 'his mountain', Chimborazo, in the Ecuadorean Andes honouring him as the 'father of mountain geoecology'. While Troll, himself, deferred to Humboldt the latter, of course, was not familiar with the term in that it was coined more than a century later. It only came to be used effectively with the establishment of the International Geographical Union's Commission on High-Altitude Geoecology during the 1968 International Geographical Congress held in New Delhi.

It is not a coincidence that Troll's Presidency of the IGU (1960-1964), his recognition as a principal figure in the revitalization of post-World War II German Geography, and the 1968 publication of the proceedings of the 1966 Unesco Mexican symposium led to the IGU endorsing his request for creation of his own commission. This he chaired until 1972 when his activities were severely curtailed by ill health.

Troll's 1972 paper, in fact, was part of the proceedings of the first meeting of the new commission held in Mainz, Germany, in 1969 with the support of the Akademie der Wissenschaften und der Literatur, Mainz. Although Troll made significant contributions to the human geography of mountains (Andes-Monheim, 1985), he defined the objectives of the new commission strictly in terms of high-altitude natural science. Furthermore, he set the immediate specific task as the study of world-wide upper timberlines (one of his great personal passions) and the overall objective as 'comparative high-mountain geography' (that is, physical geography).

To set the stage he devoted considerable effort and provoked much discussion on the problem of creating a suitable definition for 'high mountains' (*Hochgebirge*). This discourse is best deferred to Troll's many publications and those of his colleagues and students. However, he clearly recognized the difficulty of finding a widely acceptable definition. Two quotations will suffice to illustrate the problem that has remained with us to this day (c.f. Ives et al., 1997). Referring to the example of a high volcano above 3,000 m in Java, Troll (1972) expostulates: "a high mountain without a high-mountain landscape". Again, in 1972: "All these attempts [to find a universal definition] are unsatisfactory for our holistic view".

The emergence of the IGU Commission on High-Altitude Geoecology coincided with the establishment of Unesco's Man and the Biosphere (MAB) Programme, itself influenced by the 1972 UN Stockholm Conference on the Human Environment and the International Biological Programme (IBP). Of the fourteen original MAB projects, Project 6 –study of the impact of human activities on mountain ecosystems– had a profound effect on the IGU commission and *vice versa*. Ives succeeded Troll as commission Chairman (1972-

1980) and, in his preface to the proceedings of the Calgary commission symposium, wrote:

> Thus we view the work of our commission, not only as a fascinating science and academic exercise, but as an opportunity to contribute to land management problems in high mountain regions ...as reflected in the newly established Unesco MAB-6.
>
> (Ives, 1973)

Ives also served as Chairman of the International Working Group for MAB-6 and, at the end of the IGU commission's initial eight-year term (1968-1976), proposed changing its name and focus. This was approved during the 1976 International Geographical Congress in Moscow, and so the transformation to 'Commission on Mountain Geoecology'. The objectives of the modied Commission were as follows:

> to extend "beyond our early concentration in the natural sciences to embrace the human sciences" [and to become involved] "in the applied aspects of mountain human sciences research as seems appropriate to the further protection and management of mountain environments in this era of serious overuse and misuse" ...[and to] "single out as a task of special concern, aspects of natural hazards research and their application to the solution of land-use planning problems in mountain regions".
>
> (Ives, 1978: 159)

The intent of the change in focus was two-fold: to extend the area of study from the lower limits of the *Hochgebirge* (upper timberline) down to the piedmont zone (i.e. to embrace the entire mountain range); and to include the study of the relationships between human and natural processes in mountain regions. This led to a degree of emphasis on natural hazards, and hazards both augmented by, or directly caused by, human activities, leading to use of the term 'mountain hazards'. In no way was this intended to detract from the growing number of physical geoecological studies, and these have continued to expand until the present. An outstanding example is Holtmeier's (2009) monograph on world timberlines that is in the direct tradition of Troll's original interests and university teaching.

The continued expansion of studies in mountain geoecology was tied institutionally to a number of international organizations, the timing of which was critical. The convergence of the IGU Commission and Unesco MAB-6 has already been emphasized. A third development was the establishment of the United Nations University's programme on the Use and Management of Natural Resources in the Humid and Sub-humid Tropics in 1977. It included four related components: (1) rural energy systems; (2) land-water interactive

 (Pirineos, 2012, Vol. 167, 15-27, ISSN 0373-2568, eISSN: 1988-4281, doi: 10.3989/Pirineos.2012.167002)

systems; (3) agro-forestry systems; and (4) highland -lowland interactive systems.[3]

The general concept of *highland-lowland interactive systems* developed during the early years of the UNU and has emerged as a valuable tool in the present-day struggle for sustainable mountain development. In 1977 Ives was invited to serve as project co-ordinator of (4). This led inevitably to the deliberate alignment of MAB-6, the IGU Commission, and the still to be defined *Highland-Lowland Interactive Systems* (Ives, 1980a). All four UNU projects were supervised by Professor Walther Manshard who had been appointed UNU Vice-Rector in 1976 and served for many years as Secretary-Treasurer of the IGU. Thus *mountain geoecology* had discovered a source of significant funding (US $ 100,000/yr for five years) and the need to move pragmatically as well as intellectually.

Two long-term collaborative applied research projects were initiated following reconnaissance missions to Papua-New Guinea, Northern Thailand, and the Indian and Nepalese Himalaya. The first, in association with Chiang Mai University, entailed a study of alternate cash crops to opium in Northern Thailand. The second was an attempt to apply the combined Swiss Alps (Kienholz, 1977) and Colorado Rocky Mountain (Ives et al., 1976; Ives and Bovis, 1978; Dow et al., 1981) hazards mapping experiences to land-use problems in the Nepalese Himalaya, in collaboration with the Nepal National Planning Commission and Tribhuvan University, Kathmandu. Professor Dr. Bruno Messerli joined the UNU project on Highland-Lowland Interactive Systems in 1979 as co-coordinator, and the universities of Colorado, Boulder, U.S.A. and Berne, Switzerland both became UNU affiliate institutions. Thus began a long association (Boulder-Berne/Berne-Davis, California) between Ives and Messerli that formed the basis for the further development of mountain geoecology.

The next step was also institutional. The early spate of research results of the fieldwork in Nepal and Northern Thailand, together with Unesco support for MAB-6 publication, prompted the formal incorporation (in the State of Colorado) of the *International Mountain Society* in 1980 and the founding of its quarterly journal *Mountain Research and Development* in 1981, co-published with UNU. The stated objective was: "To strive for a better balance between mountain environment, development of resources, and the well-being of mountain peoples". Thus, the applied and political implications were emphasized from the beginning.

3 A major problem of the time (1970s) was to find a source of reliable funding; thus, the deliberate linkage of the IGU commission with Unesco MAB-6 and UNU was opportune-in the best sense of the word.

Until 1980 and the founding of the International Mountain Society, there are few references to a broadened approach to Troll's emphasis on natural science in the high mountains. Ives had taken the first step in the introduction to his edited volume on *Geoecology of the Colorado Front Range* (1980b) where he posed the question: "What is Geoecology?". He gave a tentative explanation of objectives:

> Frequently, in the practice of ecology, the abiotic aspects have received only secondary attention. The term geoecology, as used here, therefore, is to underline the need to redress this imbalance; but it is intended to do more than that by including man and his activities.
>
> (Ives, 1980b: xxiii)

Yet he went on to admit that the volume in question was "virtually lacking the human element" and so claimed it as "a statement of good intentions for the future, because the very justification of continued research in the Front Range must rest equally on contribution to the solution of human problems as well as on the satisfaction of human curiosity [about mountains]." He linked this intent to the goals of Unesco MAB-6 and the IGU Commission on Mountain Geoecology.

The first major English-language text on mountain geography in 45 years (Larry W. Price, 1981: *Mountains and Man*) was published almost simultaneously. Despite Price's attempt to link with Unesco MAB-6, there is barely a reference to *mountain geoecology*, as such, and the book afforded scant space to human geography. This important book illustrates two closely related problems that were facing mountain geoecology at that time: there was little sign that the gap between the human sciences and the natural sciences in mountain research was being bridged, despite the Unesco MAB-6 plea (Unesco, 1974); and any early attempts to do so were based largely on efforts by physical, rather than human, geographers. Nevertheless, there have been two major schools of human mountain geography: the German school, exemplified by the work of such scholars as Uhlig (Uhlig, 1978, 1995), Grötzbach (1976), Grötzbach and Rinschede (1984); and the French school, emanating from l'Institut de Geographie Alpine and the work of Blanchard (1924), Veyret and Veyret (1962), and others. These works, however important in laying the firm foundations of classical mountain geography, did not embrace the term *mountain geoecology*, nor its 'applied' commitment.

In practice, mountain geoecology came to be an applied sub-discipline of Geography as it evolved from the interrelationships between MAB-6, UNU's project (that was itself renamed *mountain geoecology and sustainable development*), the IGU Commission, and the International Mountain Society. The spearhead for this development was the original Mountain Hazards Mapping

 (Pirineos, 2012, Vol. 167, 15-27, ISSN 0373-2568, eISSN: 1988-4281, doi: 10.3989/Pirineos.2012.167002)

project in the Nepal Himalaya (Ives and Messerli, 1981). As the research team, that eventually included members from eight different institutions and seven different countries, had the advantage of fieldwork throughout the entire annual agricultural cycle in Nepal, the initial emphasis on mountain hazards gave way to a critical examination of the prevailing development paradigm of the day. This was the assumption that extensive deforestation by a rapidly expanding subsistence mountain population was leading to massive soil erosion and increased landslide activity that in turn were the cause of catastrophic flooding and siltation on the heavily populated plains of Gangetic India and Bangladesh. This assumption became known as the *Theory of Himalayan Environmental Degradation* (Ives, 1987). Following an international conference in 1986 held at Mohonk Mountain House in New York State the Theory was effectively demolished. Nevertheless, while this demolition was accepted generally in academic circles, the principal agencies and political parties of several of the South Asian countries directly involved have continued to base policy on the original Theory.

Despite this growing spate of research activity in the Himalaya, the UNU project, still linked to the IGU Commission and the International Mountain Society, expanded into many other mountain areas. These included Ethiopia and Kenya, Chile and Ecuador, Yunnan, China, Tajikistan, and Madagascar. Many of these activities received significant funding from the Swiss Development Cooperation. The IGU Commission, more or less independently, also organized a series of seminars and field excursions together with the publication of extensive sets of proceedings (usually in *Mountain Research and Development*). Mountain regions studied included the Caucasus, the Swiss Alps, the Moroccan Atlas, the Spanish Pyrenees, the Japanese Alps, the New Zealand Alps, and the Polish Tatra.

The strictly UNU element also supported a related training component. This enabled mountain scholars from Thailand, Nepal, Bhutan, India, Bangladesh, China, Ecuador, Chile, Ethiopia, Kenya, and Morocco to undertake a year's study leave at the University of Berne, or the University of Colorado, or both, and to return to their home countries to take part in the ongoing UNU research (and later at the University of California, Davis, following Ives's transfer in 1989).

Given the applied nature of these activities, it was inevitable that the core members moved into the political arena. From the earliest years of the IGU Commission, and especially from the identification of an international programme for MAB-6, it had been apparent that mountain areas of the world and their peoples were receiving little international attention despite the rapidly growing mainline concerns over world environmental deterioration – loss of tropical rain forest, desertification, air pollution, pollution of the

world's oceans, and more recently, climate warming. The core members, therefore, attempted to draw widespread attention to the problems facing the mountains. An early task was seen as the need to examine and, as appropriate, challenge prevailing draconian views that lacked any firm scientific basis, yet influenced public policy. This, as indicated above, became centred on the *Mohonk Process* in the 1980s. The next crucial step was the 1992 Rio de Janeiro Earth Summit (UNCED).

When Maurice Strong, a declared mountain enthusiast (he wrote the Foreword to *The Himalayan Dilemma*), was confirmed as Secretary-General of the Rio Earth Summit in late-1990, the core mountain geoecology group, with a broadened membership, informally created 'Mountain Agenda -1992' in Appenberg, Bern Canton, in December 1990. This had the express purpose of politicking up to and during the Earth Summit to ensure that mountains and mountain people obtained appropriate world-wide attention (Mountain Agenda, 1992; Stone, 1992). This proved a major force in the successful effort to ensure inclusion of a special mountain chapter in the Earth Summit's primary document, *AGENDA 21*(Chapter 13 –*Managing Fragile Ecosystems– Sustainable Mountain Development*).

From the success in Rio de Janeiro, it became apparent that mountains and mountain peoples would receive unprecedented attention world-wide. The next steps were the post-Rio establishment of the UN Commission on Sustainable Development (UNCSD), the creation of *Mountain Forum* under the leadership of The Mountain Institute, West Virginia, USA, and the Rio-Plus-Five special UN General Assembly. Chapter 13 was identified as one of ten chapters of Agenda 21 for progress review by the UNCSD with reporting to the UN General Assembly in New York (June 1997). The main Chapter 13 document (*Mountains of the World: A Global Priority*, eds. Messerli and Ives, 1997) included the work of more than one hundred contributors, and was ultimately published in Italian, French, Russian, and Spanish editions. With encouragement from the Swiss government, it was almost automatic that the United Nations would unanimously approve a motion placed before the General Assembly of November 1999 by the Kyrgyzstan delegation for declaration of 2002 as the International Year of Mountains.

From the foregoing overview, *Mountain Geoecology* can perhaps best be described as a late-twenthieth century product of convenience –that of harnessing international mountain geographic scholarship and ensuring multidisciplinary linkage to solve practical and environmental problems in the mountain regions of the world. In practice, it has subsumed an extensive German mountain cultural geography as well as the results of considerable research in mountain anthropology, for example: Baker and Little (1976)– Man in the Andes; Stellrecht (1998) –Culture Area Karakorum; and Rerkasem

 (Pirineos, 2012, Vol. 167, 15-27, ISSN 0373-2568, eISSN: 1988-4281, doi: 10.3989/Pirineos.2012.167002)

(1996)– mainland Southeast Asia, and Rhoades (1997 2007). Its primary focus can be defined as political in that the increasing international attention to mountain problems, as exemplified at Rio de Janeiro (1992), and with the designation of 2002 as the International Year of Mountains, have been the milestones of a conscious goal from the beginning. Even the over-riding political mountain concern of the post-11 September 2001 Era (the spread of terrorism and subsequent warfare in Afghanistan and elsewhere) was anticipated in general terms as *mountain geoecology* progressively entered the political arena. For instance, *Mountains of the World* (Messerli and Ives, eds., 1997) included a chapter by Libiszewski and Bächler who emphasized the disproportionate share of the world's violence with which mountain regions are beset and indicated that access to water was one of the major factors involved. In a final chapter several statements of concern were highlighted to the effect that warfare in all its forms, including 'drug wars', guerrilla activities, and marginalization of mountain peoples, represented a critical threat to sustainable mountain development:

> ...the disproportionate burden that mountains and their peoples are obliged to carry, as victims of inhuman treatment, will surely rebound on society unless the current situation can be alleviated and reversed quickly ...to end this shame on humanity ...nothing less than a major restructuring in world affairs will be required. Unless there is a strong measure of success in this arena, the long-term costs will likely exceed the ability of society to pay; the moral costs will be even greater. The losses, in terms of cultural and biological extinctions, will be beyond recovery.
>
> Ives, Messerli, and Rhoades (1997: 457)

Nevertheless, a number of *Mountain Geoecology's* main attributes can also be identified:

1. Development of the concept of highland-lowland interaction.
2. Initiation of the 'Mohonk Process' involving recognition of the need to challenge major environmental paradigms as an essential first step in rational policy making for the sustainable transformation of mountain economies.
3. The identification of mountain regions as 'water towers' of the world as well as some of the most important sanctuaries of cultural and biological diversity.
4. Recognition of the importance of mountain spiritual and recreational values.

All these concepts, however, can be related to the first published commitment of the International Mountain Society-*To strive for a better balance between*

mountain environment, development of resources, and the well-being of mountain peoples. As we enter the year 2012 (twenty years after Rio: UNCED) it has become increasingly apparent that the overall well-being of World Society will be strongly influenced by the degree to which that balance can be attained.

Acknowledgements

First and foremost, much of our success as mountain geoecologists derives directly from the leadership, inspiration, and friendship provided by Carl Troll. Walther Manshard and Maurice Strong offered vital support. I also acknowledge the comradeship and intellectual contribution of Bruno Messerli from 1972 until the present day. The evolution of mountain geoecology, of course, depended on the enthusiastic contributions of numerous colleagues, including many former graduate students.

References

Baker, P. T. & Little, M. A., 1976. *Man in the Andes: A Multidisciplinary Study of High-Altitude Quechua.* Stroudsburg, United States, Dowden, Hutchinson and Ross, 482 pp.

Blanchard, R., 1924. Sur les noms des régions naturelles des Alps françaises. *Revue des Géographie alpine,* 12: 455-462.

Dow, V., Kienholz, H., Plam, M., & Ives, J. D., 1981. Natural Hazards Mapping: The development of a prototype combined hazards map, Monarch Lake Quadrangle, Colorado, U.S.A. (with fold-in map). *Mountain Research and Development,* 1 (1): 55-64.

Forsyth, T., 1996. Science, myth, and knowledge: testing Himalayan environmental degradation in Northern Thailand. *Geoforum,* 27 (3): 375-392.

Forsyth, T., 1998. Mountain myths revisited: integrating natural and social science. *Mountain Research and Development,* 18 (2): 107-116.

Grötzbach, E., 1976. Überlegungen zu einer vergleichenden Kulturgeographie altweltlicher Hochgebirge. *Verhandlungen des Deutschen Geographentages.* 40: 109-120.

Grötzbach, E. & Rinschede, G. (eds.): 1984. *Beiträge zur vergleichenden Kulturgeographie der Hochgebirge.* Eichstätter Beiträge, 12.

Hamilton, L. S., 1987. What are the Impacts of Himalayan Deforestation on the Ganges-Brahmaputra Lowlands and Delta? Assumptions and Facts. *Mountain Research and Development.* 7 (3): 256-263.

Holtmeier, K-F., 2009. *Mountain Timberlines: Ecology, Patchiness, and Dynamics.* Springer, 438 pp.

Ives, J. D., 1973. Preface; Proceedings of the Symposium of the IGU Commission on High-Altitude Geoecology, Calgary, Alberta, 1 to 8 August 1972. *Arctic and Alpine Research,* 5 (3 Pt. 2): A1.

Ives, J. D., 1978. Preface, IN Ives, J. D. and Zimina, R. P. (eds.), Proceedings of a Symposium of the IGU Commission on High-Altitude Geoecology: Mountain Geoecology and Land-Use Implications. *Arctic and Alpine Research,* 10(2):159.

Ives, J. D., 1980 a. Highland-Lowland Interactive Systems in the Humid Tropics and Subtropics: The Need for a Conceptual Basis for an Applied Research Programme. IN Ives, J. D., Sabhasri, S., and Voraurai, P. (eds.), *Conservation and Development in Northern Thailand.* UNU Press, NRTS-3/UNUP-77, Tokyo, pp. 3-8.

Ives, J. D. (ed.), 1980 b. *Geoecology of the Colorado Front Range: A Study of Alpine and Subalpine Environments.* Westview Press, Boulder, Colorado. Preface, xxiii.

Ives, J. D., 1987. The Theory of Himalayan Environmental Degradation: Its Validity and Application Challenged by Recent Research. *Mountain Research and Development*, 7 (3): 189-199.

Ives, J. D. & Bovis, M. J., 1978. Natural hazards maps for land-use planning, San Juan Mountains, Colorado, U.S.A. *Arctic and Alpine Research,* 10 (2): 185-212.

Ives, J. D. and Ives, P. (eds.),1987. The Himalaya-Ganges Problem. Proceedings of the Mohonk Mountain Conference. *Mountain Research and Development,* 7 (3): 181-344.

Ives, J. D., Mears, A. I., Carrara, P. E., & Bovis, M. J., 1976. Natural hazards in mountain Colorado. *Annals Assoc. Amer. Geogr.*, 66 (1): 129-144.

Ives, J. D. & Messerli, B., 1981. Mountain hazards mapping in Nepal: introduction to an applied mountain research programme. *Mountain Research and Development,* 1 (3/4): 223-230.

Ives, J. D. & Messerli, B., 1989. *The Himalayan Dilemma: Reconciling Development and Conservation.* Routledge and UNU Press, London and New York, 296 pp.

Ives, J. D., Messerli, B. & Rhoades, R. E., 1997. Agenda for sustainable mountain development . IN Messerli, B. and Ives, J. D. (eds.): *Mountains of the World: A Global Priority.* Parthenon, London and New York, pp. 455-466.

Ives, J. D., Messerli, B. & Spiess, E., 1997. Chapter 1, IN Messerli, B. and Ives, J. D. (eds.):*Mountains of the World: A Global Priority.* Parthenon, London and New York, pp. 2-8.

Kienholz, H., 1977. Kombinierte geomorphologische Gefahrenkarte, 1 : 10,000 von Grindelwald. *Catena,* 3 (3/4): 265-294.

Libiszewski, S. & Bächler, G., 1997. Conflicts in mountain areas-a predicament for sustainable development. IN Messerli, B. and Ives, J D. (eds.): *Mountains of the World: A Global Priority.* Parthenon, London and New York, pp. 103-130.

Messerli, B. & Ives, J. D. (eds.), 1997. *Mountains of the World: A Global Priority.* Parthenon, London and New York, 495 pp.

Monheim, F., 1985. *Carl Troll: Tagebücher der Reisen in Bolivien, 1926/1927.* Erdwissenschaftliche Forschung, Der Akademie der Wissenschaften und der Literatur, Mainz. Franz Steiner Verlag, Wiesbaden GMBH, Stuttgart, 390 pp.

Mountain Agenda, 1992. *An Appeal for the Mountains.* Institute of Geography, University of Berne, Switzerland, 44 pp.

Passarge, S., 1913. Physiogeographie und vergleichende Landschaftsgeographie. *Mitt. Geogr. Ges.* Hamburg, 27.

Passarge, S., 1919. Vergleichende Landschaftskunde. Berlin, T1: 1-5.

Price, L. W., 1981. *Mountains and Man: A Study of Process and Environment.* University of California Press, Berkeley, Los Angeles, and London, 506 pp.

Rerkasem, B. (ed.),1996. *Montane Mainland Southeast Asia in Transition.* Chiang Mai University, Chiang Mai, Thailand, 497 pp.

Sachs, A., 2006. *The Humboldt Current: Nineteenth-century exploration and the roots of American environmentalism.* Viking, the Penguin Group, New York and London.

Stellrecht, I. (ed.),1998. *Karakorum-Hindukush-Himalaya: Dynamics of Change.* Pakistan-German Research Project-Culture Area Karakorum, Rüdiger Köppe Verlag Köln. Part I, 608 pp., Part II, 678 pp.

Stone, P. (ed.), 1992. *State of the World's Mountains: A Global Report.* Zed Books, London and New Jersey, 389 pp.

Sukachev, V. N., 1944. Grundsätze genetischer Klassifikation in Biogeocoenologie. (Russian), Zh. Obshch.

Tansley, A. G., 1935. The use and abuse of vegetational concepts and terms. *Ecology*, 16: 284-307.

Thompson, M., Warburton, M., & Hatley, T., 1986. *Uncertainty on a Himalayan Scale.* London, Ethnographica.

Troll, C., 1939. Das Pflanzenkleid des Nanga Parbat: Begleitworte zur Vegetationskarte 1 : 50,000. Wiss. Veröff. Mus. Landeskunde, Leipzig, N. F. 7: 149-193.

Troll, C., 1944. Strukurböden, Solifluktion und Frostklimate der Erde. *Geologische Rundschau,* 34 (7/8): 545-694, Stuttgart.

Troll, C., 1966. Ökologische Landschaftsforschung und vergleichende Hochgebirgsforschung. *Erdkundliches Wissen,* Wiesbaden, 11: 194-230, 296-327.

Troll, C.(ed.), 1968. *Geoecology of the Mountainous Regions of the Tropical Americas.* Proceedings of the UNESCO Mexican Symposium, A 1-3, 1966, *Colloquium Geographicum,* Bonn: Ferd. Dümmers Verlag, 223 pp.

Troll, C., 1972. Geoecology and the world-wide differentiation of high-mountain ecosystems. IN, Troll, C. (ed.), *Geoecology of the High-Mountain Regions of Eurasia.* Erdwissenschaftsliche Forschung der Akademie der Wissenschaften und der Literatur, Mainz. Franz Steiner Verlag GMBH, Wiesbaden, pp. 1-16.

Troll, C. (ed.), 1972. *Geoecology of the High-Mountain Regions of Eurasia*. Erdwissenschaftsliche Forschung der Akademie der Wissenschaften und der Literatur, Mainz. Franz Steiner Verlag GMBH, Wiesbaden, 299 pp.

Troll, C., 1973. High mountain belts between the polar caps and the equator: their definition and lower limit. *Arctic and Alpine Research,* 5 (3 Pt. 2): A19-A27.

UNESCO, 1974. Programme on Man and the Biosphere (MAB): Working Group on Project 6: Impact of human activities on mountain and tundra ecosystems. Final Report, Lillehammer, 20-23 November 1973, MAB Report Series, No. 14, UNESCO, Paris, 132 pp.

Uhlig, H., 1978. Geoecological controls on high-altitude rice cultivation in the Himalayas and mountain regions of southeast Asia. *Arctic and Alpine Research,* 10 (2): 519-529.

Uhlig, H. (ed. Hermann Kreutzmann), 1995. Persistence and change in high mountain agricultural systems. *Mountain Research and Development,* 15 (3): 199-212.

Veyret, P. & Veyret, G., 1962. Essai de definition de la montagne. *Revue de Géographie Alpine,* 50: 5-35.