SUSTAINABILITY REVIEW: MOUNTAIN ENVIRONMENTS

Kenneth Hewitt
Department of Geography and Environmental Studies, Wilfrid Laurier University, Ontario, Canada

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1. Introduction

Mountains rise above surrounding terrain and combine a relatively great range of elevation or high relief, with steeply sloping, often rugged landscapes. They are mostly generated by tectonic processes in the Earth's crust that cause substantial, concentrated uplift of land surfaces. Earthquakes and volcanic eruptions, directly related to mountain building forces, affect many mountainous areas. However, their physical environments are characterized especially by effects of topography on climate, hydrology and earth surface processes.

The climate of a region where mountains occur is modified in what are termed topoclimatic phenomena. Precipitation, temperature and other atmospheric conditions, their geographical patterns, are modified by elevation, slope and the orientation of mountain terrain. Some of the most important consequences are seen in local and regional hydrology. Mountains are important as watersheds, and in the organization of drainage on regional, even continental, scales. The quantity, timing and quality of water flowing from them can be critical for surrounding areas. Distinctive ecological and human attributes of mountain lands involve adaptations to these landscapes, climatic and hydrological conditions.

There is some difficulty deciding just how much elevation separates mountains from other landscapes which may be quite rugged but of low relief. Some accept fairly

arbitrary boundaries for mountains; for example, at least 1,000m of local relief. Or this may designate high mountains, as opposed to middle mountains and hills. Elevation effects in mountains are also to be distinguished from those of high altitude plateaux with low relief. Another approach, preferred here, gives emphasis to the altitudinal zoning of life forms and land uses. It requires altitudinal gradients sufficient to create distinctive ecozones in a vertical sense, or natural and human adaptations to topoclimatic differentiation of the habitat. These may occur with only a few hundred meters of local relief, but are certainly present in any area with more than 1,000m of relief. According to these criteria roughly one quarter of the Earth's land surfaces qualify as mountain environments, and about the same proportion of North America.

We must also recognize that mountains are found in every continent and from polar to equatorial regions. They occur as mountainous islands, coast ranges and in the innermost continental areas. There are isolated massifs or cones, single high ridges and vast regions comprising many contiguous ranges with networks of intermontane valleys. Many, but not all, have distinctive high rock and ice summits. Some mountainous areas are among the most barren places on earth, others have the greatest biological diversity established anywhere. There are, in fact, mountain representatives of virtually every terrestrial ecosystem, as well as many examples of unique communities. There are uncounted numbers of unique species of plant and animal in the mountains, sometimes the last surviving members of species exterminated elsewhere. In addition to more or less complex arrays of distinctive habitats, ecological features reflect comparative isolation for many species, problems of movement or colonization within, into and between mountain massifs, and their role as refugia during Quaternary climatic changes.

The physical conditions and ecological diversity of mountain lands are also associated with an extraordinary variety of human cultures. Many surviving indigenous peoples are found in the mountains. Their adaptations to these habitats, their cultures and environmental knowledge, are of singular interest and value for sustainable practices. Their needs and rights, or abuses of the same under conditions of modernization, are of singular concern.

Thus, there is as much variety between, and often within, mountain lands, their plants, animals and human cultures, as in all other environments together. It may be wondered, therefore, if anything is to be gained from treating them as a single concern. However, recent studies suggest a convergence of similar problems of environmental degradation and unsustainable developments worldwide.

Problems of sustainability in the mountains have been identified in three main areas:

i) the protection and conservation of ecosystems, including the great species diversity of some regions and unique communities or species in most;
ii) the threatened well-being and cultural survival of mountain peoples;
iii) dangerous, exploitative or ill-considered modern developments and the problems of promoting sustainable alternatives

On the one hand, these ecological and societal problems in the mountains largely relate to

influences external to them. They derive from national and global resource demands, state building, wars and national security concerns, recreation, tourism, and associated communication systems. Most originate in, and mainly serve, the cities and industries of lowland and coastal zones. Even in largely mountain lands such as Switzerland or Oregon, there are differences in context and needs between the cities or seats of government usually in intermontane valleys and basins, coastal zones or high plateau areas and the more rugged hinterlands. Meanwhile, in the twentieth century an exceptional number of armed conflicts occurred in the world's high mountains, from the Andes to the Mediterranean and East Africa, from inner most continental Asia, to the South East Asian mountainous islands. Many continue or threaten to return in the present century. Almost all these conflicts originated in pressures or actions outside the mountains. They are affected by state or international forces, and the international trade in arms. A large fraction of the world's refugees in recent decades more than 15 million persons in the 1990s alone were displaced from, within or to, mountain lands by war and repression. Increased vulnerability to, and inadequate preparedness for, natural disasters, added to or aggravated by forced uprooting.

On the other hand, the impacts of such pressures articulate with and highlight basic constraints of mountain environments generally. The actual processes or causes for concern tend to be the same, or of similar origin, in most mountain regions. They show little regard for habitat specifics or human diversity. Modern technologies, often developed in lowland contexts, ignore or simply override the more subtle and fragile constraining and moderating influences of rugged terrain, topoclimates, vegetation covers and traditional land uses. So do the demands or timetables of urban-industrial and consumer societies, when they take advantage of mountain resources. Conflicts pay no regard to ecological and social vulnerabilities and are a major cause of ruined habitats. They destroy pre-existing sustainable uses and prevent the development of new ones.

Indirect impacts on mountain ecosystems and societies arise through the inflow of airborne pollutants, unchecked spread of agricultural pests and human diseases. The electronic media, the influence of markets and attraction of employment opportunities outside the mountains, can cause social disruption in them. These too pay little or no regard for what and whom they may affect. Generally, modern influences have failed to consider whether mountain lands and peoples have special vulnerabilities to given developments. They fail to allow for adequate and informed transitions to new practices.

In sum, threats to sustainability in the mountains tend to reflect socio-economic, political or modernizing developments common to many countries. They are increasingly global in extent or explanation, and of similar forms everywhere. The impacts usually override physically, or ignore socially, the specifics and the diversity ecological and cultural settings. While sustainability concerns direct attention to what is special about mountain habitats and peoples, we must also address this convergence of ill-considered modern impacts. They require comparative evaluation and some common agendas of assessment. We cannot ignore the need to reverse externally-derived phenomena of abuse.

The article begins with a review of environmental features peculiar to mountain regions and that affect sustainability in them. Then it considers evidence of developments in mountains that violate ecological constraints and undermine existing or potentially

sustainable adaptations to them. Finally, some principles and proposals for improvement are examined.

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United Nations Environment Program: Managing Fragile Ecosystems: Sustainable Mountain Development (Agenda 21 of Earth Summit 1992 - chapter 13). http://www.unep.org/Documents [The importance of mountains not only for people who live there but for the larger group that depend on its diverse resources especially water, is discussed in this publication. The significance of mountains to global ecosystems is underscored.]

Biographical Sketch

Kenneth Hewitt M.A. (Cambridge), PhD (London) is Professor Emeritus, Geography and Environmental Studies at Wilfrid Laurier University, Waterloo, Ontario. He is founder Member and Research Associate, Cold Regions Research Centre at the University. His research interests include risk and disasters theory, with particular emphasis on the social geography and human ecology of vulnerability and response to catastrophic risks; catastrophic rockslides; glacier fluctuations; and the regional geomorphology of the Karakoram Himalaya.