CHAPTER 4

Scaling the Mountains: Spatial and Socio-demographic Hierarchies

1. Why Do We Need to Scale Our Thinking?

A great deal of confusion in sustainability research comes not only from multiple perceptions of the problem but also from the fact that researchers study different scales without reference to their location in either the spatial or socio-demographic hierarchy. Planners typically plan with the same confusion. Development practitioners are often unclear about what scale their project addresses, thereby constantly mixing levels in their targeting of *interventions*. While it may be necessary to internally study each hierarchical level (depending on the research question), it is equally crucial for integrated development to be able to facilitate the systematic scaling up and down between levels. The catchment, for example, is a hydrologically determined unit of regulation of nutrient and sediment flow over the landscape. It integrates the environmental effects of the mosaic of vegetation and land uses and is a logical scale for interdisciplinary efforts to improve environmental management. Yet, to have meaning beyond narrow soil science, this unit must be related to the social unit inhabiting the catchment as well as to the biophysical spatial units above and below the catchment on the scale. Unfortunately, it is not unusual on an interdisciplinary team to find soil scientists working at the level of the pedon or plot,. agronomists at the cropping system level, anthropologists working at the village or tribal level, and economists at the level of regional markets and national policy. Recognition of how different spatial and socio-demographic levels are linked must be central to any integrated design for sustainable mountain research and development.

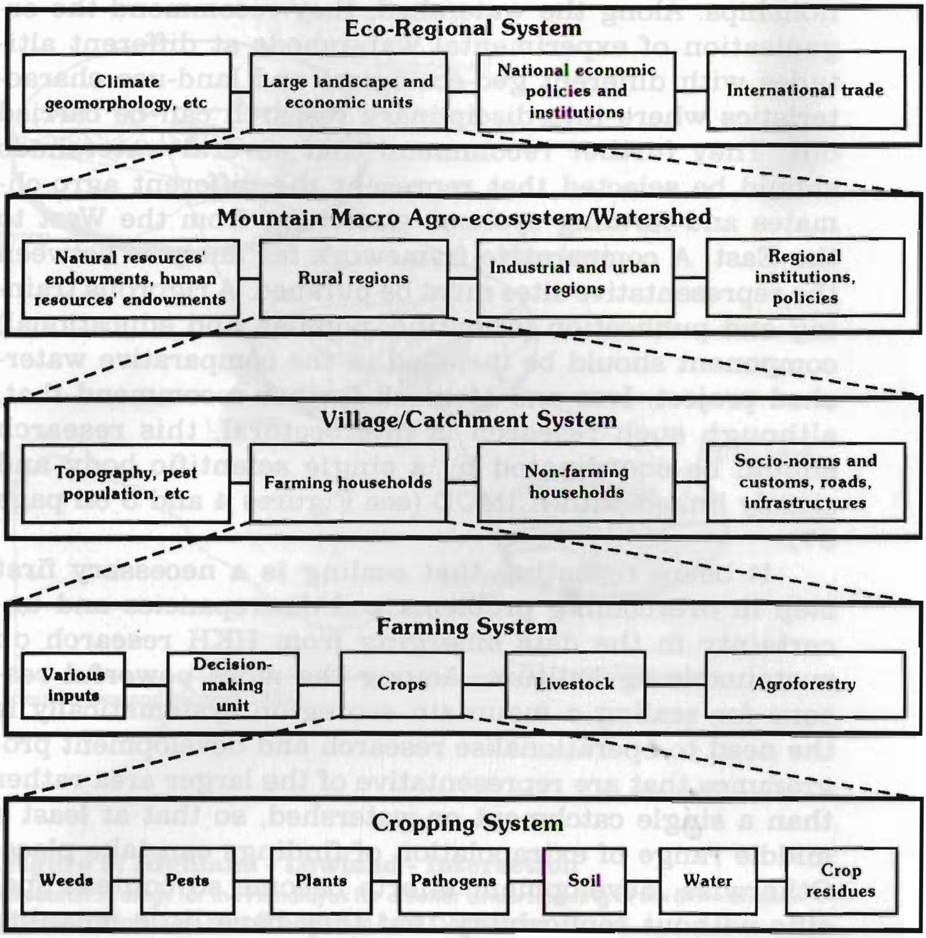
In an earlier section of this book, I pointed to the "uncertainty" that prevails in the data and definition of problems in the HKH (Thompson and Warburton 1985). Ultimately, however, this uncertainty must be reduced through a systematic database which places research into well-conceived categories of time and space. It is especially important for international research and development centres and agencies to gain a bird's eye view of their mandate region and then to be able to operationally link activities and programmes between ecoregions, agroecological zones, watersheds, and catchments and from these to socio-demographic patterns, including households, communities, tribal organisations, nations, and international bodies. This will allow further resource and needs' assessments to be made over a range of spatial scales from the highest level of abstraction down to the smallest unit. Also, scaling makes the different institutional requirements at the various levels clear, so that development integration and interaction take place across and within scales throughout the mountain ecoregion.

2. Linking Hierarchies: Spatial and Socio-Demographic Levels

Unlike single crop or livestock programmes in which researchers study a component or system on a small scale (plot, field, land facet), mountain researchers are forced to deal with a much broader range of interacting hierarchical levels in both biophysical and socio-demographic terms. Although not exactly parallel, increasingly complex social units (households, villages, tribes, provincial governments, nations) reflect larger spatial biophysical units (catchments, watersheds, agroecological regions, ecoregions). Figure 3 on page 55(adapted from Izac 1993) illustrates a ***nested hierarchy*** — ranging from the ecoregion to the cropping system.

As shown in the figure, systems are differentiated at multi-spatial levels, ranging from the cropping system to the ecoregion. Starting from the lowest level and working upwards, it can be noted that each level is constrained and controlled by the system that lies above it in the hierarchy (Allen and Starr 1982; Allen 1993). The crop-

Figure 3: Hindu Kush-Himalayan Region - Hierarchy of Agricultural Systems



Adapted from Izac (1993)

ping system is determined by the farming system, which lies within the village/catchment system, and is constrained by the regional and, ultimately, the ecoregional level. The final delineation of an agroecosystem, of course, depends on the questions or problems being addressed.

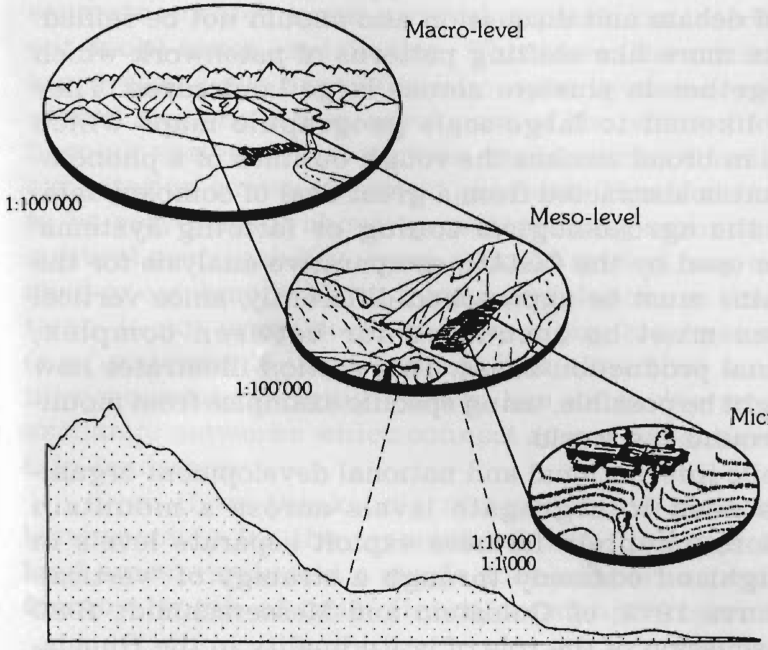
Ives and Messerli (1989:257) have argued that one approach to integration would be for countries in the HKH to select a trans-Himalayan transect along a major watershed stretching from the Tibetan Plateau down to the Indo-Gangetic Plain. Although the social and biophysical boundaries will not correspond precisely (human groups are not organised the way water flows—a watershed), it will be possible to tease out the important relationships. Along the watershed, they recommend the organisation of experimental watersheds at different altitudes with different geo-ecological and land-use characteristics where interdisciplinary research can be carried out. They further recommend that several watersheds should be selected that represent the different agro-climates and farming systems stretching from the West to the East. A comparative framework for analysis between the representative sites must be pursued. A rigorous training and publication (scientific, popular, and educational) component should be included in the comparative watershed project. Ives and Messerli further recommend that, although such research is intersectoral, this research should be coordinated by a single scientific body and closely linked with ICIMOD (see Figures 4 and 5 on page 57).

It bears repeating that scaling is a necessary first step in overcoming problems and discrepancies and uncertainty in the data emerging from HKH research on sustainable agriculture. Among the more powerful reasons for scaling a mountain ecoregion systematically is the need to operationalise research and development programmes that are representative of the larger area rather than a single catchment or watershed, so that at least a middle range of extrapolation of findings can take place. Otherwise, development efforts become so context specific without replicability that they have little meaning beyond that of the setting where the data were collected. At least, international organisations and trans-national environmental projects require the systematic comparative perspective if they are to have any role beyond that of being a clearing house for specific case studies. I will return to this point in the next chapter, as well as in the conclusion.

3. Vertical Linkages and Layers for Sustainability of Mountain Agriculture: Comparative Perspectives

In addition to scaling the mountains according to hierarchy (spatial and socio-demographic), I argue that

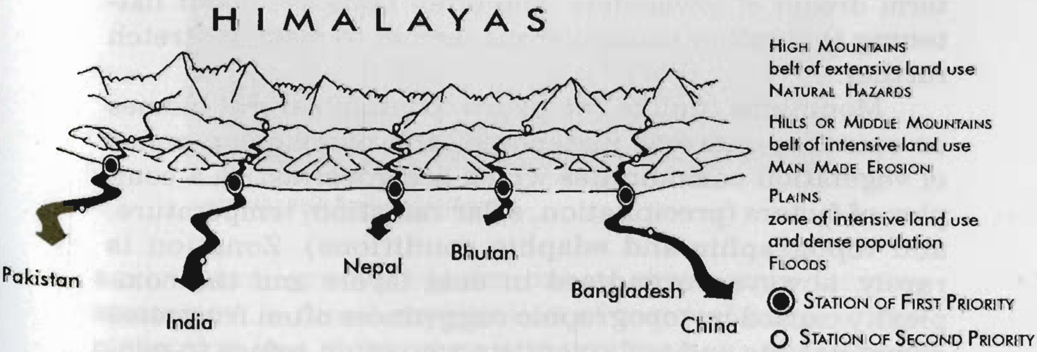
Figure 4: Scales of Research - an Integrated Approach



Source: Ives and Messerli 1989

Figure 5: Highland - Lowland - Interaction

Research Strategy for the Himalayas for a Better Understanding of the Downstream Effects: Precipitation, Runoff, Sediment Load, Soil Erosion



Source: Ives and Messerli 1989

an attempt also needs to be made to develop comparative models of mountain farming systems on regional and global scales. Such models are ***ideal types*** generated for purposes of debate and discussion and should not be reified. They are more like shifting patterns of patchwork which hold together in clusters across large landscapes. They can be likened to large-scale geographic maps which present in broad strokes the rough outlines of a phenomenon that is abstracted from a great deal of complex data. Unlike the agroecological zoning or farming systems' analysis used by the CGIAR, comparative analysis for the mountains must be approached differently, since vertical linkages must be accounted for between complex, altitudinal production zones. This section illustrates how this might be possible, using specific examples from mountains around the world.

While international and national development organisations need to segregate levels across a mountain ecoregion, mountain farmers exploit separate levels in their highland economy through a strategy of "verticality" (Murra 1972; cf. Goldstein and Messerschmidt 1980 for a discussion of the role of latitudinality in the Himalayas). The building of roads or recognition of a flat valley here or there do not completely negate the role of verticality in shaping the responses of a mountain farming community, although there is little doubt that agriculture and cropping patterns may have been altered significantly in those adjacent areas where motorable roads have been built (Allan 1986; Kreutzmann 1993). To ignore verticality is to deny that the mountains exist, a rather long-term dream of lowlanders who often fantasise about flattening this rather cantankerous terrain to make it stretch further.

Mountains, unlike the plains, contain several biomes or ecozones—narrow, juxtaposed, and overlapping zones of vegetation communities which are governed by a complex of factors (precipitation, solar radiation, temperature, and topographic and edaphic conditions). Zonation is rarely, however, organised in neat layers and the complexity caused by topographic ruggedness often frustrates climatologists and soil scientists who often refuse to generalise about their subjects. The complexity and variation that shape mountain agriculture are simply more difficult to fold into homogeneous categories. From the household point of view, zones and fields are not functioning separate entities since survival depends on interdependent multi-zonal exploitation. Therefore, mountain farming systems are expansionistic ***open systems***, not rigid ***closed systems***. An integral part of the whole mountain farming system is the various mechanisms of multi-zonal exploitation across a vertical gradient. Therefore, one has to be very careful about operationalising mountain agricultural sustainability using a closed system, say a watershed or catchment. **First**, human populations in the mountains do not organise themselves along biophysical lines (e.g., watersheds) and, **second**, it is clear that a community mountain farming system has extensive trade and exchange networks which connect across the entire mountain landscape.

Even if we think only of agricultural exploitation, leaving aside for the moment off-farm linkages in lowland areas, rarely can a single zone support a population for any length of time. Hence, most historic mountain

Mountain herds / pack animals: specialisation in a single zone - *D. Miller*

Specialisation in a single zone and procurement of the products it needs through barter or exchange.

agricultural groups opt for one of three main farming strategies: i). direct exploitation of various zones: ii) specialisation in a single zone and procurement of the products it needs through barter or exchange with other groups occupying complementary zones; or iii) a combination of zonal specialisation and multi-zonal exploitation or linkages (Rhoades and Thompson 1975). The degree to which these historic patterns have been altered by markets and roads is most likely correlated to the distance from the road head (Allan 1986; Kreutzmann 1993).

This theory of ***verticality*** argues that mountain populations must gain access to several zones through direct exploitation, trade, or exchange of the produce and resources of several zones (Murra 1972; Rhoades and Thompson 1975). Since the beginning of agriculture itself (indeed, domestication probably began through experimentation in single crops in several adjacent zones) mountain farmers have utilised—in one form or another—vertical exploitation. Also, sustainability in mountain farming systems involves not only multi-zonal exploitation but also complex, symbiotic relationships between different ethnic groups who occupy complementary niches.

In order to survive, long established mountain communities have evolved complex systems of agroecological knowledge, social exchange mechanisms, mountain technologies, animal and crop complexes, and belief systems which allow and facilitate the exploitation of several elevation zones, either directly or indirectly. Although social and economic changes have dramatically altered the traditional exploitive patterns, this does not mean that verticality does not continue to shape the present problem or that historical adaptation has no reflection in the present. The persistence of altitudinal zonation in the face of accessibility or modernisation is well documented in the mountain geographical literature (Uhlig 1995; Grötzbach 1988).

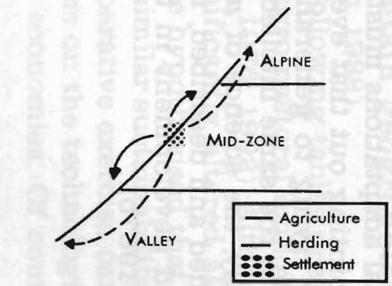
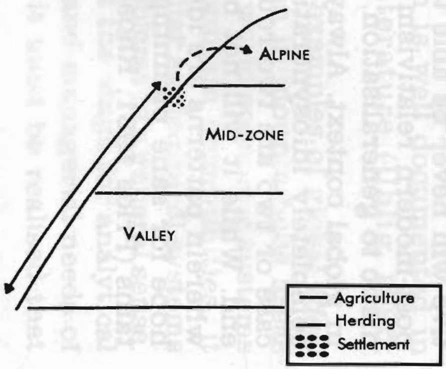
The following tables present examples of global ***ideal types*** of agro-pastoral exploitation in mountainous areas (Rhoades, 1976; 1992). Although world economic systems have significantly altered all mountain communities, it can still be hypothesised that similar agricultural systems will have similar sustainability problems in a general sense. This comparative exercise can set the stage for analytical discussions on the technological and managerial needs of mountain economies. Of course, it must be realised that the mountain physical environment only sets the limits of potential: human cultures work creatively within those limits. The manner in which human cultures—given agriculture and herding as exploitative systems—have arranged themselves within the mountain context is the fundamental platform for any discussion on sustainability. Finally, this set of ***ideal types*** is by no means exhaustive and other major types can and should be added by knowledgeable researchers (see Stevens 1993).

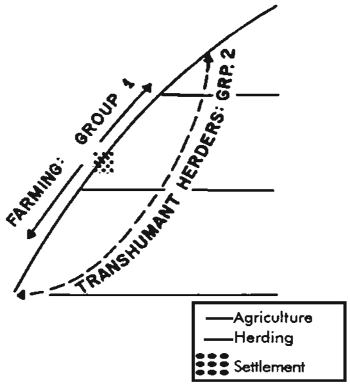
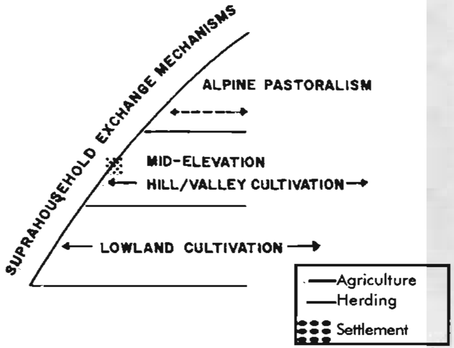
4. Conclusion

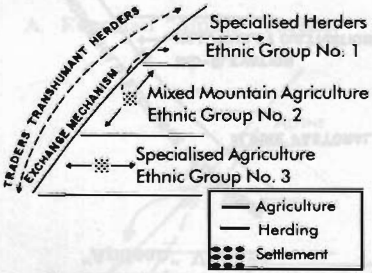
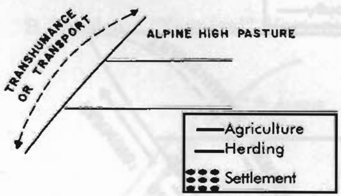
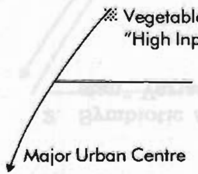
In this chapter, I have argued two points. First, before we will be able to make any sense out of the complexity and contradictions in agricultural data coming from the HKH mountains, we need to appreciate and operationalise scale. Otherwise, not only will scientists and their database be talking past each other, but planners and policy-makers will also be confused. The biggest challenge, of course, will be to create systematic, scaled databases which finally reduce the messy "uncertainty" so poignantly outlined in Thompson and Warburton's (1985)classic article 'Uncertainty on a Himalayan Scale'.

Second, I have argued for a comparative approach to mountain agriculture which provides a framework for global discussion about sustainability issues. My ***ideal types*** ('Patterns of Clustered Patchwork') may not even be the most appropriate forum for global discussion, but the point I wish to drive home is that the global mountain initiative will never be able to establish a dialogue based on a post-modern relativism and specificity which is antagonistic to generalisation. Local adaptations must be placed in global context. Always pointing out that everything is completely idiosyncratic or trying to generalise from a case or two are two routes to the same intellectual dead-end. While it will not be easy, the science of ***montology***, wherein patterns are identified and described, is our only hope for sane planning and development in the mountains (Price 1981; Rhoades 1987b).

Examples of Ideal Types: Comparative Mountain Agriculture

Type	Characteristics	Geography	Possible Sustainability Issues
1. Mixed Mountain Agro-pastoralism A. Eurasian "Alpine" Variant 	1. Single population/multi-zonal exploitation 2. Land-use/tenure a) communal forests/ pastures b) private fields/meadows 3. Specialised mountain crops/ animals/tools 4. Animal transhumance 5. Strong communal controls 6. Rich indigenous knowledge 7. Historically insulated	High valley mountain systems found in the Alps, Eurasian mountains, HKH, Inner China, Isolated cases in Mexico and Andean region Localised mountain groups relatively small in population, found in narrow steep, high mountain valleys	1. Breakdown of local indigenous knowledge and social/ land-use controls 2. Upland communal forests of special concern (fuel, uncontrolled grazing) 3. Increasing outside control by government and private enterprise over commons (includes nature reserves) 4. Impact of Tourism 5. Water 6. Effects of "global warming"
B. Andean "Tropical" Variant 	1. Single populations/multi-zonal exploitation 2. Land-use tenure a) community-owned pasture b) community-controlled 'rights' over fields c) Lower colonisation zone occupied by lowland "tribes" 3. Hardy mountain crops/animals/tools (tubers, grains, cameloids) 4. Cultivator transhumance 5. Strong communal controls 6. High levels of indigenous knowledge	Tropical mountain Exploitation system: Andes (Ecuador to Bolivia) & scattered throughout East African highlands Full range vertical exploitation from tropical lowland to highland pasture	1. Breakdown of local indigenous knowledge and social/ land-use controls 2. Shifted cultivation (small-scale plantations) on hilly slopes of lower elevations (colonisation zone) 3. Displacement of traditional crops for commercial crops; dependent on outside markets (barley for beer); genetic erosion 4. Soil erosion/land degradation in lower zones. 5. Water 6. Effects of "global warming"

Type	Characteristics	Geography	Possible Sustainability Issues
2. Symbiotic Agro-pastoralism "Eurasian" Variant 	1. Dual population exploitation 2. Land-use/tenure a. communal pastures communally owned by mountain group b. pastures seasonally rented to outside pastoralists 3. Hardy mountain crops/lowland animals (sheep, cattle) 4. Agricultural/long-range herding transhumance 5. Strong symbiotic tie between agriculturists/pastoralists (animals fertilize fields) 6. High levels of indigenous knowledge, specialised into mountain herding and agriculture	Full-range subtropical or tropical exploitation system, most frequent in subtropical mountains from Spain to the Himalayas. Also found in the Andes, especially on the western Andean slopes. This is a relatively rare type practised today by small populations	Breakdown of symbolic tie between agriculturalists, and herders. Government intervention to settle herders cut ties with agriculturalists. In some cases, uplands turned over to pastoralists who overexploit for lack of traditional social controls.
3. Zonal Specialisation Strategy "Andean" Variant 	1. Multiple population exploitation 2. Strong trade/exchange links between zones 3. Land-use/tenure specific to each zone 4. Highly developed suprahouse-hold exchange systems 5. Crops, animals, and tools specific to each zone 6. Political struggles between groups of each zone	Full-range exploitation of high tropical mountains - characteristics of Andes but variants found in Eurasian ranges. Similar to complex stratified exploitation in the Himalayas	Complex set of issues: depopulation of high zone, conversion of middle zones to commercial goals (depending on relationship to cities); loss of indigenous knowledge; break-down of exchange network; decay of traditional irrigation systems; loss of biodiversity; disruption through political decree of indigenous vertical exploitation leading to exploitation of single zones and political/civil strife over land.

Type	Characteristics	Geography	Possible Sustainability Issues
4. Complex stratified exploitation "Himalayan" variant 	1. Ethno-stratified with mix of zonal specification and intra-zonal exploitation 2. Complementarity between zones (e.g., high zones = potatoes, low zones = rice) 3. Political dominance in lower zones 4. Strong exchange/barter networks and routes 5. Trader class/farmer/pastoral symbiotic ties	Zonal specialisation type (above) and the complex stratified are closely aligned types and are found in the Karakoram-HKH and the Andes.	1. Complex set of issues. All of the problems listed above for types, 1, 2, and 3. 2. Government attempts to disrupt verticality by settling pastoralists. 3. Complexity illustrates why high mountain researchers tend to lose sight of macroview
5. Commercial agricultural exploitation A. 'North American Variant' 	1. Goal of exploitation by entrepreneurship strictly commercial 2. Transhumance of animals (by motor transport); no agriculture 3. Use of government and public land 4. Direct links to outside markets	Western United States, Canada, European Alps/Caucasus (shepherds)	1. Overgrazing of public lands 2. Uncontrolled cutting of forests 3. Erosion (water and wind) from overgrazing 4. Introduction of improved "alien" grasses, displacing native species 5. Elimination of wildlife
B. "Southeast Asian Variant" 	1. Vegetable production, commercially oriented 2. Intensive cultivation 3. Few to no livestock 4. Modern technologies/hybrids 5. High inputs	Southeast Asia and South-Pacific with variants in tropical Latin America (masl 1,000-2,500) - Similar pockets appearing in all mountain areas lying near to large cities.	1. Deforestation for new agricultural land (e.g., potatoes) 2. Heavy erosion 3. High pesticide use levels 4. Displacement of traditional crops 5. Native peoples displaced 6. Market limited to low lying urban centres