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Guidelines for the Integrated Management of Mountain Ecosystems

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Preface

The United Nations Conference of Environment and Development in Rio de Janeiro (1992), the Earth Summit, appropriately recognized the mountains as one of the most threatened ecosystems on the planet (Stone, 1992). Recent research has shown that this threat may increase significantly in the future as a result of the greenhouse effect (Nilsson and Pitt, 1991). At Rio the nations of the world agreed to a mountain agenda for the 21st century (see Annex). But although the principles are clear enough there are very few practical guides on how actually to implement Agenda 21 especially at the grass roots. This small publication is a first attempt to spell out the first steps in doing something about the crisis in the mountains.

What follows is derived from a joint project (No. FP 6101 83 01) in the 1980s involving UNEP, the USSR State Committee for Environmental Protection, Centre for International Projects, the Bulgarian Ministry of Agriculture and Food Industry, Academy of Agriculture, the Poushkarov Institute of Soil Science and Agroecology, and the Georgian Agricultural Academy of Sciences. The objectives of the project were to create an international network of experts, both distinguished scientists and representatives of the leading international organizations who would direct field experiments and consider alternative methods for the complex integrated management of mountain ecosystems. The experimental plots were in the Caucasus, the Rhodopes, and Balkan mountains, including a range of mountain situations – mediterranean, subtropical, high mountains, etc. To these sites were brought students mainly from developing countries, to learn at first hand the practical details of environmental protection in the mountains. From these courses guidelines were produced which form the basis for this publication. There were many other by-products of great use – films, advisory missions to the Himalayas and Africa, classifications of soils and productivity, technical reports on a range of topics including landslides, mechanization, and agroecology. The project was evaluated as a success story and most appreciated by the students who greatly enjoyed the summer journeys into the idyllic Georgian and Bulgarian mountains. Whatever happens to the project in these more wintry times, the networks forged in those remote valleys will endure. Indeed the project brought together from such regions as the Andes experts and students who never met at home but who now cooperate actively.

The following text is the product of many hands and it would be invidious to select a few when more appropriate would be a collective appreciation of the work of the Programme Advisory Committee (PAC), the students and the devoted organizers especially at the Centre for International Projects (CIP) in Moscow, the Poushkarov Institute in Sofia, and the Georgian Agricultural Academy of Sciences in Tbilisi. Special mention must be made, however, of V. Valev (Bulgaria), V. Metreveli (Georgia), A. Ayoub (UNEP), L. Loginova (GKPR), and G. Loukyanenko (CIP).

In addition to the editors contributions to the text were made by Chr. Etropolski, I. Kabachiev, A. Lazarov, N. Onchev, R. Rouseva, and G. Charashvili. S. Nilsson kindly facilitated publication at IIASA; Cynthia Ramirez and Lilo Roggenland typed the manuscript; Carol Pitt assisted in proofreading. This booklet forms part of an occasional series of publications promoted by IIASA and Bellerive Alp Action (see Nilsson and Pitt, 1991, for further details).

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1. Introduction

Basic purposes

The purposes of these guidelines are first to provide background information necessary for integrated land soil management in mountain ecosystems. Second, the guidelines detail key techniques for integrated management stressing protection, conservation, and development, as well as methods of planning. There is no attempt at a comprehensive treatment; rather selected techniques aimed at solving the major problems of environmental and socioeconomic degradation are described. The guidelines are intended to be applicable irrespective of global location and prevalent socioeconomic situations and systems. In a sense, the guidelines may be regarded as a kind of template in which individual users may locate the problems of their own regions and their concerns. The focus is on present and future changes in mountain ecosystems which are much affected by climate changes.

Sources

The guidelines are an attempt to analyze how multi-disciplinary data sources may be used for planning and action purposes. Such data are derived from existing expert scientific studies, but also necessitates specially designed surveys and, in particular, participatory research involving local populations. The sources for the guidelines are derived from a series of highly relevant studies that have been undertaken in specific mountain ranges (e.g., Balkans, Caucasus, Himalaya, Andes, Ethiopia, etc.). No attempt is made to provide a comprehensive survey of all global situations and the specific materials are used rather as illustrative case studies. Nor is there any replication of existing guidelines, e.g., from UNEP, FAO, IUCN, etc., which are either more general, or highly specific manuals in particular countries, though these manuals have been consulted and may be regarded as complementary. The present guidelines are a summary[1] of a larger work prepared (under the UNEP Project FP-6101-83-01) in Bulgaria and the ex-Soviet Union and are complemented by additional technical reports.

Scope

The main focus is on integrated management techniques which strive to preserve mountain ecosystems from adverse interventions and abuse, or to rehabilitate degraded systems. There is an emphasis on developing country situations where poverty and environmental problems coexist, although the increasing severity of pollution is causing major ecological problems in industrialized countries too. Such management requires a knowledge of the physical or natural characteristics of mountain areas (climate, soil, vegetation, etc.), although this pristine state might be somewhat ideal and idealized since there has always been a degree of outside intervention and certainly much dynamism. Alongside the physical factors are the human dimensions, the socioeconomic and demographic situations. A selection of existing models are described in the text. Many of the problems which are described stem from complex interrelationships between the physical and the human and optimum management requires integrated conceptual frameworks and action procedures designed to promote long-term sustainable development.

[1]For further information please contact Dr. T. Boyadgiev, N. Poushkarov Institute of Soil Science and Agroecology, 7 Shosse Bankya Str., P.O.Box 1369, Sofia 1080, Bulgaria; Telex 22701 INSOL BG.

The guidelines then move on to consider what modes of protection are needed to preserve ecological stability and to promote sustainable development, with an emphasis on erosion prevention/control and socioeconomic measures. Finally, there is a section of appropriate methodologies to be used when planning and designing integrated or comprehensive land/soil management and rural and sustainable development projects. The conclusions are presented in a checklist of desirable actions which are logical derivations from the earlier discussions in the text. To make the guidelines more useful, a list of relevant literature is appended together with a list of addresses, for further information.

Audience

The guidelines are basically for those working on or studying problems of integrated land/soil management in mountain ecosystems, including government agencies and officials at all levels, from the international to the local, environmental protection services and agencies, social and political organizations concerned with environmental management, interested scientists and students, and others. The guidelines may also be of interest to other than mountain ecology specialists who are looking for more appropriate models for environmental management generally. Mountains, after all, cannot be divorced from lowlands with which they are in a complex physical and socioeconomic interaction, nor can ecology be separated from other disciplines and sectors. Finally, it is hoped that the local people living in the mountains may refer to this guideline not least because of the increasing recognition of the desirability of local participation and self-management.

Uses

Despite the hope that there will be a general demand, the main objective is to provide a working manual for developing country officials and experts in a number of specific tasks. These include planning and design of integrated projects, decision making for the most rational policies and programs, elaboration of the most appropriate modes of protection and sustainable development. The guidelines will, it is hoped, be particularly useful for the promotion of comprehensive agricultural and silvicultural practices, of optimum manpower and economic policies, as well as a wider range of social reforms (e.g., health and education).

Outline

The book spells out the basic divisions we have described, starting with the physical and human geography of mountains, moving on to socioeconomic and physical degradation processes, the necessary solutions and protection measures and finally the techniques for planning. Those who are already familiar with mountain geography may move more rapidly on to the problems and solutions. Indeed, the guidelines may be used à la carte (e.g., using the analytical table of contents at the beginning).

2. Mountain Situations: Physical and Socioeconomic Factors Relevant for Integrated Land–Soil Management

The purpose of this first section is to familiarize the user with the basic characteristics of mountain ecosystems which are most relevant to integrated land/soil management. This survey is quite selective with an emphasis on degradation of mountain ecosystems and may be supplemented by the further reading in the bibliography. The broader global trends and interrelationships cannot be overemphasized. As the recent literature on climate change has shown the biosphere is an interrelated system. What happens in lowland Europe or America (e.g., pollution emissions) and the greenhouse effect may greatly affect mountain forests even in the tropical Third World and vice versa, e.g., the effects of glacial melt on sea levels. The world polity and economy are increasingly interrelated. Problems of poverty, for example, cannot be studied in isolation. There is much to be gained from comparative experiences in different mountains in different parts of the world and the initial goal for better management is the wider sharing of these experiences.

Mountains have been variously defined according to height, slope, aspect, temperature, growing season, etc., but there is no standard nomenclature and indeed mountains may also have various names – hills, steeplands, alps, piedmont, etc. Some definitions link mountains to plains or associated riverine and lacustrine systems. Those working in the mountains must accept the local definition which is very often relative. In low-lying countries, for example, what are called mountains may be relatively low. In this guide mountains refer to the broader definitions.

The classification of mountain lands may be based on latitude (tropical, temperate, arctic), although such a division does not take account of the common feature of zonation in many mountains from valley floors to peaks with a possible range of conditions from tropical to arctic in one system. Other classifications stress assemblages of fauna and flora creating biomes and biogeographical provinces. There are also anthropological classifications of mountain peoples. A significant proportion of the world's tribal and indigenous peoples, called by the UN, the poorest of the poor (estimated 200 million) live in the mountains which contain 10% of the overall world population, although perhaps another 50% depend directly on mountains for water, energy, food, etc.

An important characteristic of mountains for integrated land–soil management is their dynamics and instability, both physical and social, and their peripheral place in the national and international economic and political processes. Instability is especially related to slope. Preliminary calculations made in the framework of the UNEP/FAO Desertification Assessment and Mapping Project (1984) concerning the average slope on different continents show that the majority of the earth's surface has moderate or steep slopes (*Tables 1* and *2*).

Asia is the most mountainous continent judged by average altitude (see *Table 3*), excluding Antarctica.

For the purposes of integrated land–soil management Cartesian classification may be of less significance than regional models. the natural management and development unit in the mountains may be a valley, a watershed, or a river system, especially when such divisions are also administrative districts.

In these guidelines, however, a pragmatic definition is adopted which includes most, if not all, of the following characteristics (see Box 1 on page 5):

Table 1. Slope by continents.

Slope group[a]	Africa 1000 km^2	%	North America 1000 km^2	%	South America 1000 km^2	%	Europe, Asia 1000 km^2	%	SE Asia, Australia 1000 km^2	%
a	16,057	57	8,544	36	9,433	53	24,100	43	3,466	34
b	9,171	33	11,960	50	6,200	35	20,873	38	5,738	55
c	2,699	10	3,394	14	2,105	12	10,801	19	1,134	11
Total	27,927	100	23,898	100	17,738	100	55,774	100	10,338	100

[a]The following criteria are used to calculate the slope groups: a = > 60% of the area with a slope of 0–8%; b = < 50% of the area with a slope of 8–30%; c = > 50% of the area with a slope of > 30%.
Note: Data are calculated using base maps which are not equal area projections.

Table 2. World slope areas.

	1000 km^2	%
a	61,600	45.4
b	53,946	39.8
c	20,133	14.8
Total	135,675	100.0

Table 3. Mean continental altitudes.

Continent	Average height above sea level (m)
Asia	960
Africa	750
North America	720
South America	580
Australia	340
Europe	300

Box 1

Checklist of Mountain Ecosystem Characteristics

- Complex climate with sharp vertical and seasonal varieties.
- Fragile geomorphology (tectonic, erosion).
- Steep and elevated relief.
- Poor acid and shallow soils with high content of organic matter.
- Specific associations of pasture/forests.
- Specific economic orientation (e.g., tourism, agriculture, forestry).
- Socioeconomic depression and peripherality.
- Mosaic of microsituations (e.g., climate, socioeconomic structure).
- High proportion of threatened species.
- Disaster prone (human and natural).
- Difficulty of agricultural sustainability.

Climate

As with other features of the physical geography, mountain climates are extremely complicated, varying in space and time because of altitude, latitude, slope, aspect, exposure, continentality, etc., and the confined situations of valleys. Cold (accentuated by winds) greatly influences the organisms' active life, the permanent snow line and perma-frost being an important boundary. There is also a great complexity in precipitation which is not usually exactly correlated with altitude but reflects both general atmospheric dynamics (e.g., wet, windward exposures) and microclimates, radiation, air pollution, pedoclimate (soil–climate) etc., all of which must be understood as a basis for integrated management, notably for the optimum encouragement of plant growth, etc. The following checklist indicates some of the major factors that should be known. Further details may be seen in WMO and FAO guidelines. It should be pointed out that due to the complexity of mountain climates there are many gaps in knowledge. It is said for instance that the South Pole is better known than the Himalaya where most observations are near the passes and well worn routes, although this situation is being greatly changed by remote sensing meteorological satellites. Of particular importance is the recording and prediction of potentially catastrophic events and hazards, e.g., floods, avalanches, etc.

Box 2

Checklist of Climatological Information in Mountain Ecosystems

- Temperature regime (by altitude zones) (Range night/day min/max).
- Precipitation regime (by altitude zones) (intensity).
- Frost/growing season.
- Snowfall type regime (by altitude zones).
- Avalanche indicators.
- Wind speeds/directions (selected sites and times, wind rose).
- Insolation radiation balance and cloud cover (by altitude zones (hours).
- Humidity.
- Evapotranspiration.
- Pedoclimate (temperature and moisture regimes).
- Universal soil loss indicators (rain intensity, drop size, etc.)

Soils

Mountain edaphic conditions are also marked by great variation partly reflecting pedoclimate. Most mountain soils are shallow, coarsely textures, stony and rich in organic matter so creating conditions for rapid seepage. Steepness of slope accentuates the tendencies to instability and erosion. Such eroded materials on slopes denuded of vegetation lead to land and mudslides and are a prime cause of downstream flooding, hundreds or even thousands of kilometers away (as in the Himalaya-Indo-Gangetic system), although sudden catastrophic cloudbursts have also been implicated. Appropriate soil management plays a decisive role in providing the food supply for people and animals and the forest cover which both prevents erosion and provides a valuable resource for timber, fuel and firewood, etc., Although deep soils in the valleys and depressions may provide opportunities for cultivation. But mountain soils are generally very susceptible to degradation when cultivated.

The following checklist summarizes the main characteristics of mountain soils that should be known for proper evaluation and planning.

Box 3

Checklist of Key Characteristics of Mountain Soils

- Depth of soil.
- Stoniness and texture of the surface and through the profile.
- Content and nature of organic matter.
- Chemical characteristics (e.g., acidity, salinity, etc.).
- Physical properties (e.g., structure, porosity, bulk density, etc.).
- Presence of toxic elements in soil (e.g., heavy metals).
- Soil fertility (N, P, K and microelements).

Hydrology and water resources

Although the focus of these guidelines is on integrated land/soil management, water management is also highly significant. It is not enough to know only the precipitation part of the water cycle but there should be a general understanding of the whole hydrological pattern which is essential to mountain ecology – the nature of the watersheds and catchment areas, their hierarchies, the dendritic and valley systems, the lacustrine features, the incidence and nature of torrents, siltation and flow rates, etc. Such information may be vital to tasks as different as afforestation programs or flood prevention and control.

Until recently, the prevailing opinion was that water resources were practically inexhaustible. Since, at least, the Dublin International Conference on Water and the Environment (1992) and the Earth Summit in Rio water is regarded as a scarce, valuable, and highly threatened resource. There is increasing pressure from industrial expansion and public consumption demands with inevitable and adverse consequences for water quality.

Vegetation and fauna

The importance of vegetative cover is very great in mountains since this is the main method of erosion control. Such cover (especially forest) is an important method of classifying mountain lands. Latitude, altitude, geology, climate, and soils are all "indicated" in specific keystone species, while transition belts (ecotones) are marked by mixed communities. Different types of vegetation are associated with latitude, humidity, and altitude. For example, forests in the Alps and Balkans may extend to around 1,500 and 2,000 m above sea level (asl) respectively, while in the Himalaya and the Andes, the tree line rises to 3,500 and even 3,800 m asl. The upper limits of cultivation are higher in the tropics although there is variation according to the type of crop. Potatoes, for example, may be found at 4,300 m asl in the Andes. These limits have extremely important economic implications. Hardy species which can survive more rigorous temperatures may spell the difference between poverty and an adequate standard of living. There is an important difference between slope and exposure (adret–sunny, dry, ubac–cold, wet).

Typically above the tree line are the meadows (which may, because of deforestation, stretch much lower) and herbaceous shrubby areas. The former are important for the grazing of livestock on which many mountain peoples depend, while the latter may contain many rare plants, some of which are valuable herbs. More than half of mountain vegetation cover are grasslands which in a warmer, drier world assume as much importance as forests both to prevent erosion and as a "sink" for greenhouse gases.

In general, mountain areas are marked by a great diversity of species especially flora, a diversity which reflects the complexities of the mountain environment. This diversity is highly significant for conservation purposes since many of the world's threatened species are to be found in the mountains. Plant species contain many valuable or potentially valuable cultivars for many of the world's most important food crops, as well as being valuable for medicinal purposes.

Mountain zones support a large number and variety of fauna, which are significant to the ecosystem. Insects and their larvae are important in decomposition processes and as food sources for insectivores and birds. Small mammals like hyraxes, lemmings, gophers, and rodents provide food for larger carnivores. Hooved herbivores are characteristic of high mountain areas and most mountain systems have their indigenous wild species. For example, a small agile antelope, the klipspringer, occurs in the mountains of East Africa, mountain sheep inhabit the Rocky Mountains, the musk deer is found in the mountains of Asia, and the mountains of South America have a unique group of mountain herbivores, the camelids, llama, guanaco, alpaca, and vicuna. In the Himalaya/Hindu Kush no less than 11 hooved herbivores have adapted themselves to different ecological niches of altitude, temperature, and vegetation.

Many mountain herbivores are of great economic importance. The llama group provides meat and valuable wool, the yak is a draft animal in the Himalayas, and in Mongolia the Marco Polo sheep attracts game hunters. Hunting of mountain animals, however, remains a controversial issue, as animal populations are greatly reduced by indigenous hunting as well as by habitat destruction. Bears, wolves, and members of the cat family are all adapted to inhabit high mountain ecosystems.

Conservation of nature and land evaluation

Those concerned with the management of mountain ecosystems should have as detailed a knowledge as possible of both the natural vegetation and fauna and the possibility of introduced species. For conservation purposes there are checklists of endangered and threatened species in the red data books produced by the World Conservation Union (IUCN) and its local affiliates, although as yet there is no consolidated mountain list.

Knowledge about the conservation of species should be complemented by an appreciation of development processes, particularly the assessment of the optimum use and capabilities of mountain lands. FAO, for example, has a worldwide classification to be used in conjunction with detailed maps. But in this process of assessment, as in all other aspects of mountain ecosystem management, knowledge and local participation is essential. Land degradation may be most quickly and simply assessed by the degree of deforestation and loss of vegetative cover. In tropical mountains forests may be cut or burned for local subsistence or by commercial logging interests. In temperate mountains in industrialized countries pollution has become the major cause of deforestation and forest sickness. The latest reports from the Swiss Forest Institute show that over 70% of the trees have defoliation rates above 10% (up from 43% in 1985) while 24% have more than 25% leaf/needle loss.

Socioeconomic problems

Physical factors must always be considered in a broad socioeconomic context. The study of socioeconomic factors in the process of integrated land/soil management has proved a difficult task. UNESCO/MAB 6 has provided a detailed matrix of the interrelationships to be measured, including lists of 50 natural resource, economic, social system, and cultural variables with corresponding research methods and functional relationships in different use situations. The problem is both complexity and variability. Not all elements are of equal weight in any interaction. There is much uncertainty about magnitude and distribution. There are many surprises: for example, when the original UNESCO/MAB matrices were drawn up there was an inadequate appreciation of the role of climate change and pollution, or of the exponential increase in the number of tourists, or of the seemingly intractable problems involved in ameliorating poverty, or preventing wars.

In many mountain areas poverty is both the major development problem and the cause of much environmental degradation. A number of mountainous countries (e.g., Nepal, Bhutan, Ethiopia, Lesotho) are on the United Nations list of least developed countries where income and other socioeconomic indices, such as infant mortality, life expectancy, and literacy are very low. In many other countries, for example in the Andes, the Indian Himalaya, etc., the mountain districts have low socioeconomic indicators.

Even in the industrialized world mountain areas are relatively deprived, peripheral to, and exploited by richer and more powerful cities on the plains. A common feature of mountain history has been such subordination, although there have been exceptions, like the Inca Empire.

The environmental effects of poverty and exploitation are very great in mountain areas. There is much deforestation because people are too poor to afford other forms of energy or have greater need for arable or grazing land to raise cash or bolster subsistence. But more significant may be the exploitation by outside interests for logging, ranching, dam construction, mining, etc.

There is a considerable amount of literature on the causes of poverty mostly, however, written about other than mountain areas or by non-mountain experts. Much of this literature blames population pressure for the ecological damage while admitting that large families may be the result of poverty (e.g., when there is high infant mortality, families have more children to compensate). The simplistic argument is put forward that the more people there are the more trees are cut, the more there is erosion, downstream flooding, etc.

Many of these arguments, however, may be challenged in mountain areas. In both the Himalaya and Andes, for example, there is depopulation in many areas as people have left for the towns which have grown rapidly and also some tribal and indigenous mountain peoples are becoming virtually extinct because of bad health. Erosion "hot-spots" in the Himalaya do not occur where there is population concentration but rather because of geological structure. There may, in fact, be too few people available to mend the terraces which contain the soil flows. The demographic decline is paralleled by the disappearance of local cultures and traditional knowledge. Such knowledge, even if sometimes expressed in magical formulae, is often a sensible form of conservation and ecological management. As a consequence there is a major threat to mountain fauna and flora, some of great significance, e.g., rare medicinal plants or wild cultivars of basic food crops, grains, and tubers.

Much poverty relates to high rates of mortality and morbidity. The former may be due to endemic warfare and violence because mountains are contested boundaries between states and areas for interethnic rivalries, where there is outside interference or centers of dangerous occupations (e.g., Andean Southeast-Asian drug cultivation), which also cause environmental damage. Diseases may also be imported, for example, malaria with returning migrants. The causes of malnutrition may be due to natural disaster or inherent climatic difficulties. Many of the problems relate to inequities and iniquities in the food system. For example, mountain farmers may be forced more and more into the cash economy because of tax demands, tithes, rising rents and interest rates on increasing debt.

The basic causes of mountain poverty are in many cases external, often part of a global economy which needs reform. Unfortunately, although much aid has been poured into mountain regions the problems have not been solved and indeed in some senses aid may have worsened the situation. For example, dependence on outside subsidies has led to a further decline of traditional subsistence activities. Much aid is siphoned off by corrupt elites, or (as in the green revolution) landlords and the rich. Arms supplies have escalated wars and the poaching of endangered fauna. Inadequate knowledge of mountain ecosystems has resulted in the introduction of inappropriate technologies, e.g., planting trees which are not suitable and even increase erosion (by having lateral root systems).

The understanding of poverty demands a deep and sensitive evaluation of the social and cultural context. An important contribution to management techniques can be made by traditional knowledge. A basis for development may be found in community and grass roots organization.

Not all environmental degradation can be associated with poverty. In industrialized countries pollution is mainly responsible for forest death in mountain regions. Because of an increasingly upward movement in consumer demand and in the number of cars, etc., this trend is likely to continue.

In recent years, there has been a great growth in tourism and with it much construction of roads, ski lifts, and buildings. In the European Alps there are over 40,000 ski runs. Tourism is also making an impact in mountains of developing countries, and worldwide there are many environmental threats in the mountains, including road construction, dam building, military installations and activities. The erosion effects of these activities on unstable soils can be very great while the works involved destroy the vegetation, either in the process of pouring concrete or through flooding of valleys in dam construction.

The concept of "overdevelopment" has also been applied to socio-political and economic institutions. For example, Blackie (1986) has explained erosion in political economy terms, especially the over-elaboration and inappropriateness of bureaucratic institutions and discriminatory political procedures by elite groups. In assessing socioeconomic problems particularly the highland–lowland interaction must be born in mind. Although an oversimplification, there is a downward physical movement of water, soil, etc., in the river systems but an upward movement of capital, political influence, etc. However, many mountain areas are currently being deprived of their most important human resource through the urban drift.

Pollution

The mountains are particularly exposed to atmospheric pollution in acid precipitation. Aerosols and dust particles, pesticides, heavy metals and radionucleids are carried by the atmosphere to altitude. Chemical pollution is to be found even in the Arctic and the Antarctic. The chemicals reach as high as the ozone layer of the stratosphere. The increasing amount of CO_2 in the atmosphere threatens the earth with the "greenhouse" effect. The world's scientists emphasized in the 1990 Second World Climate Conference in Geneva that warming is likely to lead to much melting of glaciers, disruption of hydrology and dessication in mountain ecosystems.

International cooperation has been intensifying in recent years to promote mountain environmental protection. There are a number of programs provided by different international organizations, such as UNEP, the World Meteorological Organization (WMO), the World Conservation Union (IUCN), etc. In the UNESCO program "Man and the Biosphere" the long-term changes in the environment are studied. A major contribution to the development and coordination of monitoring and nature conservation is being made by the majority of countries who pledged themselves at the Earth Summit 1992 to accept the Mountain Agenda (see Annex).

Developing countries may also be affected by pollutants, not only as industrialization and motor transport increase but also because the global warming itself is a product of pollution with a worldwide effect.

Hazards and catastrophes

A vital part of the study of integrated processes in the mountains relates to catastrophes. Mountains are much prone to catastrophes as part of the seismic belt and subject to disastrous floods, avalanches, mud flows, fires, etc. There is a tendency for disasters to increase in number and effect. For example, climate change seems to be accomplished by a greater number of extreme conditions (e.g., heavy precipitation) while global warming in many areas dries out the forest and increases the risk of fire. Such disasters may initiate famines, epidemics, and other socioeconomic problems.

Catastrophes, such as flash flooding, severe drought, earthquakes, etc., are not easily managed or predicted by the usual precautions and procedures. For example, Himalayan-Gangetic floods may be caused by sudden enormous downpours which also have a major highly localized flood and landslip effect. Earthquakes occur in well marked seismic areas, for example the Himalaya-Alpine belt. But the periodicity of major earthquakes is long, e.g., perhaps a thousand years or more and then it is not likely that the same event will occur in exactly the same place. Nevertheless, management must take these possibilities into account in order to minimize the effect of such events.

3. Protection, Conservation, and Development: Relevant Techniques for Improved Management

Three large-scale important tasks may be identified to combat the problems that were discussed in Section 2: (i) efforts to prevent soil degradation, maintain soil fertility, and rehabilitate degraded soils; (ii) efforts to achieve the most appropriate methods for watershed conservation management; and (iii) socioeconomic reforms and community development methods that will provide a better basis for management and integrated rural development.

Soil conservation

Soil conservation relies initially both on specific techniques and appropriate farming systems. Sometimes conservation in itself is not enough. One FAO study in Southern Brazil considered it necessary to replace the whole farming system, changing biannual plowing with low tillage techniques, thus reducing exposure to erosion.

The type of conservation adopted must generally be adapted to the specificities of mountain ecosystems, particularly agroclimatic zones. There is much merit in utilizing, wherever possible, traditional techniques for not only are there many good, often neglected, ideas in the traditional treasure house of knowledge but also this greatly facilitates contact and rapport with the community.

The issue of soil and other forms of degradation have been extensively studied and selected references are presented in the bibliography (FAO/UNEP/UNESCO, 1979, 1984), presenting models of different types of degradation and desertification (wind and erosion, salinization, physical and biological degradation, etc.). UNEP/FAO/UNESCO (1979, 1984) have set out guidelines for the control of soil degradation principles which are also embodied in the World Soil Charter (FAO, 1982). In mountains the main problem is water erosion and, in general, the methods for control and prevention described here refer to this kind of degradation. Mention, however, should be made of the acidification of mountain soils, e.g., in Europe, due to pollutants.

The main methods to control mountain soil erosion can be summarized as follows:

Box 4

Guidelines to Combat Mountain Soil Erosion

A. Land Management Strategies

1. Keep land under appropriate vegetation, wherever possible natural.
2. Control logging and deforestation. Deforestation is the most serious threat to soils and mountain ecosystems.
3. Introduce reafforestation schemes using appropriate species.
4. Control water erosion (gully, riverbank, sheet, rill, etc.).
5. Make use of protective vegetation strips and belts.

6. Build areas suitable for tree plantation (e.g., microbasins).
7. Control bush and forest fires.
8. Introduce slope stabilization techniques (planing of trees, deep-rooted bushes, and grasses).
9. Develop a network of dry stone walls, particularly in exposed sites.
10. Build appropriate roads. Movement of traffic, livestock, and people will be controlled and pressure taken off soils and natural vegetation.
11. Control livestock numbers and movement. Destruction of soil by trampling and overgrazing will be reduced.

B. Livestock Management Strategies

1. Develop grassland improvement techniques. This includes different techniques such as introducing better fodder species, removal of unwanted species, encouraging species for soil conservation, etc.
2. Introduce policies of area closure. This technique closes off an area of degraded land to allow improvement of soil through natural vegetation.
3. Control grazing. Livestock can be tethered or herded in a controlled way.
4. Fence vulnerable areas. This will keep livestock away and enable vegetation to grow again.
5. Feed livestock by a "cut-and-carry" technique. Grass is cut and carried to a tethered animal to control grazing and destruction of vegetation by trampling.
6. Plant degraded or threatened land with a forage crop.

C. Agricultural Strategies

1. Plant crops that are suitable for the land. Some crops are more suitable than others for a particular site.
2. Rotate the crops to keep the land healthy. Crop rotation, including where appropriate, a fallow period, helps to maintain fertility and structure of the soil, making it less vulnerable to erosion.
3. Use techniques of reduced tillage or zero tillage to reduce exposure to erosion. This technique avoids unnecessary plowing or other tillage so that soil is not left unprotected and exposed.
4. The following specialized techniques are suggested by FAO (CFSD, 1986):
    - Strip cropping. The growing of crops in strips of different species and size, to reduce runoff.
    - Alley cropping. Food crops are grown in alleys between rows of bushes or trees.
    - Contour stripping. Crops are grown in strips that follow the line of the contour.

- Contour plowing. Plowing lines follow the contour lines and are therefore at right angles to the slopes. Cultivation takes place around the hill, not down the slope.
- Timing. Planting of crops should not be in rainy season when the soil is exposed.
- Grass stripping. This is a ribbon-like band of grass along the contour to stabilize soil.
- Grass sodding. One method of revegetation, grass sods, i.e., grass plants with a root system, are planted at regular intervals across the area to be improved. The grass will spread and make a cover.
- Level bund. This is a ridge built along the contour which has a basin at its uppermost edge.
- Graded bunds. Like a level bund but slightly graded sideways toward a waterway.
- Hillside terraces. This structure is built along the contour and is an area of land leveled for tree planting.
- Bench terraces. A slope is converted into a series of steps for cultivation, with a steep area of stones or grass between the terraces.
- Check dams. This is a wall across the bottom of a gully to reduce the speed of runoff through the gully and to prevent it enlarging.
- Cut-off drains. This is a channel created to collect runoff from a cultivated area an convey it to a waterway, to protect land at a lower level from excessive erosion.
- Vetiver grass (vetiveria zizanioides). This bushy grass which checks erosion and is also fodder has been hailed by development agencies as a miracle crop (World Bank, 1990).

Although these antierosion measures have the virtue of simplicity and are therefore very useful in management, such measures apply mainly to water erosion, especially the surface, gully and rill erosion created by moderate to intensive precipitation. It is extremely difficult to provide antierosion measures when there is very high-intensity rainfall and here the main management method may be prevention to avoid catastrophes, a topic which is dealt with later in the guidelines.

Not all water erosion is of course caused by precipitation. Improper irrigation practices notably excessive intensity of jets may also be important. Here proper controls may be of assistance such as regulation of jets, sprinkling, etc. There may also be appropriate soil protection measures, interruption furrows, mole plowing, soil mulching, etc.

Winds are often very strong in mountain regions because of orthographic and katabatic tendencies. The main methods of wind control may be similar to water erosion. Particularly important is the planting of shelter belts with multiple purpose, e.g., protecting livestock, tree crops, etc.

Mountain soil degradation is caused not only by erosion. Soils, for example, may become saturated and marshy especially in valley floors where there are floods, or leach when there is too little retention potential in the soil structure, dessicated when vegetation is reduced and in dry climatic conditions or when the soil is too hard-baked to absorb the water (pseudodroughts). The chemical content of the soils may lead to excessive salinity, acidity, alkalinity or various forms of toxicity. Irrigation can also produce salinity, since the water used may have dissolved salts which eventually rise through the water table. Specific treatments may be needed to improve such soil conditions, e.g., freshwater rinsing or pumping (salinity), liming (acidity), burying (toxicity).

But remedial actions against degradation, although necessary, are not sufficient. Farming methods must not only prevent degradation but must also preserve, sustain, and promote soil fertility and especially enhance the humus content of the soils. Great care must be exercised not to take too much out of the soils without putting nutrients and strengths back in. As in all soils mulching through composting or specific dug-in crops needs to be complemented by fallowing, as well as a sensible policy toward fertilizers, pesticides, etc. Great care must be taken, however, in the use of chemical additives which may resist biodegradable processes and so, in a sense, poison the soil, and also lead to pollution. The soil is like any ecosystem – a finite resource which cannot be overloaded for short-term production without there being long-term danger and losses.

There is a particular problem in humid tropic mountain regions where there is population pressure and hence a higher demand for subsistence food and cash crops. This pressure has undoubtedly led in some regions to deforestation and subsequent erosion, as well as overcropping and the reckless use of marginal land, so increasing the risk of crop failure, diseases, etc. Despite the complexity of the situation simple guidelines may be formulated for appropriate farming systems. For example, UNEP has recently suggested the following guidelines for farming systems to prevent soil degradation in the uplands of the Humid Tropics.

Box 5

Guidelines for Farming Systems for the Highland Humid Tropics

1. The land management system should be such that a layer of vegetation or mulch covers the soil surface throughout the year, including the dry seasons. At the same time it should minimize cultivation of the land where possible, by using reduced tillage.

2. Traffic on the land should be minimized, and preference should be given to equipment with low pressures on the soil. When compaction occurs, appropriate measures should be taken to loosen the soil and restore the structure.

3. When ridging, bedding, or mounding is necessary, it should be done with measures that preserve a mulch on the soil. Long and steep slopes must be avoided for this type of land preparation.

4. Where possible, multiple cropping should be practiced. Sequential cropping should include crops known to produce good stubble mulches and/or weed-suppressing shade crops. Inter-cropping should include mixtures of shallow and deep-rooted species. Care must be taken to return all organic residues to the soil. Judicious and timely application of the proper nutrients (N, P, K, Ca, Mg, S, Zn, and others) in adequate and balanced quantities, and also time for maximum biomass production, is necessary.

5. In most areas, soil-building rotations with planted fallows will have to be included in the farming systems, in order to maintain satisfactory levels of productivity. Alley cropping can achieve this without diminishing the production of essential food crops. Some intercropping or multi-storey cropping can be economically attractive, where market conditions are favorable.

One caution, however, must be sounded. It should not be assumed that the solution to soil conservation problems is solely in importing new farming techniques. Recent research (e.g., McNeeley and Pitt, 1985) has shown the potential of often unappreciated traditional farming patterns and associated conservation measures. Thus, for many years it was thought that slash-and-burn agriculture, e.g., in the humid Himalayas, was a wasteful method of cultivation. However, such traditional shifting cultivation systems (e.g., juming) involve a very intricate knowledge of the environment and may be one of the few ways of breaking up the hard lateritic pan typical of tropical soils. When the rotation period was long enough there was not necessarily degradation. The problem arose when the cycle shortened, although at least in areas such as Assam this was not necessarily due to population growth but rather because of administrative decrees that restricted the area where shifting cultivation could be practiced so bottling up the population. The potential of traditional knowledge has not been fully tapped, particularly the use of different species for fodder as well as for traditional medicines.

The productivity of land for producing food depends also on the level of inputs but a major FAO/UNPA/IIASA (1981) study has concluded in a series of revealing maps that present populations in mountain regions and even increasing populations could be sustained on present low levels of inputs especially if there is a relatively unrestricted movement of surplus foods and labor.

Total catchment management

An important management technique is total catchment management which has been defined as the coordinated use and management of land, water, vegetation, and other physical resources and activities within a catchment to ensure minimal degradation and erosion of soils and minimal impact on water yield and quality and other features of the environment (Journal of Soil Conservation, 1986). Catchments are areas of land in which both surface water and ground water drains to its lowest levels. Watersheds are those slopes which divide the catchment areas.

Catchments and watersheds constitute an important part of land/soil management not only because of in situ erosion but also because either too little or too much water downstream is usually the result of poor management or malfunctions in highland areas perhaps far away from where the damage is done. Catchment watershed management is closely connected to techniques which minimize human use and intervention. Watersheds are probably best maintained under forest or natural cover though this ideal situation is rarely attained and Hamilton and others (in Ives and Pitt, 1988) have argued that this is not a substitute for proper management. Forests are not necessarily the answer to all watershed problems. But there are important benefits in undisturbed forests which include avalanche protection, protection against surface and mass erosion through the shear strength of root systems, protection against splash, sheet, and rill erosion through the maintenance of litter and a vegetative understory, reduction of peak flows, and storm flows into the drainage system out of the water shed, capture of occult precipitation (but probably not increases in rainfall). Some of these protective functions quickly disappear with disturbance, e.g., avalanche protection. Mountain forests, of course, have many other benefits, for fuelwood, firewood, timber extraction, wild plants, as a refuge for endangered fauna and flora, as well as a sanctuary for many world religions and for modern-day tourists and as a "sink" for the main greenhouse gas CO_2.

There are many possibilities for agroforestry, e.g., crops interplanted between rows or using trees for food (nuts, fruit, etc.) or for fodder. But although the general rule is that trees are very useful there can be problems in introducing inappropriate exotic species which may be subject to disease or even promote erosion through inappropriate rooting systems. An overall balance is necessary. If there are reasonable pressures, e.g., to extend cultivation areas and minimize dangers or for sustainable development possibilities in watersheds, then a greater use can be recommended.

A particular problem in mountains often relates to livestock, especially in high watershed pastures. The effect of livestock on land/soil conditions may be considerable. Livestock, rather than population pressure, may be the immediate cause of overgrazing of mountain vegetation, including fodder trees. Apart from browing, livestock stamping may disturb the soil cover. In watersheds, striplings may be crushed or trampled, or trees debarked. Water courses may be polluted by purine flows. Livestock may be disease vectors. But livestock may be, of course, a management asset as well as a liability. Protein products from livestock may improve food and nutrition levels to higher levels than crops provide and anyway fit well with the cultural tradition of the nomadic or trans-humant life style of many mountain peoples. Dung may be a very valuable natural fertilizer as well as a fuel source.

Integrated development

As we have indicated land/soil mangement success depends on all sectors working smoothly together. Integration depends on both the application of interdisciplinary knowledge and the cooperation of different programs, departments, agencies, etc. In mountain management, as in other ecosystems, the most difficult task has been to integrate socioeconomic factors into the ongoing processes of land/soil management, even if there exist comprehensive models of theoretical integration. The problems are not only to integrate different disciplines and activities but also spatial and temporal aspects. For example, mountain ecosystems cannot be divorced from the lowland systems with which there is a constant interaction, both downstream (outflows of water, erosion, natural resources, migrants, etc.) and upstream (inflows of capital, knowledge, technology, administration, tourism, etc.). Rural development cannot be considered separately from the urban centers which have emerged even in hitherto remote mountain countries, such as Nepal, and which even in the most isolated valleys exert a profound influence. On the other hand, the necessity for integration pursued to a logical conclusion would involve the whole world in a network. The practical necessities of everyday management indicate the smaller the unit of area the more likely it is to succeed especially in intersectoral socioeconomic activities. Relatively small-scale frames for operation fit well with both the physical ecology and the social structure based on kinship systems. Many countries are subdivided into districts (or whatever they are called) where there are marked regional or ethnic differences. In mountain areas the unit may be a valley (which has been described as a sociological island) or a watershed. Ethnic boundaries may mirror these physical facts. The management task is first to know with some intimacy this local scheme, especially the cultural nuances, the patois, etc. Ideally, the management office should be in the field, through in many mountain areas as elsewhere there is a tendency to centralize functions and to leave managers stranded in bureaucracies many kilometers away from where the action is. If such situations exist the tendency should at least be resisted through the maximum number of field trips and contact.

The temporal problem of integration is rarely considered but important. Basically, there should be a continuity in time as well as space. For example, wherever possible, traditional customs should be used as an essential complement to grass root processes. But efforts should be made to build on the best of whatever exists.

The main difficulty in integrated activities has been to incorporate social and economic factors into the process. The main object is clearly to improve standards of living locally, but the content of those standards has many cultural variations. There is also a very serious problem of who decides and controls the process. In many cases decisions are made from outside and if only for this reason are rejected. Very often externally imposed programs are misguided even if well intended and have unforeseen adverse consequences.

Many useful models put the stress on self-reliance, bottom-up processes, development from below where there is an internal generation of development more than an external imposition (Pitt, 1976). In some areas, e.g., the Himalaya (Dani and Campbell, 1986), such processes are stimulated by cash or in kind incentives, although in the long run the best results come when there is a genuine local motivation as in the Himalayan Chipko movement (Ives and Pitt, 1988). Here initially the women of the village prevented outside exploitation of timber resources by passive resistance as well as promoting local welfare.

In improving standards of living the first objective is to provide a list of the basic needs which includes: health, education and training, income, food, and water. All these relate to integrated land/soil management as well as the raising of standard of living. As programs become more decentralized there is a tendency to better integration, but very often there is a specialization of function in management. For example, health will be incorporated in a program of primary health care or family planning; education will be in the hands of teachers, etc. Nonetheless, there is much more that can usually be done by specialists in integrated land/soil management. For example, health depends on the provision of clean drinking water and adequate sanitation, or the control of disease vectors which utilize water resources in their cycle. These activities involve proper land management especially the prevention of erosion and flooding which is often associated with epidemics. The provision of herbal medicines is related to forests where these valuable species come from.

The provision of adequate food and cash cropping stem from proper land management and the dissemination of vital knowledge both in the formal and informal education system, especially through extension services.

A complicated problem also relates to carrying capacity. Population and related livestock have been blamed for much environmental degradation in developing countries' mountains especially; but there may be a sustainable use with high population densities, e.g., as in the customs in the Indian Himalaya of utilizing only dead wood, weeds, inconsequential branches for fuel and firewood, or the economics of small-scale family production, distribution, and exchange.

Whenever subsistence agriculture offers significant opportunities there is usually a way to generate income for food, for taxes, for other desired consumer items. Apart from cash-cropping, towns and industries in mountains and indeed large-scale investments may have detrimental effects on the environment while off-farm labor and migration tend to take away vital manpower.

Much more difficult are the ways to combat problems which are external in origin, for example, debt, inflation, oppressive land tenures, taxes, wars, etc. One possible approach may be to encourage the process of self-reliance and self-management. Subsistence farming and livestock production was the basis of traditional mountain society and economy and some problems are certainly lessened by localizing economic activity, e.g., transport problems, food deterioration, middleman costs, currency fluctuations, etc. The aim, however, cannot be completely achieved if only because the expectations of mountain people are for a higher standard of living, or more consumer goods than can be provided locally. A sensible mix with an appropriate technology is then called for.

The most significant point is that whatever kind of socioeconomic development path is pursued local participation should be maximized to the full. Mountain people have long traditions of independence and a capacity to direct their own affairs. Particularly valuable are the cooperative social structures to be found in many mountain areas. Very often women and young people, neglected or underutilized in development programs, are in the forefront of such grass-root cooperation. There is a growing amount of literature on mountain success stories at the grass roots involving a productive relationship between local people and development agents to especially promote income generation, e.g., published by ICIMOD in Kathmandu and some of these items have been included in the bibliography.

Whatever activity is encouraged there is a basic need for forestry. In mountain areas, the basic energy needs are for cooking and heating which must be met by renewable local materials as far as possible. In addition, mountain areas may need some motor power to operate small machines, as well as energy for pumping water. There is at present no viable alternative to fuelwood for many of the world's rural poor. Petroleum-derived fuels cannot be afforded by most rural people, including mountain populations and there is little hydro electricity.

In many upland areas there are shortages of fuelwood as a result of deforestation caused mainly be commercial felling, or the need to clear the land for food production and livestock raising. Such deforestation is caused by the increasing demands from growing urban and lowland centers of population. In general, it is rarely the mountain people themselves or their energy needs that cause deforestation.

It is important to intensify agricultural production, i.e., increasing yield per unit area of land, in an attempt to prevent clearing of further forested areas for agriculture. This would, in addition, protect the traditional energy sources of rural people. The development of alternative energy sources for towns and cities would reduce pressure on fuelwood supplies from the rural areas.

For example, Nepal has a serious firewood crisis at the present time and an overall shortage of energy has caused severe socioeconomic problems. Biomass provides 93% of the total energy used by the country and dwindling forests can no longer serve the needs of the country's burgeoning population of sixteen million people and their attendant herds of livestock.

As fuelwood suppliers are becoming depleted, animal manure, grass, and stubble are playing a much more important role as domestic fuel. Such agricultural residues tend to have largely a local application as transport adds considerably to their costs. The seasonality of supply is one constraint to their utilization.

It is necessary to seek alternative energy sources. For example, peat is formed in some parts of mountain districts with high rainfall and the deposits can be an important local supply of fuel. As peat is heavy, there are high transport costs, and as it is normally water-logged or very moist on harvesting, drying presents a major problem. Continued use may lead to respiratory aliments from the smoke.

Another alternative is biogas. In general, high temperatures are needed for methane production, yet the addition of a solar heater can keep the temperature of the digester high and the gas can then be effectively produced at high altitudes. The addition of a solar heater does not raise costs appreciably and this technique has now great potential in highland areas. Systems of stall feeding can promote regular supplies of manure for biogas plants. In addition, bacteria involved in biogas production destroy pathogens in the organic material which would otherwise be harmful to human health. Currently, China has between 7 and 8 million digesters, many of which are being used at altitude.

These are potentials in certain specific localities for wind, solar, or geothermal power but the high cost of purchase and installation of equipment imposes constraints. Solar energy is not always appropriate for cooking but can be useful for water heating and drying of grain. Photo-voltaic cells are useful for water pumps and there has been much interest expressed lately in the possibility of solar hydrogen. Wind energy is used to raise water in some mountain areas. Geothermal energy is important in the Tibetan Plateau and provides the city of Lhasa with 70% of its winter energy requirements. In addition, it is used for processing, livestock and agricultural products.

The small-scale energy system that offers most promise in mountain areas is small-scale hydro-electric power. In accessible areas, small units of 16–40 mW are sufficient for domestic lighting and for the establishment of small industries (Metravelli, 1989). These small units have the advantages of being cheap and easy to install and maintain. Small units are not environmentally damaging and can promote the establishment of small industries in mountain countries. Finally, much can be achieved by energy conservation. The Bellerive Foundation has, for example, designed a wood-burning stove which saves 50% of the normal fuel requirements.

Tourism in mountain areas

In many areas tourism has been suggested as an alternative source of income utilizing the scenic and recreational assets of the mountains. But there are dangers and pitfalls. The following list indicates some of the benefits, costs, and necessary steps for appropriate tourist management.

Box 6

Management of Tourism in Mountain Areas

1. Steeply sloping mountain areas have low resilience to the impact of mass tourism.

2. Environmental damage, as a result of tourism, may be permanent or take years to be restored.

3. Tourism can lead to land degradation and soil erosion as a result of tree cutting for fuel wood, accidental bush fires, and destruction of vegetation.

4. Other environmental effects of tourism on mountain ecosystems include the collection of flowers, trampling of alpine vegetation, poaching of wildlife for sport or food, and habitat destruction.

5. The pollution of mountain areas by tourists involves litter, remains of camp fires, and human waste. The pollution of water occurs as a result of dumping garbage and depositing human excreta.

6. The flora of mountain areas is fragile and slow to regenerate. Mountain fauna can experience harassment or habitat destruction as a result of tourism. The establishment of reserves protected from tourist pressures, preserving genetic resources, must be an important part of integrated mountain development. The removal of trees, for example, for ski runs, reduces the food supply and habitat for wildlife as well as increasing the risk of landslides, water run-off, and erosion.

7. Tourist-related constructions (e.g., ski lifts) can reduce the aesthetic value of the environment for summer visitors.

8. Tourists can be confined to certain areas to reduce environmental degradation. Routes can be fenced, picnic sites can be organized, and litter bins can be provided.

9. Steps can be cut into the soil at the summits of mountains to reduce the impact of a large number of visitors and to reduce the trampling effect of many visitors on soil and vegetation.

10. A raised metal walkway can be built across Alpine meadows to protect vegetation and soil. Tourists can be advised to walk on a grid which is constructed 6 to 10 inches above the surface of the soil.

11. The construction of ski pistes for down-hill skiing and other ski structures leads to erosion. In addition, trees may be felled to clear a slope for skiing.

12. Agricultural mountain communities can be significantly affected by tourism. High tourist pressures can have an adverse effect on the social structure of the local population.

13. An influx of visitors from another culture, geographical area, religious and economic background and value system can erode local cultures. Unsophisticated local people can be influenced by visitors.

14. Exposure to the conspicuous wealth of foreign visitors can affect poor people from developing countries.

15. The effects on the indigenous society can include: the influence on young people by material possessions, habits, and values of tourists; removal of people from their traditional culture; discrimination against local people, e.g., pilgrims, in favor of tourists who pay more for goods and services; local artifacts or religious objects receive a monetary value. Formerly, such artifacts would be outside the economic system; they were revered and could be given no cash value. Under the influence of tourism, everything has a cash value. In these ways, traditional values can be eroded.

16. The benefits of tourism can include provision of employment opportunities, for example, as guides in mountain areas, and by bringing cash into the economy. An increased demand for fruit, vegetables, and other foodstuffs can provide an incentive to agriculture. Tourism provides significant sales outlets for handicrafts and may promote and stimulate this aspect of indigenous culture.

17. Development plans and feasibility studies must not rely solely on economic considerations but must assess consequences to society and to the environment.

18. As far as possible, tourist-related activities should be close to the value system of the region and to the traditions of the indigenous people. For example, in the Himalayas, the provision of safaris by mule, donkey or horse is close to the culture, where people travel with pack animals for trading purposes.

19. Mountain areas with tourist potential must decide between high investment "hard" tourism, with its consequent social and environmental pressures, and a "soft" approach to tourism which can be less damaging.

20. Tourism can result in a decrease in mountain agriculture as land is made over for tourist use, or agricultural workers leave the land for jobs that are more highly paid in tourism. This could result in food scarcities. Productive land can be changed to unproductive land.

21. Mountain areas may receive their visitors seasonally and the land may be used for two different purposes and diversify the local economy. Pastures may be used for cattle in summer, for example, and for winter sports in the cold months when the land is covered with snow.

An important but neglected part of tourist potential in mountains is the cultural heritage. Mountains are home to many indigenous peoples, some threatened with extinction, all with vibrant cultures. The artifacts of these societies are under great threat from neglect, vandalism, and theft. The cultural patrimony needs as much protection as the natural heritage.

Protected areas and conservation

Although the integrated use of land is a major part of mountain development, the very fragility of the ecosystem demands more than any other ecosystem that areas are protected or even retired from production (as in the Southern Alps of New Zealand). This task may not only be to prevent erosion but the wider conservation purposes of preserving threatened species of fauna and flora. Many of the strictly protected areas listed by the IUCN and the UN are in the mountains, or watersheds, or in the wetlands that are part of the riverine and lacustrine systems of mountains (see, for example, UN, 1985).

In addition to strict conservation reserves there are models of partial use of mounting ecosystems in which conservation and development are combined. One of the most promising models is the biosphere reserve, whereby there is a strictly reserved core, surrounded by a buffer zone where there is some use, and finally the peripheral areas where there is multiple use (UNESCO, 1989).

Multiple-use planning of this type is a means of accommodating not only agriculture, silviculture, etc., but also tourism, which has boomed in many mountain areas in the less developed countries as well as industrialized countries and which has led to problems, e.g., in the construction of the infrastructure, buildings, overloading sanitation systems, etc.

Even if there is no protection every effort should be made to encourage what are now called "soft" interventions, i.e., less damaging tourism (for example, cross-country rather than down-hill skiing), organic farming, self-sufficient energy, and generally self-reliance.

Finally, protected areas may have a very significant role to play in promoting education, training and awareness. The areas may be used for field trips, classes, courses, or their photogenic nature captured on instructive films. Protected areas may show the proper respect for environment or values such as peace, well demonstrated in the 46 transboundary peace parks around the world, most of which are in mountain regions.

Education, training, and awareness

A key to successful management is appropriate education, training, and awareness. This means that essential messages should exist in both the formal (UNESCO, 1989) and informal (open) education systems as well as more widely in the media. Training courses should be available and availed of. Extension techniques should appropriately reflect a close rapport with the community and its traditions.

Bibliography

The sources for these guidelines are basically derived from several longer works (UNEP, n.d.; UNEP, 1990, UNEP, 1988), prepared under this UNEP/COM project. Several technical reports complement these guidelines (Metravelli, 1989; Charashvili, 1989; Turmanidze, 1989). The material in the tables and boxes are extracted from the following: Tables 1 to 3 (UNEP, 1987); Box 4 (UNEP, 1986); Boxes 5 and 6 (UNEP, n.d.).

Further reading can be found in Stone (1992) or in the United Nations University/International Mountain Society Quarterly - Mountain Research and Development, which has special issues on the Andes (in Spanish as well as in English - Vol.1, No.2, 1981; Vol.2, No.1 and 4, 1982; Vol.4, No.2, 1984), the Himalaya (Vol.5, No.1, 1986), Africa (Vol.8, 1988), high mountains (Vol.4, No.4, 1984), instability (Vol.4, No.1, 1984), as well as reviews, comments, etc. A good bibliography on highland-lowland interaction for the Himalaya is Bruijnzeel (1989).

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Useful Addresses for Further Information

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CIPRA (International Committee for the Protection of Alpine Regions), Heiligkreuz 52, 9490 Vaduz, Liechtenstein.

Commonwealth Agricultural Bureau, Wallingford, Oxford, OX10 8DE, UK.

FAO, Viale delle Terme di Caracalla, 00100 Rome, Italy (Mountain Pasture Network, Station Federale de Recherche Agronomique, Changirs, 1260 Nyon, Switzerland).

ICIMOD (International Centre for Integrated Mountain Development), PO Box 3226, Kathmandu, Nepal.

IIASA (International Institute for Applied Systems Analysis), 2361 Laxenburg, Austria.

International Mountain Society, PO Box 1978, Davis, CA 95617, USA.

IUCN (World Conservation Union), 1196 Gland, Switzerland.

Mountain Agenda, c/o Geography Institute, University of Bern, Hallerstraße 12, 3012 Bern, Switzerland.

UNEP, PO Box 30552, Nairobi, Kenya.

UNESCO (MAB), Place de Fontenoy 7, 75700 Paris, France.

World Bank, 1818 H St NW, Washington, DC 20433, USA.

Annex 1: Mountain Agenda – UNCED, 1992[1]

Towards Sustainable Development in the Mountain Areas

INTRODUCTION

In many significant ways the mountains of the world have made major contributions to the growth of human civilizations. Though not adequately recognized, these roles are becoming more and more crucial as we approach the 21st century.

Over the last few thousand years the relative inaccessibility of the mountains and their proneness to hazard, have acted as barriers to the easy expansion into the mountains of major human civilizations which have normally grown in the plains on the banks of rivers. Similarly, there are examples of important mountain civilizations like those of the Andes and Tibet which have, by and large, remained geographically restricted. This geographical restriction and isolation have, on the one hand, led to rich ethnic, linguistic and cultural diversity while at the same time causing the marginalization and poverty of the mountain people.

In the last hundred years or so, there have been some significant changes, made possible by the development of mechanical means of transportation like automobiles, ropeways or aircraft etc. These new technologies have generally made the mountains more accessible to the larger economies of the plains. They have opened mountain resources to exploitation on a larger scale, often impinging negatively on the natural ecosystem In this way forest cover in the Himalaya was damaged, mineral extraction in the Andes destabilized catchment area hydrology, tourism in the Alps took pollution up to the skyline and commercial farming in Africa provoked large scale desertification. This continuous process of the enhancement of accessibility has changed the demographic balance. The sharp increase in mountain populations in many areas has led to over exploitation and degradation of the mountain soil resource and forests to a level which has raised great concern.

Such quick transformations guided largely by exogenous economic motives are also seen in other smaller mountains of the world and have caused serious ecological degradation, enhanced the loss of top-soil, and threatened bio-diversity whilst mountain people have remained poor. The fragile mountains need to be ecologically stabilized before their inherent fragility takes them beyond the point of no return. The resulting impact on the stability and survival of the human societies are surely going to be disastrous both in the mountains as well as in the plains.

The mountain ecosystems with their immense water resources and hydro-potential as well as the agricultural productivity of the mountain lands need to be managed to face the challenge of securing and increasing food production, conserving the rich bio-diversity, enhancing the quality of life for the mountain people over and above the task of leaving of sufficient space for the use of the mountains for spiritual rejuvenation and recreation by ever increasing numbers of people from the plains.

In view of the urgent need, AGENDA 21 proposes two distinct programme areas which are being put forth in view of para 2 of the Revised Draft Decision submitted by the Chairman to the PREPARATORY COMMITTEE which asked for further elaborations on the fragile mountain ecosystems and the development of a separate programme with regard to all the mountains of the world. The Programme Areas are as follows

A Generation of Mountain-Specific Ecological Knowledge and Database

B Evolving Approaches to Sustainable Development of the People in the Fragile Mountain Regions of the World

[1]Proposed text of chapter for Agenda 21, prepared by UN University, International Centre for Integrated Mountain Development, Nepal, and International Mountain Society.

A. GENERATION OF MOUNTAIN-SPECIFIC ECOLOGICAL KNOWLEDGE AND DATABASE

BASIS FOR ACTION

The mountains are characterized by complex ecosystemic linkages and a high degree of vulnerability to ecological destabilization. In the design of sustainable development in the mountains the ecological knowledge and data would be a necessary input. However the present state of data and scientific knowledge on the mountain ecosystems are highly inadequate for such a task. In the absence of such an information base, interventions in the mountains have been characterized by uncertainties which have often aggravated ecological instabilities. In facing the challenge of sustainable mountain development today, we urgently need a far more comprehensive knowledge and information base. This urgency is the main basis for action in this programme area.

OBJECTIVES

- To provide in a phased manner, data base and ecological information that would be useful in the advancement of integrated management of natural resources and of comprehensive environmental impact assessment in the fragile mountain ecosystems

  To understand, examine and circulate widely by the year 2000, ecological knowledge, technologies and practices already existing in the various mountains of the world

  To undertake a systematic and intensive survey of the crop, plant and animal genetic resources and establish mechanisms for their conservation in situ wherever feasible

  To foster ecological sensitivity and competence in the various organizations dealing with development and disaster management in the mountains.

ACTIVITIES

MANAGEMENT RELATED

a. To build up the multidisciplinary ecological knowledge base by creating new institutional mechanisms or strengthening existing ones at national and regional levels which are working on mountain ecosystems

b. To produce, within the next five years, maps of the mountains showing hazard zones in terms of soil erosion, land instability and other mountain hazards

c. To provide the mechanisms that would catalogue and preserve biological diversity, both in protected areas as well as in private lands and of financial support from international sources to farmers opting for *in situ* conservation of bio-diversity

d. To evolve mechanisms to encourage the use and transfer of environment friendly technologies and to discourage strongly ecologically destabilizing ones; in particular farmers adopting ecologically preferable farming practices need to be supported technically and financially.

DATA AND INFORMATION

- To build up the strategy for the establishment of meteorological and hydrological monitoring stations at a scale matching the microclimatic diversity existing in the world's mountains

- To catalogue the crop, plant and animal genetic resources, with priority to those under threat of extinction

- To develop quantitative and time-series data on the land cover characteristics of the various mountain areas, especially forests, snow cover and land prone to drastic soil erosion

- To develop quantitative and time-series data on the use of local forest products according to types of production and consumption in various mountain areas

- To generate comparative figures for the cost of using major technologies, for example in road building or dam constructions, on the basis of their ecological preferability

- To generate shadow prices for the resources, like fresh water, made available free of cost by the mountain ecosystems

- To collect, examine and disseminate knowledge and information on ecosystems and local technologies available from various mountain inhabitants, of a kind that would be useful in the promotion of sustainable mountain development.

INTERNATIONAL AND REGIONAL COOPERATION

- To promote international and regional cooperation to facilitate free availability of scientific knowledge and data that would be useful for sustainable mountain development

- To promote international networking of people's initiatives, active non-governmental organizations and environmental movements working for sustainable development in the mountains

- To establish a Coordinating Secretariat for global promotion of the **MOUNTAIN AGENDA** in association with an existing institution already engaged in its promotion.

MEANS OF IMPLEMENTATION

SCIENTIFIC AND TECHNOLOGICAL MEANS

- Consider undertaking pilot projects that combine environmental protection and development functions with particular emphasis on some of the wider uses of environmental management practices / systems that have been tested over a long time by the mountain people.

- Strengthening of interdisciplinary scientific research and technological development programmes including diffusion through national and regional institutions in particular in meteorology, hydrology, soil sciences, earth sciences, plant sciences etc.

HUMAN RESOURCE DEVELOPMENT

- Regular conferences, workshops and training at various levels to advance the ecological understanding of the scientific and technical manpower involved in research on mountain ecosystems

- Production of audio-visual programmes about mountain societies to facilitate their ecological understanding

B EVOLVING AN APPROACH TO SUSTAINABLE DEVELOPMENT OF THE PEOPLE IN THE FRAGILE MOUNTAINS

BASIS FOR ACTION

The mountain areas are generally rich in natural resources but the mountain people are also poor and underdeveloped. The issue of environment and development is more closely intertwined in the mountains than in the plains. It is impossible to ignore the potential of the mountain land, forest and water resources in the attainment of sustainability in mountain development. By taking care of the mountain resources, by stopping land degradation and soil erosion, through wise utilization of climatic advantages, mountains can be developed on a sustainable basis. The potentialities as well as the fragility of the mountain areas pose a special challenge to the evolution of an approach to sustainable development. This is why this programme area is of great significance.

OBJECTIVES

- To plan and manage the development process in the mountains in such a way as to ensure a better quality of life of the mountain people on a sustainable basis
- To locate by the year 2000 major hazard zones and degraded areas in the mountains and evolve on a participatory basis, programmes for the rehabilitation of degraded areas so as to improve directly the quality of life of the people, in particular women and children
- Based on microlevel data and recognition of local potentials, help provide river basin / catchment area-based programmes of economic activities for removal of mountain poverty on a sustainable and environment friendly basis.

ACTIVITIES

MANAGEMENT RELATED

- To network various micro-level efforts at sustainable development of the mountain people and help disseminate positive experiences thereof
- To strengthen existing institutions already working at national levels and help promote similar ones for the promotion of sustainable mountain development
- To promote the growth of sustainable farming practices that make better use of the soil, water and climatic advantages of the specific areas in the mountains
- To promote non-farm activities in the mountains as an alternative to ecologically unsustainable agricultural practices.

DATA AND INFORMATION

- To gather demographic information on mountain societies including specially those on socio-economic, health, education and employment- related issues

- To gather quantitative information on the extent of the non-formal economies and in particular the contribution of women and children

- To catalogue and disseminate widely conservation-based and mountain-appropriate technologies like micro-hydro, small bridge construction, solar cookers etc in languages of the mountain population

- To collect ethnographic details and patterns of cultural diversity in the context of people-nature relation in the mountain societies as an input to sustainable development strategies

- To gather and disseminate indigenous practices, like those for to soil conservation, plant protection, composting etc that would be useful in enhancing sustainability of mountain farming systems

INTERNATIONAL AND REGIONAL COOPERATION

- To initiate regional contacts and cooperation on the basis of mountain ranges and river basins towards exchange of data and information, especially in the context of management of mountain disasters like earthquakes, flash floods, avalanches etc.

- To encourage international cooperation among regional centres for mountain development (like ICIMOD) through the Coordinating Secretariat to be established for the promotion of MOUNTAIN AGENDA

MEANS OF IMPLEMENTATION

SCIENTIFIC AND TECHNICAL MEANS

- To establish regional training centres to promote ecologically sustainable techniques, either from endogenous or exogenous sources

- To enhance exchange and interaction among natural scientists, social scientists and engineering scientists working in fields related to mountain research and development

HUMAN RESOURCE DEVELOPMENT

Being a programme for determining the approach to sustainable development in the mountains, it needs planners and development professionals well trained in the ecology and socio-economy of the mountains. The Coordinating Secretariat for the promotion of MOUNTAIN AGENDA may be entrusted with the task of conducting intensive training programmes and production of training materials.

Annex 2:

Next Steps for Sustainable Mountain Development[1]

- the fuller incorporation of mountains and the cryosphere in the World Climate Convention process. The cryosphere may want separate treatment in a Law of the Ice process;
- the immediate expansion of protected areas in specially designated mountain and mountain forest areas. A map for the Alps was prepared as long ago as 1974 for the Trent Conference (Club 1974);
- an intensive campaign of education, training and awareness;
- a coalition and network of interested NGOs and official bodies to facilitate the exchange of information and improve co-ordination. There are still major obstacles to communication between the cultures and language groups in Europe;
- increased participation at local level in reforestation schemes such as the Bellerive Alp Action Green Roof project or Global Releaf;
- more emphasis on the preservation of biodiversity through more comprehensive red data books and rescue operations;
- the preparation of templates for sustainable development in different mountain regions to feature soft tourism "distance" employment[10], an agricultural renaissance and community development;
- contingency plans and funds for surprises and disaster relief.

[1] From Nilsson and Pitt (1991).