# The Three Dimensions of Himalayan Development

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We have gathered here to do reverence to the abode of the gods in a way that may seem unusual to traditionalists but which the gods themselves would wholly approve. We are here as developers, and nothing is more urgently needed in the Himalaya today than constructive measures of development. Before we start our task it is absolutely vital that we know something of the daunting variety of the Himalayan situation. Can we approach it with ready-made models conceived in distant offices? Where, indeed, should we begin? The answer can only be: On the ground, and we will never be able to comprehend the ground truth unless we shed many of the preconceptions acquired in years of happy wandering in the Himalayas, of study, and even of worship.

For each one of us here the Himalaya may have a different meaning. For the geologist it is a striking example of tectonic upthrust, for botanists a rare treasure house of species, for climbers the ultimate challenge, and for those of us who depend on them for a livelihood the Himalaya are a demanding taskmaster. The first preconception we have to shed is that the Himalaya are some kind of Eden on earth where only man is vile.

For good or ill there are fifty million of us in this Eden. We cannot be wished away. But it would be disingenuous to suggest that the changes man has set in motion are not in most cases anything other than highly adverse to Himalayan ecology. Our first task therefore will be to study the interplay between man and the resources which exist in his given piece of real estate. These are the two principal factors we have to take into account in formulating our approach to development.

To start with, the natural environment itself is differentiated beyond belief. I shall not presume to remind this learned audience of the geological, climatic, and other factors. In its great length of 2,500 km and average width of 200 km the system comprises an unparalleled range of characteristics. The mighty upward heave which created the Himalaya in four major longitudinal belts has also torn them apart in a chaotic web of towering mountain, gorge, and valley, facing every conceivable point of the compass. As if this wild diversity were not enough, as the connecting arc between what Arrian, in his account of Alexander's campaign, called the Caucasus, and the shelving hills of South-East Asia, the Himalaya at one end are temperate and at the other tropical, with an intermediate zone in which there is a shading off of characteristics.

Adopt whatever criteria we may, whether soil, climate, height, rainfall, situation, or aspect, it will be difficult to find two watersheds that are identical. Often what is most striking are the differences. Thus, only the razor's edge of the Rohtang pass divides the rich and fertile Kulu valley from the harsh cold aridity of Lahaul-Spiti. But eco-systems differ also in adjoining areas in the same zone, between Sikkim and Chumbi, for instance, or on either side of the Se La in Bhutan. Ecological differences will be found even if the ring is drawn much closer in the same environment. For example, the Dombang micro-watershed, which is a small confluent of the Lachung Chhu in Sikkim, has sizeable stands of larch in a continuous and unbroken zone of abies. When closely studied it will be found that each watershed is sufficiently differentiated to be treated as a distinct entity for the purposes of development.

Enter man, and with him we meet the most decisive factor in the vast processes of change that have overtaken the entire mountain system. He is at once the principal beneficiary of its resources and the primary agent of change. It must be said too that man is the main sufferer of the sequence of diminishing resources which he has set in motion by his struggle for survival. I need hardly remind this audience of the enforced exodus from Mahabharat to the Nepal Terai and from the districts of Garhwal division in Uttar Pradesh virtually to every corner of India. The floods and devastation that have doubled in the plains of India in the last twenty years can be traced back to the remotest watersheds in the Himalaya, over-tilled and bereft of vegetative cover. I have tried not to load this paper with statistics. My argument is essentially simple, but to clinch the point that man is the most critical factor in the making and unmaking of Himalayan ecology, I shall repeat a table of figures from a paper by the noted agricultural economist, Dr. S.L. Shah. These figures apply to the eight hill districts of Uttar Pradesh, but they are equally typical of the entire region.

| Year | Population (million) | Forest stock (million cubic metres) | Cattle units (millions) | Grass stock (dry matter) (mill. tonnes) |
|---|---|---|---|---|
| 1981 | 4.787 | 66.00 | 3.40 | 8.86 |
| 1991 | 5.995 | 36.30 | 3.46 | 5.30 |
| 2001 | 7.508 | 19.96 | 3.52 | 3.17 |
| 2011 | 9.404 | 10.98 | 3.58 | 1.90 |
| 2021 | 11.777 | 6.04 | 3.65 | 1.14 |
| 2031 | 14.750 | 3.32 | 3.71 | 0.68 |
| 2041 | 18.472 | 1.77 | 3.78 | 0.41 |

(Source: Presidential Address, dated 25th December 1981 at Dharwad, Karnataka University).

As you will see, resource depletion is a stark fact. It did not happen all at once. The pressure on resources can be traced back to two different demands. The expanding local population needed ever increasing areas of land to till, and supplies of firewood, fuel, and fodder. But a much more formidable and variable demand arose from markets outside the Himalaya. It was not for forest produce only, but also its abundant waters and latent energy. The unprecedented expansion of communications and industry after the First World War was a major turning point. Three factors combined to make it easier to satisfy the intensified demand for Himalayan resources–the road, the motor truck, and the railhead. Whole hillsides of timber fell to the axe. More than anything else it is the depletion of the forests which has brought about devastating changes in Himalayan ecology. The effect on the resource situation has generally been very adverse, but because of the operation of complex local factors, the effect has also been highly diversified.

Why is this so? The short answer is that it follows from the diversity of peoples who have made their home in the hills, and even more so because their response to available resources has perforce been determined by the situation in each watershed. Even when community structures and cultural mores have been similar, nature may have been prodigal in one case and harsh in the next.

To start with, there could hardly be a more startling conglomeration of people anywhere in the world. The population of fifty million or so have been brought together in a unique contact zone from three different civilisations—from the north, south, and west. All the world's major religions have found lodgement there. These demographic and cultural movements have followed the natural passages, north to south along the river courses, and laterally, in the great transverse valleys.

There is no better example of these process than the Kingdom of Nepal. Upheavals in the plains of Hindustan forced proud Rajputs into the interior of the middle hills, and the transverse movements were typified by the conflict of Gorkha and Malla kingdoms in the Kathmandu Valley in the 18th century. Distinctive demographic enclaves can also be found in the Tibeto-Buddhist highland valleys and the Hindu dominated areas in India, such as the polyandrous Jaunsar Bawarias in Dehra Dun district and the isolated village of Malana in Kulu. It has been surmised that these blue-eyed people are descended from stragglers of Alexander's army. We know that as he moved on he left behind the old and unfit.

Up to this point I have stressed the high degree of environmental, ecological, and human variability in the Himalayan situation as it is today. Conditions have been created from watershed to watershed that defy standard approaches. Thirty years ago the UP government in India passed the Zamindari Abolition Act. Its provisions were applied without variation to the highland valleys populated by Bhotias, whose main economic activity was trade with Tibet. When that stopped, they found they had lost substantial portions of their holdings. In keeping with the resilience of most border communities they soon turned their trading instincts to the lower valleys. Von Fuhrer Haimendorf has described how the Thakalis of the Karnali valley responded in exactly the same way to changed conditions on the border.

Even such a manifestly beneficial measure as abolition of serdom can misfire. A few years ago, the Sulungs of Chayang Tajo in East Kameng were freed by paying off their Bangni masters. It didn't work. As one enlightened Sulung put it, they didn't know the meaning of freedom. Instead, the government should first of all have given them good medical facilities, then education, and finally independent settlement. By themselves, good intentions are seldom enough.

These are two examples of misconceived approaches unrelated to the prevailing situation. Let us take another case, of application of standard development programmes. Earlier this year the middle Teesta Valley was the scene of an ecological disaster of considerable magnitude. The facts are fresh in our minds. In the last twenty years short-sighted measures of so-called development had resulted in overloading the support capacity of this extremely fragile valley with excessive infrastructure as well as a disproportionately large influx of outside labour, all scraping a living from the soil. Disaster followed. Why? Because year after year considerations of ecological security in this particular watershed had been tragically subordinated to other considerations, even though the two could have been reconciled.

In short, even if we, as developers, should perchance forget, the Himalaya will unfailingly teach us what we need to know. Fix whatever unit we may, and I shall just say it should be a hydrological sub-system, a mini eco-system in which natural and human resources are integrally related to each other, let us start by getting to know it. This process must begin with understanding the people, their present needs and potential, their community structures and management system. Then, in association with them, the resource situation will be studied and development plans drawn up, designed for the sub-system itself, and not for a hypothetical unit conceptualized in our central offices. Guidelines will help, but standardised approaches are likely to prove expensive failures. More than anything else, let us start only with as much as the people can assimilate, using, as far as possible, local initiative, manpower and even know-how. If extension is handled correctly it should result in effective technology transfers at the level needed.

There is time only to indicate the outlines of the approach I have recommended in detail elsewhere. The goal of socio-economic development must rest on the secure foundations of resource protection, regeneration, and production in the unitary eco-systems. Forests and vegetative cover generally hold the key to the situation. Their protective value is well understood, particularly in strategic and endangered areas, and they are vital for the regulation of the water regime. Socio-economic development of the constituent micro-watersheds need not be postponed until after the resources situation in the eco-systems has been stabilised. It should go together, but, as in the case of the eco-systems, clear priorities need to be adopted so as to obviate the all too common danger of diffusion of effort. Reforestation of depleted village forests with species which satisfy the people's needs for timber, fuel, and fodder, intensive rather than extensive agriculture, and measures to control erosion and extend irrigation are some of the main items of socio-economic development of the micro-watersheds. Realistically, we cannot hope to achieve a significant increase in the support capacity of heavily populated areas without turning down the graph of population growth.

As this brief outline of development strategy suggests, a simple set of measures based on clear priorities are more likely to be within the performance capacity of the people than elaborate schemes based on counsels of perfection. Before we can hope to land on the moon, let us set up a firm launching pad. And let me make one final point. Unless we can improve the lot of Himalayan man we were unlikely to succeed in our endeavour. This imposes a tremendous responsibility on the governments of the region. They have a clear obligation to set an example in judicious resources use. Directly or indirectly, they are the biggest converters of Himalayas resources, whether the end products are wooden furniture in Singapore or electrical energy in the glittering cities of the valleys and plains.

**Summary**

1. Himalayan environment is a complex of three factors: the natural endowment, men, and the interactions between the two. The three together make up the ecology of the Himalaya's constitutent watersheds. Because of the great diversity of natural conditions and population groups, ecological conditions and population groups, ecological conditions in each watershed are distinctive rather than uniform.
2. In natural conditions ecological balance should exist in watersheds, which are the basic hydrological units. In

practice, however, most of them suffer from grave ecological imbalance because of faulty and also excessive use of their natural resources. There can be no lasting development in the Himalaya without man's just needs being met. Therefore the aim of Himalayan development should be to reconcile ecological balance of resources in the watersheds with their support capacity to sustain human needs.

3. Development plans should follow general guidelines, interpreted and applied in the light of conditions in each watershed, rather than standard models. Because of the alarming rate of resource depletion, the primary objectives of development should be protection, regeneration, and production. Restoration of forests and vegetative cover hold the key to control of erosion and stabilisation of water regimes, which are the two most urgent resource problems of the Himalaya.
4. A simple set of measures and adoption of clear priorities is recommended because:
   i. protection of strategic and endangered areas cannot wait;
   ii. money is not unlimited:
   iii. the assimilative and performance capacity of the local people is dependent on the time they can spare from subsistence occupations.
5. Priorities recommended are:
   i. Resource development in the eco-system (catchment). (This will automatically look after water regimes).
   ii. Reforestation of depleted village forests with species to meet the people's needs for timber, fuel and fodder.
   iii. Socio-economic developments, starting with the most vulnerable micro watersheds.
6. Genuine community involvement is essential for success in development. How to achieve this in each case is a test of the ingenuity of social scientists and administrators. The actual executing agency has to be put together in the light of the heavy commitments of existing district and block staff. They are also habituated to a style of functioning which does not easily harmonize with a mass movement at the people's level. Something like a people's volunteer force could provided both motivation and drive, provided it is drawn from the areas to be covered and not inducted from outside. If importation of outside labour is unavoidable, measures should be taken to ensure that they do not settle down to add to the burden on the limited support capacity available.

# Factors Affecting Pressure on Mountain Resource Systems

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*"Man, being the servant and interpreter of nature, can do and understand so much, and so much only, as he has observed in fact, or in thought, of the course of nature: beyond this he neither knows anything nor can he do anything."*
Francis Bacon, *Novum Organum,* 1620

**Introduction**

With many others, including many of those millions working and living in the remote mountain areas of the Earth, I have long shared the hope that there would one day be an international centre which would focus the talent of the scientific community on the critical problems of the people of the uplands of our planet. For they are a significant portion of our human family. Worldwide, they account for perhaps as much as 10 per cent of the Earth's population and they occupy a quarter of its land surface. Throughout much of human history, they have been both isolated and disadvantaged; isolated by the difficult terrain they inhabit and disadvantaged by the unforgiving environment in which they live.

Modernization and the transformations which have occurred in the larger lowland world have only recently begun to affect the lives of upland people. These impacts have been significant and not always positive, yet study of their effects has been sporadic and limited. This organized effort to bring talent from around the world to bear upon the problems of mountain people is long overdue.

I begin with a fervent plea to scholars, administrators, scientists, and political leaders to recognize the great opportunity which ICIMOD presents to do something substantive for upland people. Through ICIMOD, knowledge can be generated and applied to critical problems which affect us all; what happens in the mountains affects both the inhabitants of the uplands and those downstream whose lives are inextricably bound up with events in the mountain watersheds.

ICIMOD must move beyond collecting data and generating studies to applying knowledge to programmes designed to improve the longterm prospects of mountain people the world over. The process of applying knowledge to human problems must, therefore, be a central concern–perhaps *the* central concern–of those directing ICIMOD during its formative years.

**Pressures: Natural and Man-Made**

An assessment of the pressure on resources must begin with definition of pressure. The primary meaning, "the action or fact of pressing . . . compression squeezing, crushing, etc.", applies to the effect of natural forces at work within the mountains. A second meaning, "the condition of being painfully oppressed in body or mind . . . the action of political or economic burdens", is also relevant as we consider the effects of man's interventions upon man himself in the uplands. Yet "pressure", as we use it in ecology and demography, goes beyond these meanings to include the concept of sustained and increasing demands upon natural systems by plants and animals–most importantly, perhaps, by humankind.

Pressure on mountain resource systems arises from two sources: the first natural and the result of forces outside the direct control of man; the second man-made and within man's influence. This typology, which seperates man from nature, has a long scientific history but has difficulties. A century ago, an early environmentalist argued that, "It is not the earth which makes man but man who makes the earth", (Marsh, 1964). Yet modern science as a humanistic discipline draws its inspiration and uniqueness from the Baconian view that it is founded on the order of nature rather than upon the primacy of man and that, "Nature, to be commanded, must be obeyed", (Bacon, op. cit.).

**The Forces of Nature**

Within limits, the man-nature dischotomy may, therefore, be a useful starting point. Natural pressures begin with the geomorphological forces which created the Earth's mountains and which continue to alter them. Tecto-physics, the relatively young science concerned with the shaping and transforming of the Earth's continents through the movement of tectonic plates, suggests that the process of mountain formation continues, and that in areas such as the Himalayas the subduction of one continent beneath another may still be proceeding at a rate of as much as 50 mm per year. This movement through geologic time affects both the height and the backfolding of the mountains. In combination with rainfall, glaciers, and rivers eroding the valleys, the long-term consequence is to make mountain hillsides steeper, less stable, and more hazardous for human enterprise. For gravity, that inexorable natural force, works upon the soil mantle to establish the shearing weight at which it must pull away from the underlying bedrock. Thus, massive slips of land, landslides, and the steady erosion of upland soils into the rivers and their transport downstream are part of an ongoing process which has continued for millions of years, and which has created the fertile, alluvial plains. Without these natural processes, the major river basins upon which the human species is dependent for a high proportion of its food could not have been formed, and would not now be annually replenished.

Natural forces–including snow, ice, wind, and the heat of the sun–account for additional pressures on mountain resource systems. Yet, it is difficult, if not impossible, to quantify precisely what proportion of the total "pressure" can be attributed to natural, as contrasted to man-made, forces. Some observers conjecture that in the Himalayas at least one half–and, in some areas, as much as 70 per cent–of current environmental damage is the result of processes which are largely outside of the direct influence of man. The actual percentage clearly varies from one location to another through time, and depends heavily upon what is being measured.

Historical and demographic assessments would suggest that during the past century the impact of human intervention has increased as a proportion of the whole, and that the rate of that increase continues to accelerate. A basic task for the scientific community is the careful observation of natural processes over time, utilizing rigorous techniques for precise measurement, to build an empirical basis for understanding. Only with such knowledge of trends can we hope to improve future assessments, policies, and development programs.

The list of other ways in which natural forces affect pressure upon upland environments is long. Where in our catalogue should we consider plant life? What is the role of the grasses and the naturally occurring shrubs? Indeed, the trees and the forests themselves–which must now be considered in conjunction with man and his organized interventions–earlier were entirely natural. And the insects and mammals? The critically important earthworm and the lowly mole? Each has an important role in maintaining the fertility of the soil upon which mankind depends for its basic food supply. Yet, we know too little, in a scientific sense, to assign any precise measurement to the contribution of such sources to pressure on mountain systems.

What about the role of fire? It occurs naturally, but it was also among the first great natural forces employed by man to alter the environment. Archaeological evidence "seems sufficient to sustain the opinion that man has set fire to the landscape during his entire history (Stewart, 1956: p. 123), and contemporary observation indicates that grassland and forest fires are often started by humans, generally pasturalists grazing in the area. They possess cultural knowledge based upon generations of experience which indicates that burning improves the pastures. They believe the ashes enrich the soil and produce abundant shoots from the old roots, thus furnishing better fodder. Swidden agriculture, dependent upon the cutting and burning of forests in a long rotational cycle, has been a primary means of subsistence among many upland peoples. Clearly, their view of fire, like that of early man elsewhere, is that it can be a positive force when correctly used. This stands in constrast to the usual view of conservationists and foresters who probably have never had to clear a forest for cultivation with simple wooden hand tools.

Beyond traditional beliefs, scientific evidence supports the view that long-needle pine and other forests are sometimes dependent upon fire for their very existence, and that over many thousands of years man, fire, forests, and grasses have evolved a pattern which, so long as it is maintained at an appropriate level, is both economically advantageous and environmentally sound. What is "appropriate"? Where is the balance beyond which man must curtail or eliminate the use of fire in his management of mountain forests and grasslands? There is a large grey area between what is purely natural and what is the result of human intervention; an area where man has learned to manipulate and use natural forces, including not only fire and water, but also plants, animals, and insects to serve his interests—often without fully understanding the environmental or long-term resource depletion costs of such interventions.

Any explanation of pressures and their impact on mountain resource systems must go beyond simple cause and effect. Even excluding human interventions, these are complex interacting systems, each possessing an internal logic and cohesiveness; each interacting with and impinged upon by a myriad of other naturally occurring and man-made systems. These systems are always adjusting and modifying themselves in relation to each other. Thus, the term "balance", as applied to the component elements in the natural environmental and resource systems of the mountains, must be seen in dynamic terms.

Man is only now in the early stages of understanding the interactions of these complex systems. The most distinguished scientific minds acknowledge that the "interaction uncertainties" considerably outweigh our understanding of the "laws" affecting the inter-faces of such systems. For those who live in mountain systems at a subsistence level, an absence of future-time orientation and the imperatives of survival make it difficult, even impossible, to comprehend the long-term consequences of many environmental interventions which they initiate for short-term gain or survival.

This underscores the importance of the basic task of ICIMOD to document and understand process and affects through time, and, thus, enable humans to relate knowledge to action in ways which increase understanding and well-being. Such knowledge and understanding must exist as a precursor to the establishment of sound development alternatives for upland people.

**Man and His Works**

In an important sense, it is the growth of human population since 1650–demographic pressures–which lies at the heart of our current dilemma. For, while natural erosion and underlying geological processes continue, there appears to be, nonetheless, a rough dynamic balance within natural systems. It is important to recognize that man's impact upon these systems may be less than we have thought. These systems are so large that man's interventions may not, as yet, have had the irreversible consequences once feared. The scale and frequency of landslides appears, for instance, to be more nearly constant through recent decades than had been previously conjectured, substantial changes in vegetative cover notwithstanding. Thr critical importance of careful empirical measurement of both incidence and intensity of landslides, earthquakes, floods, and other natural events over time should be evident. To date, only a beginning has been made.

It is important to distinguish between what "everybody knows" and what is empirically established. "Everybody knows" that the mountains are young; that they are fragile; that population pressure has been increasing rapidly; that people need fuel and animals need fodder; that too many trees have been felled and that, as a result, run-off rates have accelerated, silt loads have increased, downstream canals and rivers have been clogged, flooding has had greater destructive effect, and the topsoil of the mountains has been washed into the seas creating new islands in adjacent estuaries. In a few places, no doubt all of this is true. Yet much of what "everybody knows" is not scientifically documented, and some of it is probably not true.

It is important to provide empirical foundations for general assertions which have become accepted as the basis for political and resource mobilization, for our conjectures to date have been only proximate models for what is actually happening. We must now move beyond conjecture and speculation to careful scientific assessment.

**The Process of Mountain Settlement**

Man did not always live in the high mountains. As population grew and pressure upon lowland environments increased, human groups are believed to have migrated from river valleys and ocean shores into the mountains. Perhaps men first came to the mountains as hunters. In addition to the search for sustenance, man also came to the mountains seeking refuge and spiritual re-creation–refuge from the aggressions of his fellow man and from starvation and pestilence, and re-creation through the spiritual affirmation which high places, across many cultural and religious boundaries, are perceived to inspire. Man's initial impact was not environmentally significant. The scale of his activities was so small in relation to the enormity of the uplands as to be of little consequence. Only when man began to take up fixed residence–when he ceased to be primarily a pilgrim or transient refuge–did his works affect the mountains.

There is little point in attempting to give false precision to a hypothetical sequence of man's intrusions into the mountains. This was almost certainly location-specific and affected by the time, technology, scale, and circumstances. Probably domestic livestock and grazing of hillside pastures came early in most places. When hunters and gatherers shifted to fixed agriculture, they no doubt began by cultivating the fertile river valleys. Presumably, immigrants brought grains from nearby lowlands, later learning to use hardier barleys, millets, and wheats occurring naturally within some uplands. Much later, potatoes, maize, and oats became a part of his diet.

The change from being hunter-gatherers to fixed farming may have proceeded through grazing to transhumance; the seasonal movement of herds and herdsmen to upland pastures in the summer months and downwards to lowland valleys during colder weather. The transition to farming may have been accelerated where swideen (slash and burn) cultivation became established. This shifting pattern of cultivation was presumably well suited for many upland areas with heavy forest cover, fragile soils, and low human population, for it permits land to be left fallow for longer periods than it is cultivated. That the system has survived to the present suggests that it continues to meet the needs of upland people.

Man learned early how to control and use both fire and water. So long as human populations remained small and settlements widely scattered, the environmental impact of man was quite limited. With the exception of religious shrines and fortresses, man's archaeological residue above 2,500 metres is scanty. His works have not constituted a source of destabilizing pressure–at least not until the present century.

A fundamental change originated with the advent of new technology based upon mechanical energy. Improved means of harnessing energy and, later, of control of early death through public health measures have had a profound effect. Human population growth during the last hundred years has been a major variable affecting mountain resource systems.

Population density, while currently secondary to geomorphological and climatic forces as a source of environmental pressure, is increasing steadily. Wherever man goes, he uses his physical and intellectual energies to bend nature to serve his ends. Where human populations are low, food production does not require that man move far from fertile river valleys or gentle, lower slopes. But, as population increases, higher, steeper slopes are clear-felled, brought under cultivation and grazing and, as in Nepal, often converted to terraced, permanent fields.

**The Adaptive Technology of Terracing**

The extent of terracing in the Himalayan uplands and the magnitude of the human effort required to transform steep hillsides into productive farms is so great that it requires special note. Himalayan terraces represent one of our species' great achievements, equivalent many times over to more recent mechanically created "wonders", such as canals and high dams. Hill terraces are a much undervalued and understudied engineering feat. They make it possible for human groups to use productively an otherwise harsh environment. It may require twenty years to fully transform an afforested hillside into relatively stable irrigated terraces. The enterprise is marked with difficulty, setbacks, and occasional failure. Yet, what is worthy of note is the skill and energy which goes into their design and execution and how successful the hill farmer is in maintaining and improving his terraced fields year after year, generation after generation. Flooding, landslips, grazing of goats and cattle, drought, and earthquakes are taken in stride. With only hand tools and simple bullock drawn ploughs–but with enormous fortitude–the mountain farmer rebuilds, reploughs, reseeds, and survives. Whatever the cumulative environmental impact of his terraces, the Nepalese mountain farmer is among the great engineers and builders of all time, and by his own efforts he has found the means to control and shape his environment and to make it productive.

Little systematic study of the engineering or hydrology of the Himalayan terraces has been undertaken. ICIMOD has an opportunity to make a fundamental contribution, for terraced agriculture represents a major effort to adapt the mountain to man's increasing need for cropland. Through terracing he captures and holds the rain and, where upland springs and rivers permit, he diverts water through irrigation to insure sufficient moisture for his crops. So long as populations are relatively low, and demand for fodder and firewood permit farming communities to leave the upper slopes heavily forested, terracing is a solution rather than a source of pressure. Only when human and animal population densities increase do the hydrological forces working upon the terraces increase the potential for environmental disaster. For as trees are thinned, trimmed, and eventually felled, the capacity of the soil mantle to serve as a moisture bank is diminished. The deterioration and eventual destruction of the network of plant roots and the opening of the upland slopes to the direct impact of monsoon rains means that run-off descends in greater volume and at higher velocity to "test" the newest and steepest terraces while eroding more of their precious topsoil.

It is now recognized that the soil mantle must be continuously monitored across a range of geographical, environmental, and vegetative conditions. Soil may be our most sensitive indicator of the effects of both natural and human pressures. Yet, baseline studies have generally not continued through sufficient time to provide the data needed to assess accurately the dynamics of the processes at work. It is especially crucial that accurate monitoring be done at the micro-level; not just of landslides, but of the leaching of nutrients from the root zone of upland field, for it is this top ten centimetres upon which man is dependent.

Water is a major force acting upon the soil mantle, not only through gravity powered irrigation. Scientific understanding of mountain irrigation systems is limited. Modern irrigation engineers tend to become transfixed with the pouring of concrete, of which little is used in the small systems built by farmers to irrigate upland terraces. Yet, in many upland areas, wherever gravity systems can be installed, there is irrigation. Up to a point, these have provided an ingenious solution to man's problems of survival. But future development will require more knowledge about the dynamics of hill irrigation if substantial breakthroughs in water management are to be achieved. Soil mechanics and hydrology can help farmers understand more about the degree to which further irrigation may serve to increase the risk of disaster rather than to improve long-term productivity and stability.

**The Impact of Development**

During the past fifty years, much has been done in the name of development. One of man's most obvious intrusions into the mountains has been road building. Early doctrine, possibly based on less sophisticated technology, dictated that roads be built high on the mountain sides and ridges, and that bridges be kept short. The cost to the stability of the hillsides of such high roads is everywhere evident. More recent approaches that keep roads in the valley where possible, while less environmentally disfiguring, have the disadvantage of converting high quality agricultural land on the lower slopes into roads and settlements, and require expensive bridges of great length.

Upland roads and trails expose the bare soil of the hillsides to the direct impact of the monsoon and, unless skill is shown in preparing protective drainage systems, the effects of rainfall collecting on the roads and on adjacent slopes can be devastating. More often than not, drainage is badly handled and badly maintained. In addition, because of the major earthmoving associated with road building, their construction tends to alter the slope and stability of hillsides so that the soil and underlying rock often move under the pressure of heavy traffic. Fortunately, public works engineers everywhere are becoming more environmently sensitive and skilled at evolving appropriate road building technologies. With effort, it is possible to build roads which limit environmental damage.

The construction of dams, with large upland reservoirs, is another engineering phenomenon with great potential, both positive and negative, as it is with pipelines and electrical highlines. All exert pressure, yet, with sensitive engineering much of the negative impact can be contained and limited.

Commerce, governance and planned development penetrate the mountainous uplands following road building, improved trails, and suspension bridges. Administrative headquarters, schools, public health centres, post offices, and radio communication centres are established in or adjacent to hill bazaars. When these bazaars are connected by road to larger market areas, a change in order of magnitude begins in commerce and trade. Trucks and buses not only bring outsiders and their products into the hills, they offer attactive incentives for local enterprise to produce products valued by the outside, "downstream" markets. Often, this process begins with firewood and expands to extractive commercial forestry. Political leaders find that the way to reward their supporters and, perhaps to gain financial benefits, lies in ensuring that local entrepreneurs are granted licenses. Where minerals are found the same pattern is repeated. In both timber extraction and mining, temporary access roads may be constructed by simply bulldozing the hillsides without regard for environmental impact. Hence, the very development processes designed to stimulate short-term productivity in the mountains constitute an increasing source of pressures which affect and may, in time, erode—in both the literal and the figurative sense–the capacity of mountain resource systems to support human life.

A third critical factor increasing the instability of mountain resource systems is extractive, production-oriented development. While development, as such, need not be environmentally destructive, its impact during the past fifty years has, to a large extent, been environmentally negative.

The values of the larger world of markets and economic forces to which roads and airfields link the mountains are those which often place a premium upon the maximization of private, short-term profit. Poor people struggling to survive in harsh upland environments cannot easily resist the enticements of immediate financial gratification. A farmer living in an over-extensively tilled and over-grazed upland with a young and growing family may find it difficult to take a long view of the environmental consequences of selling timber or firewood at an advantageous price. To suggest otherwise is to blame the victim.

Small may be beautiful, and one can cite water-powered technology, bio-gas generators, passive solar heating, and improved household stoves as means of ameliorating environmental pressures. These should be encouraged and supported; they are human scale, within the reach of those most directly affected, and they serve to benefit directly the poor and the powerless.

**Economic, Legal and Bureaucratic Pressures**

In thinking systematically about the sources of pressure upon mountain resources and mountain ecosystems, we should not let our zeal for small, practical, and direct interventions obscure the significance of the more macro forces; economic, legal, and bureaucratic. Commodity prices policies and exchange rates may seem far removed from the mountains, yet getting them right at national and international levels may be of greater long-term benefit to upland people and their resources than community level interventions.

As with appropriate technology, community and social forestry and, more recently, agro-forestry have come to signify efforts to help upland farmers find more productive ways of managing the resource systems upon which they depend. It is assumed that new means of organizing their resources will result in higher benefits with less harmful effects upon their environment. These initiatives could, in some cases, however, increase the incentives to deplete upland resources. Integrated mountain development approaches must, therefore, take cognizance of both micro and macro economic factors. The long-term social costs of depleting resource systems must be considered, as well as the private costs and short-term benefits.

Until the overall market system, within which the managers of upland resources make decisions, provides adequate incentives (or penalties) to make it attractive to forego or defer short-term benefits for the sake of long-term environmental stability and the maintenance of a socially determined minimum level of renewable resource stock, local level initiatives may have only short-run benefits.

Just as it is important to consider how a lowland dominated "international economic order" exerts pressure upon the upland resources which, when extracted, destabilize the environment, it is important to review the ways in which national and international legal systems may work to accelerate the depletion of mountain resources. The concept of land, forests, water, and minerals as property which may be traded, bought, and sold by individuals or new owners who have scant regard for the social and environmental consequences of their use, is one which is alien to traditional common-property practice in mountain regions. This concept is of recent origin in the uplands, being an import which came with the extension of "law and order", the settling of the land, and the fixing of titles and taxes according to lowland and, often, Western practice. Customary practice treated such basic resource systems as a trust to be husbanded by each successive generation as the custodian for future generations. Usufruct, not ownership, was the common practice.

Privatization of formerly open-access or common-property resource systems can be seen as both a potential disaster or a potential solution to the problems of rapid exploitation. Much depends upon the values which society enshrines in social practice and law. Progressive legislation can afford upland peoples the framework within which to be more articulate politically and provide the protection they need to husband their resources to benefit both themselves and their children. Such legislative interventions may be essential to ensure both the long-run stability of the uplands and the productivity of the downstream agricultural production systems fed by mountain rivers. Yet, upland farmers are fearful of lowland lawyers. Upland people are concerned that, all too often, where hill farmers fight over land, lowland lawyers eventually become the owners. Sensitive public interest lawyers may have a role in helping build the institutional arrangements for long-term mountain development.

Urban-based government officers have often been insensitive in applying economic and legal policies indiscriminantly to upland areas. Yet, it is development donors with their enormous resources who may constitute the greatest destabilizing threat over the years ahead. Progress has been made and donors have shown increasing sensitivity to environmental problems, but the internal pressures upon donors to devise time-bound, results-oriented projects which respond to the current priorities of their own agencies, means that it is often difficult for them to take a long and systematic view of the process. ICIMOD may be well placed to assist both national leaders and expatriates working in programs of induced change to better appreciate the complexity of the interacting systems within which they must work, and the pressures which their activities may generate.

**Tourism**

With the increased affluence of the middle classes in the industrialized nations and increased mobility through relatively low cost air transport, a new era has opened during the last quarter century. Formerly isolated and less developed mountain nations are now accessible. International tourism, on a scale and of a character quite different from the traditional pilgrim or world traveller, is now a reality. The pressure which this exerts and its impact upon mountain resources can be both positive and negative. Awareness of the cultural heritage of the uplands may be hightened, while demand for food and fuel along major tourist routes inevitably increases the resource depletion rate. Sensitive management, concerned with the obligations as well as the desires of tourists seeking "re-creation" within the mountains, is essential. Exposed colour film may be a highly desirable export, but tourism can be exploitative if few benefits accrue to the upland people themselves.

Fortunately, responsible tourism officials working closely with national leaders and international organizations are actively seeking to evolve practices which limit and control the negative impact of trekking, high altitude climbing, and general tourism while, at the same time, making the beauty and the inspiration of the mountains more readily available to those who are attracted to them.

**Summary and Conclusions**

I have attempted to categorize pressures operating upon mountain resource systems by distinguishing between those which are primarily the result of natural forces, and those which are man-made. Where man has learned to use natural forces, such as water and fire, for his own purposes, there must necessarily be some overlap.

Within the broad category of human interventions, I have suggested three types of activity that can be considered separately for purposes of analysis. The first embraces those subsistence activities needed for the survival of human groups. The second are activities or values held by the larger human community outside of the mountains which establish the framework for development, extraction, and exploitation of mountain resource systems through marketing, administrative, pricing, legal, and other arrangements. The third, while related to the second, is concerned with the temporary incursions of non-mountain inhabitants into the mountains as pilgrims, travellers, climbers, and tourists.

It is not for me to suggest the means of finding solutions to upland resource dilemmas. The pressures are multi-faceted, complex and, in some instances, of geologic origin. The solutions will, I believe, be found to be equally complex and multi-faceted but, regretably, we do not have a geologic time-frame within which to find them. Upland populations continue to grow and people's expectations continue to rise. The overall depletion of renewable resource systems accelerates, and the stability of the environment becomes less robust. We do not yet know enough about phenomena, either natural or man-made. Yet, the wings of time are beating, and we must seek the means of relating current knowledge to action. For, in many mountainous areas, poor farmers are clinging by their fingernails at the margins of subsistence.

It is all too simple to prescribe solutions with which few will disagree: massive reforestation, community control of resources, major capital investment in the development of water for irrigation and power, farm employment through agro-industry, reduced populations (human and animal), out-migration, more robust and productive upland cereals, such as triticale, horticulture, roads, transport, credit, markets, price incentives and input subsidies, appropriate technologies, decentralization. The list is long and grow with each successive development cycle of planning, temporary achievement, and frustration.

Yet, surely, those who would seek to advance human understanding of the processes of integrated mountain development must eschew any "golden key" approach. No single solution exists. No panacea awaits our discovery. The struggle will be long and the outcome will remain in doubt. Such is the nature of our Promethean struggle.

That the challenge is truly Himalayan should not daunt us. For our species is distinguished by its capacity to respond to challenge. Perhaps, in time, we come to understand that the conservation and development of the high places of our planet is the responsibility of all mankind. For the environmental stability of the upland watersheds is essential to preserve the productivity of the alluvial plains upon which we are dependent for our food. Perhaps mankind will have the wisdom to realize that within the larger global whole concessional transfers of resources from the productive lowlands to the fragile uplands must become an inherent part of the global management system for our small planet. Yet, this will only come as we reach new levels of awareness and come to understand the true nature of our interdependency. The political will to advance beyond the petty constraints of short-sighted nationalism can only come when humankind is forced by fact to recognize that we are more united by the commonality of the problems which confront us than we are divided by race, religion, ideology, or national boundaries.

ICIMOD must seek the facts and present them in compelling fashion. For, to turn again to Bacon, "Human knowledge and human power meet in one; for where the case is not known the effect cannot be produced." This paper has sought to identify some of the cases. Godspeed to those who, in association with ICIMOD, must now produce effects.

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# The Contribution of the Green Sector

Dr. Klaus J. Lampe

To be honest, the hill farmer community in the Third World not only belongs to the most neglected part of the world's population, but their prospects for profiting from research findings and development programmes are rather gloomy.

The gap between the standard of living of the hill population and those of the lower valleys continues to grow. The reasons for this are manifold, and an essential part of my paper. Our modern society with its division of labour has led to a scattering of disciplines in modern sciences, or what is labelled as such today, up to an almost Babylonian confusion of ideas.

Agriculture today is not just a single subject of specialization. Rather, one has to be a wheat or rice breeder, a pigeon pea pathologist or an entomologist specialized in citrus fruit flies. The development problems in the hill regions, however, are far too complex and, in view of the above, will not be solved on a short-term basis, not even by a larger group of subject matter specialists.

**The Living Conditions of the Hill Farmer**

Integrated Rural Development today is the key phrase in discussing rural development problems and, in spite of substantial progress in many areas of agricultural research, these have not been overcome. Agricultlure is, nonetheless, inconceivable without its integration into a number of other disciplines which in themselves are also quite complex.

Especially in the hill regions, agriculture and forestry (in other words, exploitation of timber and fuel wood, as well as forest pastures) are decisive factors for the absorption capacity of water for drinking and irrigation purposes, ultimately, and vitally important erosion control. The health of hill region people is closely related to the proper functioning of forests as a water reservoir. Whereas medical care is admittedly inadequate in rural areas, it is, apart from the larger valleys, practically nonexistent in hill regions. This situation, especially in the curative field, will hardly change in the future, since the economic circumstances in most of the hill regions, along with the lack of infrastructure, prevent an improvement.

Efforts must be made, however, to provide village health services for man and animals which are designed, as self-help initiatives, to take over the most important tasks of preventive medicine, nutritional counselling, and family planning. Only a population which is essentially healthy will be able to preserve and develop the ecosystem hill regions in the medium-term.

Health and modern agriculture, especially in marginal areas to which all hill regions of the world more or less belong, are not feasible without modern training that is adapted to the needs of the target group. In this respect, the widely scattered farms and settlements, along with the ecological sensitivity of specific habitats, require special measures. School books that portray life in the city many hundred kilometres away from the village classroom, and which do nothing to foster understanding for country life and the features that make it worth living, are, at the most, a contribution to rural exodus, especially of the most capable sections of the young generation.

Education in the hill regions should be geared less towards formal degrees but rather should have its main emphasis on transmitting knowledge and skills which contribute to realizing existing correlations between the various disciplines, and to promote the long-term utilization of those fragile resources. Properly trained and motivated teaching staff are needed for this purpose. How to motivate them? Is there a country with a substantial share of hill population that has developed an appropriate educational policy? I am afraid it does not exist, and you can hardly blame those who still work with the agricultural methods of their fathers and grandfathers, even though general and environmental conditions have changed today. The result is a total loss of their production base, mainly through erosion and the loss of soil-fertility.

And yet, the hill farmer seldom needs advice on the interactions of agriculture, forestry, soil, water, and erosion. More often, he is able to realize the reciprocal effects from his own observations in contrast to many roadbuilders, for instance, who will be led by short-term economic considerations–or by ignorance–to induce erosion that often cannot be stopped.

This in no way means to say that roads do not need to exist; they are, on the contrary, a prerequisite for any development whatsoever. Their construction in suitable locations should be supported, even if it may entail higher investment costs. Co-operation with the farmers in the early planning stages should also be considered. Thus, subsequent damage and maintenance costs could easily be minimized.

Only a road system, which to a great extent would have to be maintained on the basis of self-help in order to be supportable with respect to national economy, could create the preconditions for a home industry, thus providing an additional source of income to the ever growing population of the mountain regions in Asia and Latin America.

Typical of almost all hill peoples is their craftsmanship and creativity. The sensible utilization of these abilities for the national and international market and, under certain conditions, tourism, is more easily accomplished with minimum advisory assistance from outside than a larger change of behavioural patterns that might be prescribed in the scope of agricultural extension efforts. Problems here arise mainly in connection with a fair price policy that ensures quality work of high craftsmanship on a long-term basis, as well as securing smooth marketing. Promotional efforts have often failed in the past due to numerous levels of intermediate trade. On the other hand, promotion of carpet manufacturing in Nepal by the Swiss Development Assistance shows how much success is possible.

**The Green–What does it Include?**

If professional differentiation, with all its negative results, is to be successfully dealt with, then agriculture as an integral part of rural mountain regions needs to be defined in much broader terms than is generally accepted by the public administration. In my opinion, a productive interaction of research, development, training, and extension is only possible if the different activities the hill farmer confronts daily are also comprehended by the servicing bodies as a functional entity. The term "servicing bodies" defines all institutions from research to administration that claim responsibility for the development of the hill regions.

Agriculture, in its broadest sense, therefore, comprises:

- all areas of plant production, including horticulture and fruit growing, plant protection;
- storage of food and feed products;
- livestock production, including animal health services;
- pasture management;
- forestry, including timber industries;
- agricultural engineering, including irrigation;
- agro-industry, at least as far as the first level of processing in home industry in small and medium-sized factories is concerned;
- aquaculture and fisheries;
- rural craftsmanship;
- training and extension programmes; and
- agro-economy on the micro and macro sector as a basis for sensible agro-political decisions on a national and regional level.

A great number of problems—and not in the area of public administration alone, with its often limited possibilities–are the result of the dispersal of the above mentioned working areas into several ministries and executive organizations. Thus, a great part of the available resources is not utilized or lost. The really damaging effect on the target group, however, is the loss of credibility which emanates from the competition of training, extension, and executive organizations.

Throughout the entire world farmers in mountain regions are even more mistrustful of the "modern" world than their colleagues in the plains, who are more familiar with it through closer connections to urban centres. Hill farmers have been deceived and disappointed too often during the course of history, their lifestyle being shape by individuality and mistrust due to their limited mental mobility–even if there has existed exchange of information in the past as well as the present. This holds true just as much for the Alps or the Andes as it does for the Himalayas. Only those who really understand the hill farmer in his environment will be able to help him with the solutions to his problems. But understanding without mutual trust is not possible. We surely would be further advanced at the commencement of the work of ICIMOD today if researchers, administrators, teachers, and extension officers had succeeded in the past in bridging the existing gaps of understanding. Ignorance, lack of sensitivity, and also obvious self-interests prevented this.

**The Production Base of the Hill Farmer**

In comparing population density of the Himalayan region of ICIMOD (figure 1) to that of the European Alps, overpopulation is quite obvious. Whereas in the Alps 38 inhabitants share in each sq. km., there are almost 100 to 143 respectively to the same area in Nepal and the Indian Himalayas. Information about population density related to the total area is merely of theoretical value. Relations of fallow land to arable areas are of central importance, especially in an exclusively agricultural region.

In Switzerland, as well as in the German Alps, areas of practically no agricultural value can better be marketed for tourism than a comparable area of pasture land. But this does not apply to most parts of the world where location and the overall economic situation form a constraint to such exploitation. In view of this, any comparison of potential and actual development of hill regions in the Third World to those of the European Alps will inevitably lead astray.

The differing economic basis is made even clearer when relating the arable land to population density (figure 2). Even the densely inhabited region of Nyabisindu in the southern highlands of Rwanda, with 3 persons/ha, still lies below that of the German Federal Republic with 4.6/ha. In Nepal, with 15.5 persons/ha., three times as many people have to live off one hectare of arable land as in the highly industrialized German Federal Republic, where only 4 per cent of the total population are still employed in agriculture. You can hardly show more clearly than with these figures the obligation to intensify production efforts in agricultural areas already under cultivation, and the need to search for non-agricultural employment opportunities.

Yet, one should not underestimate the potential for an increase in productivity. There is past experience, as well as data available from Nepal, that document average and maximum yields in different regions which give at least an idea of the development potential (figure 3). According to these figures, yields of about 5 tonnes of maize against an average of 3 tonnes in the central hills, and almost as much wheat against an average of approximately 0.8 tonnes in the far eastern hills, can be obtained.

The hill farmer's limitations, however, are not adequately outlined through the availability of arable and pasture land alone. Cultivation seasons become shorter with increasing altitude and permit the growing of a few early-maturing crops only with a substantial risk of late or early frosts. Intensity and irregularity of precipitation and the influence of the monsoons in the Himalayan region represent additional unfavourable factors impairing stable yields which the hill farmer can hardly avoid.

Extended, non-vegetative periods finally force him to carefully store food, firewood, fuel, and seed. When family size is out of proportion to available agricultural area, the risk of crop failure becomes a question of survival.

**The Problems of a Hill Farmer**

If the production base of a hill farmer is defined as "subsistance farming on marginal locations with the necessity of maximizing yields", one has pretty well described his problems. Apart from the land/man ratio, vegetation period, and quantity of precipitation and its distribution, production is limited considerably by the low quality of land, often with little top-soil which is susceptible to erosion. Lack of capital for necessary and feasible investments; e.g., for small irrigation projects, and lack of modern mans of production further restrict the scope of action for the hill farmer in the Third World. But these are not the only reasons for him to stand last in line on the list of priorities of not only the politicians in the urban centres but also for agricultural science itself.

Agricultural science on a national and international level, up to now, has bothered little and, if observed under comprehensive aspects, not at all with hill region development. The international agricultural research institutes, whose work is regularly mentioned when talking of progress in rural areas in the last 20 years, have proved of very little use to the hill regions. Single crop-oriented in almost all cases, they are unable to contribute to the specific and complex production systems in the mountains. It is surprising that international donors for agricultural research activities have not yet conceded the priority which is due to the mountain regions, in spite of the acute problems that face not only the mountain regions themselves but also areas many times greater in size along the lower courses of rivers.

Mountain regions to this day have remained places of interest for tourism more than for scientific research work; many scientific studies were selected according to the individual interests of their authors, rather than the needs of the hill people.

Unfortunately, problem-solving with respect to a sensible development of mountain regions is not stimulated by the incentive of a possible Nobel Prize, and, therefore, does not attract–with a few exceptions, however–agro-scientists of the high calibre that would be required in view of the problems.

Finally, those few on-going research programs that do exist generally refer to singular aspects only, and hardly ever are they directed towards achieving integration or interdisciplinary concurrence on problem solving. Mono-sectoral studies, however, will not solve the multi-sectoral problems of the hill farmer.

Neither has there been a scientific study of the interdependencies between mountain regions and their dependent lower plateaus through research on the river systems that comprise the entire highland-lowland ecosystem. The results of such studies could very well serve to sharpen the senses of the political authorities and decision-makers for the general economic significance of sensible mountain region development. Comparative studies on mountain regions of different continents for which relevant data have existed for a long time may prove to be especially helpful. At this point, I may refer to the studies of Aulitzky in 1974. He has examined the deforestation and the avalanche endangered areas of some regions of the Austrian Alps for the time between 1774 and 1953 (figure 4).

The farmer in the mountains, however, capitalizes little on the scientific foundation of such experiences that he is able to derive himself from observations made over generations. Thus, considerably more specific demands are put forward to research projects as specified in the following few examples.

First on the list of priorities concerning plant production, is the substitution of commercial fertilizer and plant protection products by undemanding crops which guarantee stable yields. High expectations are put here on the most modern branch of agro-biological research. Where mixed cropping systems and biological nitrogen fixation by conventional methods do not meet their targets, one has to resort to the results of genetechnological research. Maize, with its nitrogen-fixing qualities, planting of barley, the use of mykorrhiza for the purpose of chemical decomposition of phosphoric acid, which is available for wide implementation, are alternatives to the application of commercial fertilizers, a practice which is becoming more and more doubtful when it is applied in regions where transportation takes place on the back of people over long distances.

Many areas at higher altitudes can be utilized little–or not at all–because of the short vegetation periods. Thus, a logical conclusion is the shortening of vegetation periods of important crops by way of modern plant breeding. The 70-day barley, the 60-day potato are demands which have already been successfully met, as in the case of the mungbean, for instance.

What also needs to be done is a scientifically performed retrospective evaluation of the old experiences and their exploitation by scientific methods; the use of the active substances of the neem tree as a means in pest control, known on the Indian subcontinent for more than a thousand years, is just one example.

Finally, plant breeding in connection with plant sociology must develop high-yield crop varieties which will be instrumental in bringing barren land and marginal areas under cultivation again. Tree and bush crops, for instance, would not only protect against erosion but could provide food for animal and man at the same time, and could be of use in wood and fibre production, as well as for extraction of dye and medicinal substances. In this manner, new raw materials could be produced, creating additional jobs in the rural areas without putting additional strain on the carrying capacity of the available land.

Vegetable growing would considerably enhance the nutritional basis in the mountain regions, ensuring a substantially healthier food supply. In this respect, however, research and development work is required that would take into account the particular local problems of high altitude areas. New plant and crop varieties and sensible mixed cropping, in order to fully utilize allelopathic and biozenotic properties, can open up avenues for development which have been pursued only on a rather small scale up to now.

Agriculture without integrated animal husbandry is hardly imaginable, according to the understanding of traditional European agricultural production. If the Western world in the last fifty years has renounced an experience many thousands of years old, it may very well turn out to be only a "vacation". Looked at more closely, "fertilization from the bag", the application of commercial fertilizer, is nothing more than the addition of nutrients that have their origin in organic substance. The energy required for its production from coal or oil is also nothing but a transformation of organic substance.

The hill farmer cannot afford this luxury. Wherever the fodder basis permits, cattle, buffaloes, goats, sheep, and fowl, as draught or pack animals, as suppliers of wood and meat, as egg or milk products, will take their part in keeping up the circular course of nutrients. It is the task of animal production to make this circulatory system most effective, i.e., to utilize organic substance unfit for human consumption through the animal stomach, thus contributing to the provision of proteins. Therefore, life without animal keeping is hardly imaginable in the mountains. Here, undoubtedly, reserves and potential are available that must be made accessible through multi-functional utilization. Substantial progress is possible solely through improved animal husbandry and an animal health service that would have to be developed similar to the basic principles for human health services.

**Conclusion**

Somewhat like the inhabitants of the desert regions, people at home in the mountain areas of the world belong to the most frugal and, at the same time, the most endangered population group on earth. Even the slightest changes within the ecosystem threaten their living environment and production base, and, thereby, their future. Not unlike the progression of the desert, the destruction of the mountain ecosystem is synonymous to endangering human life within the areas of entire river systems.

The inhabitants of mountain regions are, more than anyone else, essential parts of a highly fragile ecosystem. According to rough estimates, the life of over 800 million people depends on the long-term conservation and preservation of mountain region ecosystems. Anyone who has knowledge of these facts and still shuts his eyes to the resulting needs and necessary consequences will have to be in a position to justify his responsibility towards the coming generations, generations from whom we have borrowed this earth, for we have not inherited it.

The underlying task is not only a challenge to all of us, but it is a matter dictated by reason that calls our political decision-makers off their reserve. It would be up to them to promote the confidence of the mountain population in their respective governments, to assist in stimulating their readiness to rely on self-help measures, and to increase their self-assurance, instead of fighting against their efforts. The sense of responsibility of village communities must be revitalized. To motivate the population–not to administer them–should be the objective of the public authorities. Setting up an efficient network of adequate services in close co-operation with the target groups would help crease an atmosphere of trust in the government–a quality which is, unfortunately, lacking in the hill regions in almost every continent.

Selfishness, exploitation-oriented thinking, and dominating behaviour that lowlanders have showed against hill people in the past, have been some of the main reasons the latter feel such a strong aversion to them.

Not without particular reasons has the International Centre for Integrated Mountain Development (ICIMOD) been established in Asia. Great religions, numerous mythologies, and philosophies are rooted in the mountain regions of Asia. Contrary to our Western Hemisphere, tradition is still alive in Asia, and decision-makers in the capitals still feel obliged to them.

Maybe one will succeed in bringing the responsible leaders to realize fully the current problems and urgent needs of the hill population, and to set the necessary priorities.

The matter can't wait any longer!

The inception of ICIMOD through our mutual efforts is a good basis towards this end, and a benchmark of credibility.

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# Integrated Mountain Development: The Role of Industry, Energy, Tourism, Transportation and Communication

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I am greatly honoured to have been invited to this First International Symposium and Inauguration of the International Centre for Integrated Mountain Development (ICIMOD). I am thankful for this opportunity to Mr. P. Gueller, Regent of ICIMOD, and all others connected with the organization of this event.

As you know, the central theme of the Symposium is "Mountain Development Towards 2000: Challenges and Opportunities", and I am expected to present a paper on the role of such sectors as industry, energy, tourism, transportation, and communication in integrated development within the framework of this session's theme, "The Concept of Integrated Mountain Development." I thought I knew the scope of the topic and what the contents of the paper would be until I actually sat down to write the paper. I have fairly good ideas about the role of the various sectors enumerated above in the context of a country like Bangladesh, which is mostly plains. In a mountain situation, the ecosystem is sharply different which has its peculiar implications for production and resource management systems. Socio-cultural dimensions also have their own peculiarities and dynamics. I, therefore, immediately saw the limitation of my knowledge for preparing the paper. But then I realised that this Symposium was being organized to explore ideas and review experiences with a view to elaborating further the role and tasks of ICIMOD, among other things. And I felt I could make some contribution to this process. It is, by and large, in this context that I share with you some of my thoughts and views, keeping the sectors I am supposed to cover in this paper in broad view.

In the conventional approach, development is sought to be achieved through a process of industrialization and modernization. Development proceeds as the contribution of industry and modern sectors to GDP and to the absorption of labour increases. Transportation and communication facilities are developed to support the economic transformation. The role of energy in the process is crucial because it is a driving force behind technological advancement without which industrialization and modernization cannot be achieved. As development proceeds, import expands both to support the production system and to meet the requirements of the changing consumption pattern, which requires increasing amounts of foreign exchange. The sources of foreign exchange are export and invisible earnings, foreign aid, and foreign borrowing. Tourism, the one other sector that has been included in the list of sectors this paper is supposed to deal with, has a special role to play in earning foreign exchange.

The GNP-focused modernization strategy of development has been followed by many underdeveloped countries over the past decades. And yet an estimated 780 million people in underdeveloped countries (excluding China and other centrally planned economies) were absolutely poor in 1980; the figure must be much higher now. Half of them live in South Asia, mainly in India and Bangladesh; and the other half elsewhere in Asia, Africa, Latin America, and the Middle East. In Bangladesh, for example, over 80 per cent of the population is estimated to be below the poverty line (defined in terms of a calorie intake of 2122). The Nepalese situation in this regard may not be very much better, where the per capita income of about US $120 is not much higher than in Bangladesh. Poverty is, indeed, the main problem faced by the large majority of the people in Nepal, as well as in Bangladesh and many other underdeveloped countries around the world.

It is now widely recognized that the conventional techno-economic approach to development with its primary focus on capital, which has so far generally produced deleterious results for these countries in that poverty, unemployment, and inequality have been very high and increasing in most of them, cannot solve their problems. A completely new approach centered on the people, who are both the subject and the object of development, is necessary. This immediately brings into focus the specific social, economic, cultural, and ecological realities faced by the people one is concerned with. These realities vary widely from country to country, and there may also be significant area-wise variations within the same country.

For people-centered development, relevant social and cultural factors must be taken into account in planning development. The process must ensure the access of individuals to productive resources and opportunities for development and must not place a burden on the ecosystem, by way of callous exploitation of natural resources and introduction of inappropriate technologies and action programmes, which it cannot carry without being irreversably damaged. Obviously, what is needed is an integrated approach to development. It may, however, be emphasised that since mountain ecosystems are rather fragile the need for ecologically sound planning is of particular significance in a mountain situation.

But, integrated mountain development, or for that matter integrated rural development with which I am more familiar, cannot be pursued in a sustained manner in isolation. It must be an integral part of the overall national development strategy.

Keeping the broad framework outlined above in view and taking poverty eradication to be the most important national goal, I shall in what follows make some observations concerning the sectors under review.

**Industry**

The role of industry in development is, of course, very important; higher value added in industry is an important source of growth; capital and intermediate goods produced in the sector sustain an expanding production structure, and the manufactured consumption goods supply the consumption requirements as income expands. But the process of industrialization must be so designed that the benefits accrue to the people at large and not to a few capitalists, local of foreign. This means that the production structure must be planned on the basis of certain principles which may include:

- The production and import of luxury goods should be banned or so regulated that their production and distribution are not profitable and even loss-making activities.
- Investment should be substantially increased for the production of those goods and services which the poorer classes consume. The resources saved by restricting production of luxury goods may be used for this purpose. In fact, deficit financing may be resorted to for financing production of consumer necessities. Since these goods and services have short gestation periods, inflationary impact of deficit financing for the purpose will be limited. These activities will also create employment opportunities on a wide-scale since these are necessarily more labour intensive and can be dispersed geographically.
- In order that the long term stability and sustained progress of the economy can be ensured and that the structural dependence on foreign countries is minimized, investment in key heavy industries (machinery tools and equipment etc.) must be increased.

Insofar as the mountain situation is concerned, industrial activities should be planned not only within the framework of the broad principles outlined above, but also taking into account the ecological peculiarities and needs and circumstances of the mountain people. In this context, type, size and location of the activities are all very important issues.

Since poverty alleviation is the central aim, it is necessary to promote industrial activities in such a manner that there is wide participation of the poor in them as owners. This calls for promotion of small-scale and cottage industries. Such activities require small capital investments and simple technology; and people of small means and little education or training can undertake them with some assistance. Studies in Bangladesh and elsewhere show that such manufacturing activities offer a large scope of employment generation for the poor by way of both self and wage employment.

Decision on the type of industrial activities should be made within the framework of the national production strategy developed on the basis of the principles outlined above, taking into account the existing and potential demand structures. The sources of demand may be the income of the mountain people themselves, markets elsewhere within the country in rural areas and urban centres, export markets, and production linkages within the mountain sector and with activities outside. Careful market studies will be necessary to generate the information base for planning the activities to be promoted. Assistance may be necessary on the supply side also in such areas as entrepreneurship and skill development training, advice on technology, supply of credit, provision of marketing facilities, and development of infrastructural facilities. The requirements for assistance may vary from product to product and individual to individual, which will have to be ascertained through appropriately designed studies. Effective extension programmes will have to be launched to assist the entrepreneurs in starting their activities and solving their problems on both supply and demand sides, as they run their enterprises.

Regarding location, many small-scale and cottage type activities may be home-based. Depending on the ecological and topographical conditions, certain locations may also be chosen as industrial estates. The availability or potential for the development of infrastructural facilities will also be important considerations in the choice of the location of the activities.

Insofar as large scale industries are concerned, the question of suitability to the mountain ecology and mountain people must be very carefully addressed.

**Energy**

Energy is important, but it was not an issue in the development debate in the decades prior to the early 1979s. With the oil prices starting to go up steeply in 1973 at the instance of the Organization of Petroleum Exporting Countries (OPEC), the energy issue assumed a particular significance, since the unprecedented technological advancement hitherto achieved was largely based on liberal-even wasteful-use of cheap oil. Suddenly energy costs were rising sharply and the supply of its main source, oil, was also being regulated by OPEC.

A whole lot of literature is now available on various aspects of the issue, such as prices, supplies, surpluses and their recycling; adjustment processes, including conservation and alternative sources of energy, and choice of technology; and impact on development, looked at from the point of view of the importing countries, both developed and undeveloped, and also from the point of view of the oil exporting countries. Debates are now going on in international fora, both UN and NGO type, and also at bilateral and national levels on how to tackle the various energy related problems faced by the world community, as well as by particular countries and groups of countries.

The Third World countries like Bangladesh or Nepal, depending as they do on western oil-based technology, have found themselves particularly hurt by oil price increases. While they also use such commercial sources of energy as coal, hydro, and natural gas, generally, oil has been the major source. Thus, for example, in Bangladesh petroleum import consumed 63 per cent of the country's total export earnings in 1981, while the figure was only 6.7 per cent in 1972. Similar experiences have been encountered by many underdeveloped oil importing countries. Now, as these countries continue to pursue growth, which is a must for improving the standard of living of the people, their energy needs will be increasing. And particular underdeveloped countries will have to find ways of meeting those needs to be able to pursue the goal successfully. The various lines of action that can be pursued include; (i) seeking of international assistance in securing increasing import of oil; (ii) expansion and development of indigenous sources of commercial energy; (iii) improved efficiency in energy management and use; and (iv) choice of technology more in line with domestic endowment of resources, including energy sources.

Energy development in the mountain sector should be pursued within the framework of a national energy development plan. In a mountain situation, hydro may be a highly potential source of commercial energy. It would, therefore, seem, suggested that this source is properly developed, indeed, other sources, as well, if prospects are there. However, projects should be designed on the basis of, among other things, careful evaluation of locational factors, scale economies, and ecological implications with a view to minimizing unit cost without adversely affecting the ecosystem. In this context, a useful first step would to identify and elaborate the basic factors which must be taken into account in planning exercises so as to make the projects consistent with an integrated, ecologically sound process of mountain development.

In the household and informal production sectors of a country like Nepal or Bangladesh, traditional sources of energy; e.g., draft animal, fuelwood, cowdung, and agricultural residue, do play the major role and will continue to do so for a long time to come. In this context, a basic issue is to improve the methods of use (improved wood burning devices-stoves, kilns) with a view to reducing the drudgery to the users and increasing the use efficiency of the materials. Particularly in the case of fuelwood, there is also the very important question of the ecological implications via deforestation. Hence, fuelwood supply and a reforestation programme should be carefully planned to maximize the supply of fuelwood while, at the same time, preserving the ecological balance.

Towards improving the level and quality of energy use by the mountain household and informal sectors, the following steps may be undertaken: (i) surveys to ascertain the pattern of use of traditional sources of energy by the mountain people; (ii) research and development for improving the devices of using these resources; (iii) generation of information base and training materials for ecologically sound planning of fuelwood supply; and (iv) extension and training programmes to popularise the use of improved devices and the need for and ways of forest development, as trees are felled to obtain fuelwood. These steps are directly aimed at poverty groups and should form a part of a poverty eradication programme.

**Tourism**

Tourism can be an important source of foreign exchange earning for the host country if there are historical monuments and sights and scenic beauty for foreign visitors to enjoy and shopping facilities for them to collect exotic and attractive items. Tourist spots generate employment opportunities, and local incomes rise as visitors, both foreign and from other parts of the country, come and spend money there.

But it is important that the tourist attractions are identified and properly maintained portraying their cultural heritage and natural endowments and complementary facilities, such as hostels, transport, and shopping centres are developed. Appropriately designed publicity drives should also be mounted to popularise the attractions.

In a mountain situation, scenic attractions should be plentiful. What may be necessary is to select the spots and sights and create the appropriate tourist environment to attract visitors. But care must be taken so that the mountain ecosystem is not damaged in the process and that the tourism development is planned as an integral part of the overall mountain development strategy. Care must also be taken so that tourism development does not promote social and moral degradation.

**Transport and Communication**

Needless to mention that transportation and communication play an important role in the development process by facilitating movement of people and spread of information and ideas. Hence, development of these facilities must be carefully built into the integrated mountain development strategy.

**Conclusion**

It has been contended that the mountain development strategy should be formulated within the framework of the overall national development strategy. What kinds of activities and what approaches in respect of industry, energy, tourism, transportation, and communication may be incorporated into an integrated mountain development strategy have been indicated. The focus has been on ecologically sound integrated mountain development and eradication of poverty. It has been suggested that, if poverty alleviation is a serious goal, development process must be people centred and access to productive assets and opportunities for development must be ensured for the poor.

ICIMOD can play an important role in this process by undertaking and assisting others interested in undertaking such activities towards integrated mountain development as surveys to generate the data and information base, preparation of guidelines covering various sectors, and appropriate action programmes in the areas of extension, training, and awareness building.

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# Alternative Energy Sources for Integrated Mountain Development

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The existing sources of energy in the mountains are being depleted at a very fast rate and mountain environments are facing an immediate danger. Energy plays a crucial role for integrated mountain development. However, the problem of energy development and conservation cannot be seen in isolation. It is to be seen as a part–albeit a very important one—of the total integrated system for mountain development. Almost all other sectors; e.g. transport, industry, agri-development, housing, are energy consuming. With population increase and concomitant increase in human activities, energy needs have increased. The relationship of man with his habitat has changed tremendously at the cost of the environment.

Mountains are beautiful and majestic. In the past, life used to be much healthier in the mountains than in the lowlands and the necessary resources were easily available and sufficient. Now, with modern medicine and health facilities, transportation and communication facilities, modernization in farming, and other urban amenities in the lowlands, life there has become easier and more comfortable than life in the hills. In the mountains, available resources are depleting at a fast rate on the one hand and urban amenities like health, education, transport, and other facilities are lacking, on the other hand. The hill people are finding life more and more difficult due to soil erosion, landslides, declining productivity of land resulting in food and energy shortage, and population growth.

The principal sources of energy the mountain people use today are forest products (firewood), agricultural wastes, animal wastes, and, to a far less degree, water power. Muscle power (human) is used always and animal power is used for farming. Solar energy is used to a certain extent for drying agricultural produce and timber for construction purposes. At present, firewood is the most important and extensively used energy source, accounting for more than 90 per cent of the energy demanded in the mountain regions.

Firewood is used for cooking, heating, animal food, alcohol making, processing of food, wool dyeing, and a variety of other purposes. Firewood is available almost free of cost, the only cost being the cost of labour to collect, although its extensive use and misuse by the people is surely going to have far-reaching repercussions in the near future. This present situation implies that any alternative energy to firewood for the poor population in the mountains will become feasible only if the alternative is almost free of cost. Because of the total dependency on Firewood as a source of energy, coupled with rapid population growth, the rate of degradation has reached alarming proportions. In Nepal, the comparison of maps and aerial photos show that the forest has been reduced from 60% to 30% in thirty years. In many places, the desertification process has already started. Mountain environment, in particular, is now characterized by rapidly decreasing vegetation coverage with the concomitant landslides and erosion. As the population in the mountain regions is increasing, these ecological problems will become more and more severe. For instance, according to Forest Resource Survey, the hills and the Himalayan region in Nepal require 15, 074 sq. km. of plantation compared to 3,780 sq. km. in the Terai area. In the hills, the forest area needs to be more than doubled. The average growing stock per hectare has reduced from 2,564 cu. ft. to 1,769 cu. ft. per ha. in the hills in the course of the past 13 years.

Given the resource constraints, it is very difficult to create big centres of development in the mountain regions. The settlement patterns are extremely varied, scattered, and dispersed. The population of settlements does not exceed a few thousand. Because of formidable transport conditions and extreme hardships under which the people are struggling for survival, it is not possible to establish big energy stations to cater to the energy needs of a considerable area. Most of the settlements, on the other hand, are rapidly decaying and they are so poor that it is virtually impossible to own such energy units for their own local demand. But decentralised energy implementation programmes will be more effective, as the development and use of appropriate technologies depend largely upon local needs in relation to local socio-cultural system. This is true for other energy consuming sectors, like tourism and industry, as well. While centralised energy development programmes are not feasible on the one hand, a very small settlement may not be able to sustain and use even a moderately sized energy unit. The trade-off between these two diverging requirements is, in fact, concentrated decentralisation. A policy of concentrated decentralisation will, thus, have a wider application. Energy development programmes have to be launched at selected small centres and growth points where other activities can also be located.

The ecological crisis cited earlier can be avoided through energy development and use programmes. Energy plantations and energy cropping programmes are essential, but these may not be adequate. It is essential not only to produce more firewood but also to make a much more judicious use of this ecologically important natural resource. Misuse of this source is to be completely checked and alternative sources must be explored. The following measures become imperative:

- optimum use of forest production in building construction;
- national export policy for forest production and policy implementation;
- inter-regional (intra-national) trade policy on forest products;
- more efficient and effective use of firewood for domestic and local consumption;
- exploration of alternative energy sources.

Of these measures, this paper is primarily concerned with the last two. It deals with alternative energy technology to ensure a more efficient use of firewood and development and use of alternative energy sources.

Alternative energy sources for the hills are water, solar energy, bio-gas, wind, alcohol, gasification, pyrolysis, charcoal, and geothermal. Besides the methods of reducing firewood consumption, the most important AER (Alternative Energy

Resource) is water, then solar, wind, bio-gas, human and animal power. To consider any of the forest products (presently used or not) as AER is a delicate matter and has to be approached with much careful planning and control. The following AET (Alternative Energy Technology) can be considered for the hills with reference to Nepali experience.

**Improved Cooking Stoves:**

In Nepal, the most important source of energy for cooking and heating is firewood. The energy problem of the rural and hill people can be alleviated by improving its use. Traditional village cooking stoves are being improved, not only for better efficiency, but also for improving lifestyles by avoiding health hazard and making rooms cleaner and smokeless. That is why awareness of the use of improved stoves has increased. About ten institutions are concerned with research and implementation of improved, smokeless stoves. The present use of prefabricated fired clay stoves may not be the only suitable solution for wider application in the mountain region due to difficult transport network and unavailability of potters.

A majority of the mountain population has been using simple tripods (Odan, Agena) for cooking. These also provide them with room heating, a source of light, and drying of grains and mattresses. This is one of the most inefficient methods of using firewood. Due to this type of complex need and also socio-cultural reasons, people will not easily accept any presently available improved designs of stoves. We have to consider that any new idea should be socially acceptable, as well, and its quality should be maintained.

Based on discussions with the local people, it is found that a semi-tripod type of the cooker is acceptable. The front half of the semi-tripod cooker will serve their usual purposes and the other half could be used as the source of heat for the second pot. The use of a chimney can be made optional.

A lot of firewood is being consumed for cooking animal feed. Even in the areas where the closed type of stoves are used, cooking food on the tripod is the normal practice. This is due to bigger sized pots and also cultural practice in some places. A simple portable, closed stove with grate should be appropriate for this purpose.

Presently, available improved fired-clay stoves could be used by lower hill people who are already using traditional stoves. The last variety of stoves can be build *in situ* as improved mud stoves with cast iron grates and cast iron rings for the pots. These will serve tea shops, restaurants, and bigger families. However, the grate and rings can be very useful for other stoves, as well, because by adding one of the rings even smaller pots will fit into it and the grate will greatly help combustion. These grates and rings are locally manufactured.

Efficiency can be maintained if people clean their chimneys regularly. Therefore, the people should be instructed and encouraged to keep the chimneys clean.

**Solar Energy:**

Solar energy has been used since time immemorial for drying of agriculture products. The speciality of this source is that it is a constant source available everywhere to everybody free of cost. The application of solar energy has been very successful in the use of solar water heaters. Several hundred solar water heaters have already been successfully operating in different parts of Nepal. Of course, it is not suitable for low income people, but it is good for the higher income groups: hotels, lodges, industries, and hospitals. It could also promote mountain tourism. These units can be manufactured in a standard mechanical workshop with some skilled labour. In these areas with problems of freezing, a modified type of system with anti-freeze has been developed. Simple solar water heaters have proved to be functional at an altitude of 8900 ft. above sea level.

Several solar dryers of various designs are working in different parts of Nepal. They are being used for drying ginger, apples, apricots, mushrooms, herbs, and seeds. These units can easily be manufactured in the mountain regions with locally available materials and skills, except for the transparent glass or plastic sheet which must be imported.

Solar dryers are of great importance for the hills. But the present design may not be appropriate for all the variety of needs. The dryers should be designed with the capacity of producing optimum temperature and airflow. The mass transfer of moisture which takes place during drying is a very important process for getting a high quality product. A close co-operation of food technologists and agriculturists with the designers of the solar dryers will ensure a better application of this technology to produce quality products.

Solar electricity is being widely used for telecommunication in Nepal and its application is of importance. The cost of solar electricity is coming down, whereas, the cost of other technologies are increasing. Although it will still be an imported item for the hilly region of developing countries, intensive research for its wider application becomes highly relevant.

Passive solar application has to be emphasized for proper utilization of solar energy in new buildings for heating and cooling.

**Hydro-power:**

The potential of hydro-power in the hills is the highest for both the short and long run. It is renewable and usually available in abundance. For many years, the work has been done mainly in the development and manufacturing of cross-flow turbines with an output of 10–50 HP. Some work has also been done in the field of propeller turbines and overshot or breastshot water wheels. More than 140 turbines of different capacities have been working mainly for mechanical power generation for primary food processing; a few of them for electricity generation.

Traditional mills (ghattas) have been in use for grinding grain all over Nepal for generations, and have been serving the local population to full satisfaction. These are generally integrated with hill irrigation systems. For the last three years, much attention has been given to the improvement of these ghattas which are made of mainly wood and stone.

For oil pressing, a local device (Kol) is used, for rice hulling a "dhiki" is used, and for home grinding in small quantities a "janto" is used. It is believed there are more than 30,000 traditional mills still functioning in Nepal. But due to the growth of population and resulting increase in demand, a technology is needed for oil expelling and rice hulling.

A new approach was started three years ago with the so-called MPPU (Multi-Purpose Power Unit). It is an improved design with spoon-shaped blades of metal instead of wooden, straight paddles, closed penstock pipe instead of open wooden chute, and with a power take-off device for other machines. Its main function is for grinding grains, rice hulling, oil expelling, and mini-electricity production, either with DC car generators or AC generators. It is produced in the range of 2.5 to 10 HP. The advantages of these units over other mini-scale hydro-power applications are that these are easily transportable and installed in a short period of time. The villagers will have no problem in using MPPUs as they are based on traditional devices.

Given the scattered settlements in the mountains, even an improved water mill like MPPU (for grinding, hulling, and oil expelling) may not be feasible due to low load for processing. Hydro-power, therefore, has to be used with integrated application. It should be used for many purposes like irrigation, water supply, electricity production, grinding, hulling, expelling, grading of flours, small scale industries, improved production of everyday products (ropes, mats, etc.), handicraft making and woodwork, etc. The extension of immediate use of water power could be for grading of ground flour, which is a time-consuming manual process (ground maize is separated into four different products), for winnowing, and for food packing. Such machines are available in the market, as well as can be locally manufactured with little effort and cost.

The use of water power is severely limited now as the needs of an individual community are so small that even the smallest improved power unit remains under-utilized. Approximate minimum settlement size required to sustain a 7 HP water power unit for the purpose of grinding, hulling, and oil expelling, given the present standard of mountain people, is about 5,000 people. This implies that if water power is to have greater future in the mountains, we should try to create bigger settlements instead of present pattern of scattered settlements. If not, we will have to choose integrated uses of the power unit and diversify its use to small industries, food processing a packing, rural industries, and electrification. The settlement size may decrease accordingly.

The installation of water power units has to be carried out by technicians. The total cost of such power units are within the reach of local people and cost of recovery is possible. The cost of power units will decrease considerably if power units can be standardized using modular concepts and considering the demand pattern of the hills. It is also valid for the micro-hydro turbine units. Preferably, the power unit should be owned by a private party, but at places where there is strong community action, it may be owned by a community organization, a panchayat body, or even by a group of small farmers.

The establishment of a turbine institute is very important and could enhance the utilization of water power and will help national testing and R&D activities for energy development.

**Bio-gas:**

Where wood is a scarce commodity, the people, especially low income groups, use animal waste directly for cooking and heating. This rich, valuable manure is being misused as source of heat instead of using it as a fertilizer which could contribute enormously to hill agriculture. At present, there are already 1,200 bio-gas plants installed and 25 per cent of these are in the lower hills. Bio-gas has mainly been used as an alternative for cooking and lighting. Recently, it is being used in deisel dual-fuel engines. About 10 dual-fuel engines with about 25 to 30 per cent bio-gas and 70 to 75 per cent deisel consumption are in use for grinding, rice hulling, oil expelling, and as a source of light. However, investment in bio-gas digesters for such engines is not yet economically feasible. In one of the operating 7 HP dual-fuel deisel engines for grain processing and light, there is a saving of only 3 litres of deisel per day. A bio-gas system costs about 45,000 rupees and the gas lasts for about 4 hours daily.

Bio-gas as AER can be used for cooking and lighting. It provides a powerful source of light attractive to the hill people. The energy required for light is almost one-third of that required for cooking. Bio-gas plants have a better future as a source of light compared to cooking. Bio-gas potential is high for the lower hills but present technology is not appropriate for higher altitudes due to cold climate. More effort is needed to cut down the cost of the plants, to use other organic materials besides animal dung for digestion, and to improve fermentation at lower temperatures. At places where there is no alternative energy source and the people depend upon animal wastes, these plants should be encouraged by all means.

**Wind Energy:**

The application of wind energy has been tried at several places but there has been little success so far. Sophisticated systems, manufacturing problems, maintenance problems, and lack of wind data are the major constraints hindering the use of wind energy. However, there is a good prospect for this energy use in some places. The recording of wind data should be carried out as soon as possible and some windmills should be installed on an experimental basis.

**Human and Animal Power:**

Muscle power is widely used all over the hills but pedal power has been neglected. Animal power is used for farming and transportation. Some local manufacturers are already producing hand corn shellers, pedal corn shellers, pedal paddy threshers, pedal pumps, and many other agri-tools. Many new items, like rice huskers, rice polishers, winnowers, crushers, chaff cutters, and silage cutters can be easily manufactured and used in smaller communities where water power technologies are not feasible. Increased use of muscle power requires more food. Serious thought should be given for intensive use of these energy sources in isolated, dispersed settlements.

**Implementing Strategy:**

For successful implementation of energy development and use programmes, based on energy potentials and appropriate energy technologies in the hills discussed earlier, the following measures should be taken:

**Implement AET at Selected Focal Points:**

As mentioned at the outset, it is essential to select certain potential centres where energy development programmes can be intensively launched. These centres should also act as receiving stations for the technology transfer process. R&D activities are vital in adapting and adopting innovations. These centres will also be a potential place for markets. Integrated development plans for these centres, in view of the service area, becomes necessary. It is easier to organize community action and participation at such centres.

**Categorize Main Purposes for which AET is needed in the Hills:**

The energy potentials available and the energy needs are the two factors that should decide energy development programmes. For integrated mountain development, agriculture, transport, communication, and industry (including tourism) ought to be developed to ensure viable and sustained development. Assessments of the potentials, conservation and development, and the ultimate use of energy form a complete cycle. An inventory of energy sources for integrated mountain development assumes crucial dimensions. Population location as well as activity location should be given due consideration.

**Develope and Adopt Modular AET:**

This is essential for mass production of designs. It has several advantages: technology becomes cheaper and costs are reduced;

the production process becomes mechanized and simplified; technicians will be more efficient in implementation; technology transfer to local people becomes easier; and publicity and communication become wider. However, standardization is the final stage in the adaptation of new appropriate technologies. Only with the careful study of the local needs and after the experimental stage should one proceed towards standardization. It should be seen as the end of R&D activities.

**R&D Activities:**

R&D activities help enormously in the implementation of energy development and use programmes. It should, in fact, be seen as an integral part of implementation programme. Feedback between implementation and design phase becomes possible only when there is an on-going research work relating to needs, potentials, and use/application of energy sources. As the energy sector is a relatively new field, it is essential to adopt a policy of "learning-by-doing" process. The essential component of such research activities should be to relate community needs, resources, and enterprise with potentials of energy development.

**Maintain the Quality of AET and Give Training to the Local People:**

For successful application of appropriate technology, it is essential to launch technical and communication support programmes. The new technology must be well demonstrated to ensure and maintain quality. Local people should be selected as dissemination agents and given training. Information dissemination at the household level becomes more effective when local people are used. Community participation in energy development programmes will improve maintenance and ensure sustained use of energy sources. Socio-cultural resistances can be minimized by involving local people. The local needs can be more easily ascertained. When an AET becomes acceptable economically, socially, and culturally we should go for mass application of the technology and the local people could play a key role here, as well.

For the successful implementation of the above strategies, international co-ordination among government and non-government organizations, manufacturers, research centres, and users' group should be established.

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# The Task and Significance of Integrated Approach–A brief Account of Chinese Expedition to the Himalaya and Tibet

**Sung Hong-Lie**
Commission for Integrated Survey of Natural Resources, The Chinese Academy of Sciences

Mr. Chairman, dear friends,

I would like to thank you for the honour of being invited to address this distingushed gathering. The Chinese Academy of Sciences intends to summarize all available data concerning the formation and evolution of the Himalayas and the Tibet Plateau, and to formulate a proposal for the management of natural resources and conservation against natural catastrophes. In accordance with these objectives, a number of expeditions have been organized to the Himalayas and Tibet since the 1950s. These multi-disciplinary expeditions have facilitated a much broader understanding of this region.

The expedition which began in 1973 lasted longer and involved many more disciplines than the others when, for ten years, scientests from over 50 disciplines were engaged more than 400 scientists and technicians participated in field work and over a thousand in laboratory work. Based on the results of this expedition, a series of monographs has been published or is in the process of being published. Some of them will be presented to ICIMOD. At present, this expedition is concentrating on field work in the Hengduan Mountains, the eastern part of the Tibetan Plateau.

I have had the great pleasure and honnour to serve as the head of this expedition since 1973. I would like to give you a brief introduction to this research and to emphasize the following points according to my own experiences.

First, the integrated multidisciplinary research is really important. I think it is the principal approach to safeguard the ecological balance and to ensure the rational development of the mountain area. In my opinion, problems such as excessive deforestation, overgrazing, soil erosion and so on, and due to the lack of integrated development.

In order to organize integrated research based on a number of disciplines, it was necessary, first of all, to develop a well-coordinated plan, and especially to define the theme of the project. This theme provided a focus for all the disciplines involved. Otherwise, effective integration of each of the disciplines would not have been possible. For example, the theme of my expedition was the formation and evolution of the Himalayas and Tibet and their influences on the environment and human activities.

There are really four problems to this theme: (1) the evolution and upheaval of the Himalayas and Tibet; (2) the influence of the Plateau's upheaval on the characteristics, evolution, and differentiation of the environment; (3) the flora and fauna, and their adaptation to the Plateau environment; and (4) the evaluation and utilization of natural resources and environmental conservation.

According to my experiences, an integrated approach must involve the collaboration among natural and social scientists, as well as technicians. As mentioned before, more than fifty disciplines participated in our integrated research including geologists, geographers, biologists, agronomists, economists; and so on.

An integrated approach must involve also collaboration between the scientist and the decision-maker. For example, in the very begining of our expedition, we sent a task force to the area to identify gaps in knowledge and to determine the urgent practical needs of this region. After the formulation of the programme, we discussed it not only with the authorities of related institutions, but also with the local decision-makers. We usually encouraged the local scientists and practitioners to participate in our expedition team with assistance from the local inhabitants. Sometimes, the local decision-maker himself served as one of the leaders of the expedition. In this manner, the opinion of the scientist and the local decision-maker could be duly considered. Another example is that the Commission for Integrated Survey of Natural Resources, of which I am now the director, is under the dual leadership of The Chinese Academy of Sciences and The State Planning Commission.

The integrated approach must involve the cooperation between the scientist and the local population. I think this cooperation should not be neglected because the local residents are the practitioners. They have a great deal of experience. We scientists must learn from them, and on the other hand, the scientific results must be implemented by them.

Development of the resources of mountain areas may result in widespread harmful environmental effects. In the meantime, a number of successful examples of rational protection and utilization of natural resources have been achieved. So I think the most important task for us is to organize related disciplines to sum up these successful experiences and to determine the scientific approaches to rational mountain development.

In my opinion, one of the more effective means is to hold seminars and symposiums in those places where successful examples can be displayed. Of course, we have adopted the experiences of other countries outside this region.

Finally, it is necessary for us to establish research stations in some key areas. Such stations may be used for studying the relationship among the various elements of mountain ecosystems and the interactions between highland and lowland for comparison of the original conditions with the developed conditions and for recording the economic benefits and ecological effects of mountain development. We have already established several stations in the Hengduan Mountains and other mountain areas. The results of research will be published in due course.

Distinguished colleagues, dear friends, we would like to see that more and more attention is paid to research in the Himalayas and Tibet by scientists from all over the world. We know that numerous important results have been achieved by many scientists in this region. We would like to learn about the successful experiences from our foreign colleagues. We do hope that this symposium and ICIMOD will pave the way for constant exchanges of views between scientists of this region, as well as scientists of the whole world. Let us, therefore, increase our efforts to discover a more effective approach to integrated mountain development.

# Highland-Lowland Interactive System on a Local, National, and International Level

Bruno Messerli
University of Berne, Switzerland

The programme, "Highland-Lowland Interactive System", of the United Nations University (UNU) has a special significance and importance for ICIMOD's "Mountain Development: Challenges and Opportunities".

Mountains, regardless of absolute altitude, are areas of sufficient relief to reflect significant ecological differences, as can be seen in the Hindu Kush-Himalayas on a local and regional, but also on a national and international level. Ecological differences also mean socio-economic differences, and these different impacts of human activities will ensure continuous interaction between two or more ecological belts (Messerli 1983–84). Therefore, an integrated approach is needed in a double sense: First, to understand the interaction between ecology and human activities, which may or may not be adapted, and second, to become the interaction between higher and lower ecosystems and land use communities.

**Integration and Interaction on a Local and Regional Level:**

In a concept for a case study (fig. 1)*, the main steps from the objectives to the decisions and measures are shown in a very general and very simplified way. Only in a detailed case study can the functioning, the capability, and the dynamism of a regional ecological-economic cultural system in a really integrated approach be analysed and understood. Before any decisions are taken, some scenarios should be developed. The increasing influence of external factors; e.g., policy and administration, economy and communication, demography and socio-cultural changes, and the internal differentiation at a passive and an active attitude should be taken into consideration. Scenarios help to evaluate the consequences of decisions and measures to a certain degree. Scenarios are hypothetical sequences of a development, constructed with the idea of focussing attention on causal processes and important points of decisions. Fig. 2 could give an impression of how mountain ecosystems are determined by man's activity and by highland-lowland interactive process. With regard to the Himalayas, it must be stated that human energy has converted the original forested, steep slope into an intensively used agricultural system. Owing to deforestation, the slope had become potentially unstable, but terracing has once more transformed it into a stable system. Nevertheless, erosion forms and processes can be observed (Kienholz et al., 1983: 195–220). Is this obvious damage a deliberately calculated risk, well-known and maintained within acceptable limits over generations, or is it an intensifying process that is beyond control, an indication of accelerating instability, a sign of a fundamentally changing environment? The question is very difficult to answer. It is, nevertheless, an important, even critical, question for the Himalayan region. The answer requires basic ecological research and also a much fuller understanding of the natural and human structures and processes.

**Integration and Interaction on a National and International Level:**

Fig. 3 shows an attempt to generalize the natural and man-made hazards in mountain areas, concerning not only the local and regional, but also the national and international level. In order that the process may be understood, an integrated approach is needed for every altitudinal belt with its special natural and human conditions. In order that the consequences of the processes may be understood, a study of the interaction between different altitudinal belts is required.

The most important element with long-term effects is the soil erosion and fluvial erosion and accumulation, beginning in the highest belts of the Hindu Kush-Himalayas, and ending in the densely populated plains of the surrounding countries. For years the same assumption of population growth, deforestation, erosion, and floods has repeatedly been made with the result that everybody believes in this vicious circle without proof for any particular region or river system. After the detailed field work in the Kakani area near Kathmandu, we begin to realize that we have not enough data to be able to say how much of the sediment load of the river is natural and how much is man-made. It is the fundamental problem of the Himalayas, and it needs international collaboration between the Himalayan countries on basic research to understand the ongoing processes. Is it not surprising that we do not have enough data available on soil loss under different types of land use practices? Is it not astonishing that we do not know the origin of the flood waters and silt, whether it is the Siwaliks, the Mahabarat Lekh, the Middle Mountains, or the great Himalayas?

Results of a research project on mountain hazards in the Khumbu area do not allow us to estimate exactly the direct influence of geomorphic processes-weathering, erosion, flooding–on lower regions (midland and Terai) that occur in the high mountains, but two examples from the field work of Zimmermann (publication in preparation) may illustrate a tendancy:

1. The load of the rivers with detritus and suspended matter is not very big, because of a low weathering rate and only little glacial and fluvial deposits. The erosion in the Khumbu area is not as important as in the deep weathering layers in the Middle Hills.
2. A catastrophic flood, the outburst of a glacial lake with $5 \times 10^6$ m$^3$ of water, that came down from the Nare Glacier (5000 m asl) did a lot of damage in the high valleys below; e.g., landslides caused by undercutting, flooding of terraces, destruction of several bridges. At Rabuwa Bazar (460 m asl, 80 km below the glacier) the peak of the glacial flood was not as intensive as the run-off of a normal monsoonal precipitation in the lower part of the Dudh Kosi watershed.

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*Figs. 1–4, pages 49–52

The hydrograph (See fig. 4) shows that the maximum water discharge of precipitation during the monsoonal period (26th to 28th August, 1977) went up to 1600 $m^3/s$ above the basic run-off, the discharge of the glacial flood (3rd September, 1977) was only 800 $m^3/s$.

The latter instructive example shows that a catastrophic event in the high mountains has had no effect on the plains below.

The following data (table 1) were published from an international congress on river sedimentation in Beijing in 1980. An interesting fact is that the high rate of average sedimentation concentration in $kg/m^3$ of the Yellow River (China) and the Colorado River (USA) is comparable to all the other big river systems of the world, except the equatorial ones. If the annual sediment load is taken into consideration, the Ganges has an extremely high quality. However, as a whole, the Himalayan rivers are in comparable order of magnitude. Are the data too old? Is the recurrence interval of the floods during the last few centuries known and can an acceleration really be observed? Finally, how much is the man-made rate of sediment load and which zone or belt is responsible for it?

All these questions are still open. Answers are needed for eco-development of the different regions and to find them it is necessary for scientific collaboration between the higher and the lower countries of the Hindu Kush-Himalayas.

**The Contribution of the Scientific Community to ICIMOD's Activities:**

The main objectives of development in the Himalayas are to guarantee long-term sustainable and stable production in the mountainous areas, especially on the marginal land, where high subsistence agriculture has to be developed. Therefore, basic application-oriented research is required. Better knowledge is necessary to reduce the constraints and to increase the potential of the mountain eco-system and the surrounding lowlands and plains.

In this sense, ICIMOD has to stimulate research activity in the Hindu Kush-Himalayas, but it also has to see that the results are available (documentation), applicable (training), and, finally, that they are applied (information). The main responsibility for all the research is borne, wherever possible, by the scientists themselves of the countries of the Hindu Kush-Himalayas. One problem must be solved, however: research for the rural population can never be done in a capital, in an institute of an university, in an office, or in a laboratory. It must be done in the field where people are working and living.

It should be further borne in mind that a lot of farmers know much more about ecology–their knowledge having been accumulated over generations and centuries—than any scientist. It is not true that the scientist must come and tell the farmer what he has to do. Quite the opposite: firstly, the farmer has to tell the scientist what and why he is doing something in a certain way. Then, the "foreigner", even if he is a native of the country, will understand the key problems and the limiting factors. He will also see that behind a certain problem there is, perhaps, not a scientific but a social or a political constraint. For instance, if a farmer has to pay more than 50% of his yield in taxes to a landowner, how can he afford to improve his farming methods? If the population increase leads to such an intensification of agriculture that the soils are progressively impoverished, how can the downward spiral be reversed when the farmer is forced to utilize increasingly marginal land in order to survive (Ives and Messerli 1984)?

If the scientist begins to see and understand these problems, his thinking and working become integrated and interactive. The truth is not to be found in the book of the office, and the truth was not the same yesterday as it is today and will be tomorrow. Natural and human conditions are in a dynamic equilibrium-or disequilibrium–and ecological stability is the continued existence of an ecological system and its capability to restore its original state after a change (Gigon 1983:96; see also Winiger 1983:106).

Though the scientists of the countries concerned have an absolute priority for research, foreign specialists or generalists could be helpful; e.g., methodological aspects (system analysis and scenario techniques as tools for integrated approaches); technical problems (instrumentation, data collection and evaluation, etc.); special scientific questions (analysis of a nutrient cycle); and, finally, as a means of comparing Hindu Kush-Himalaya research problems and projects with other mountains of the world. The deterioration of mountain ecosystems is a world-wide phenomenon and ICIMOD should be ready to facilitate the import and export of knowledge and know-how.

**ICIMOD from the Scientist's Point of View:**

The understanding of structures and processes in mountain ecosystems, the integrated approach of natural and socio-economic sciences, case studies with a long-term monitoring concept, and programmes with a special reference to highland-lowland interaction are not only questions of research but also of international collaboration, documentation, information, and training.

The experience of several years of scientific work on the Swiss Mountain-MAB Programme has shown that considerable efforts were necessary regarding the education of participating scientists. Most of them were not trained in interdisciplinary work, and it was difficult to adapt the approaches, methods, and results of discipline-oriented work to the problems of an integrated man-environment system. The scientist had not the time nor the training to think about the needs of local inhabitants and decision-makers. However, the different levels of decisions have to be taken into consideration and our work and findings have to be adapted to the reality of the local population and administration (March 1983: 117).

Finally, long-term oriented research is needed because the deterioration of the mountain environment is frequently the result of slow acting processes that are often not clearly identifiable within a decade or within a single generation (Ives and Messerli 1981). The very high costs of these slowly accelerating and uncontrolled processes must be paid by all the subsequent generations. The mountain ecosystems of the Third World are now changing in somewhat the same way.

With regard to the Hindu Kush-Himalayas, the same processes can be observed and differentiated from high to low, from humid to dry, from cold to warm, from steep to flat, from intensive to extensive use, and from adapted to non-adapted techniques. Therefore, a regionalization within the ecological differentiated regions is necessary to place a series of case studies with a long-term monitoring system. These test areas have to be integrated in a highland-lowland interactive system based on friendly international collaboration. If all the Hindu Kush-Himalayan countries are willing to support ICIMOD as a main agent in solving these fundamental problems, then they will have important feedback on the future development of their own fragile mountain ecosystems.

Fig. 1 **Concept for a Case Study**

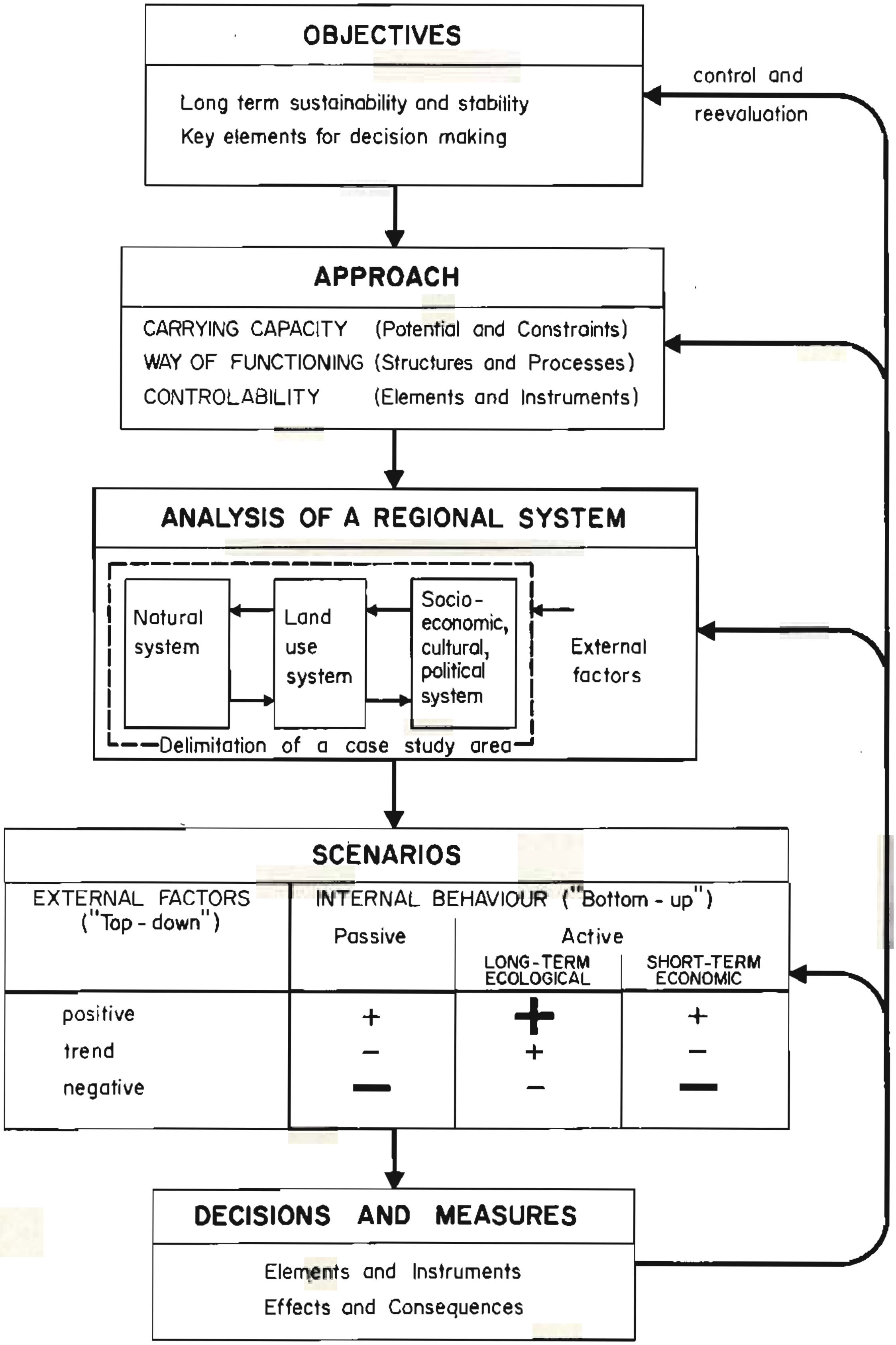


Fig. 2

**Stability, Vulnerability, Fragility, Instability**

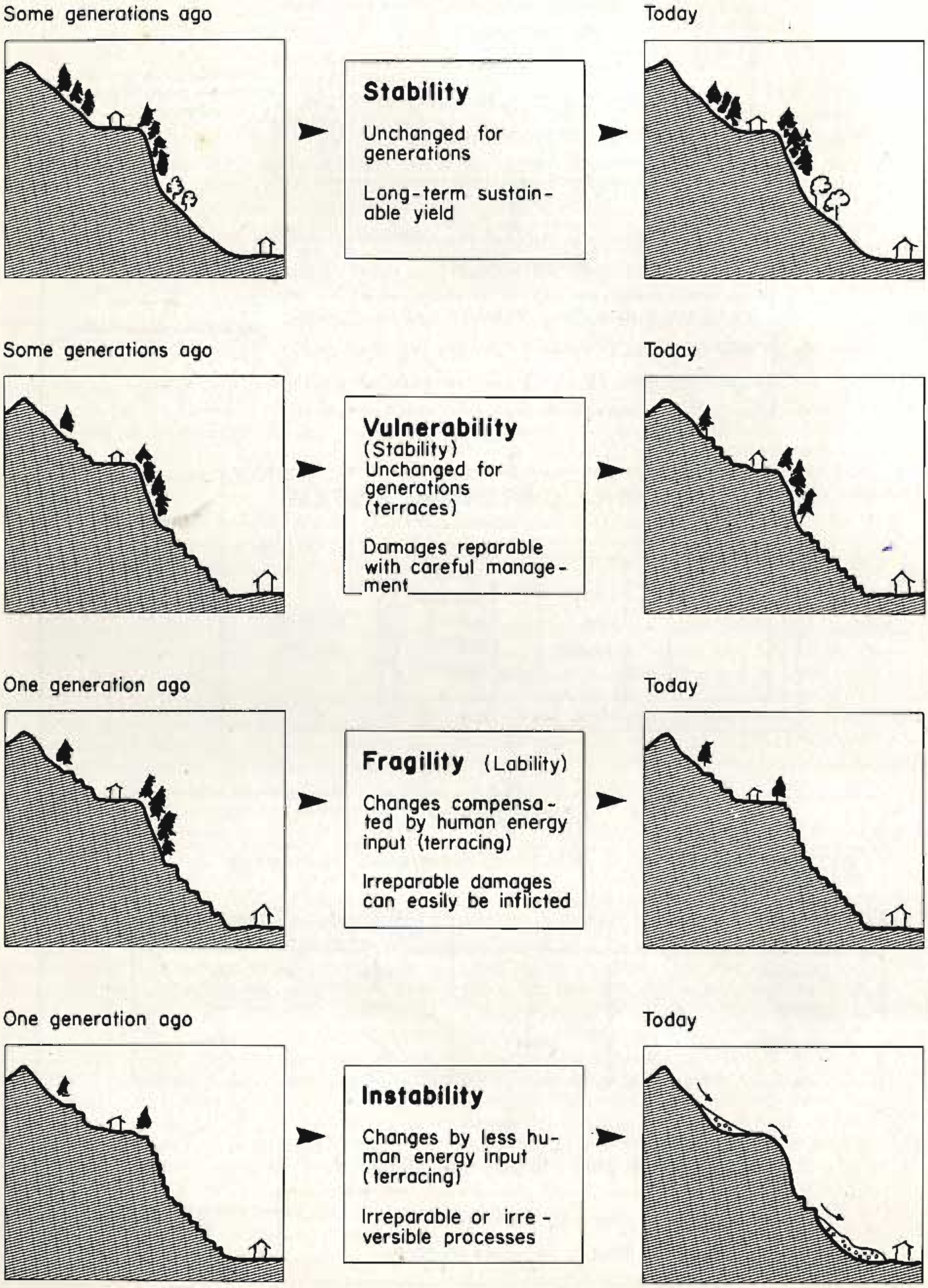


Fig. 3

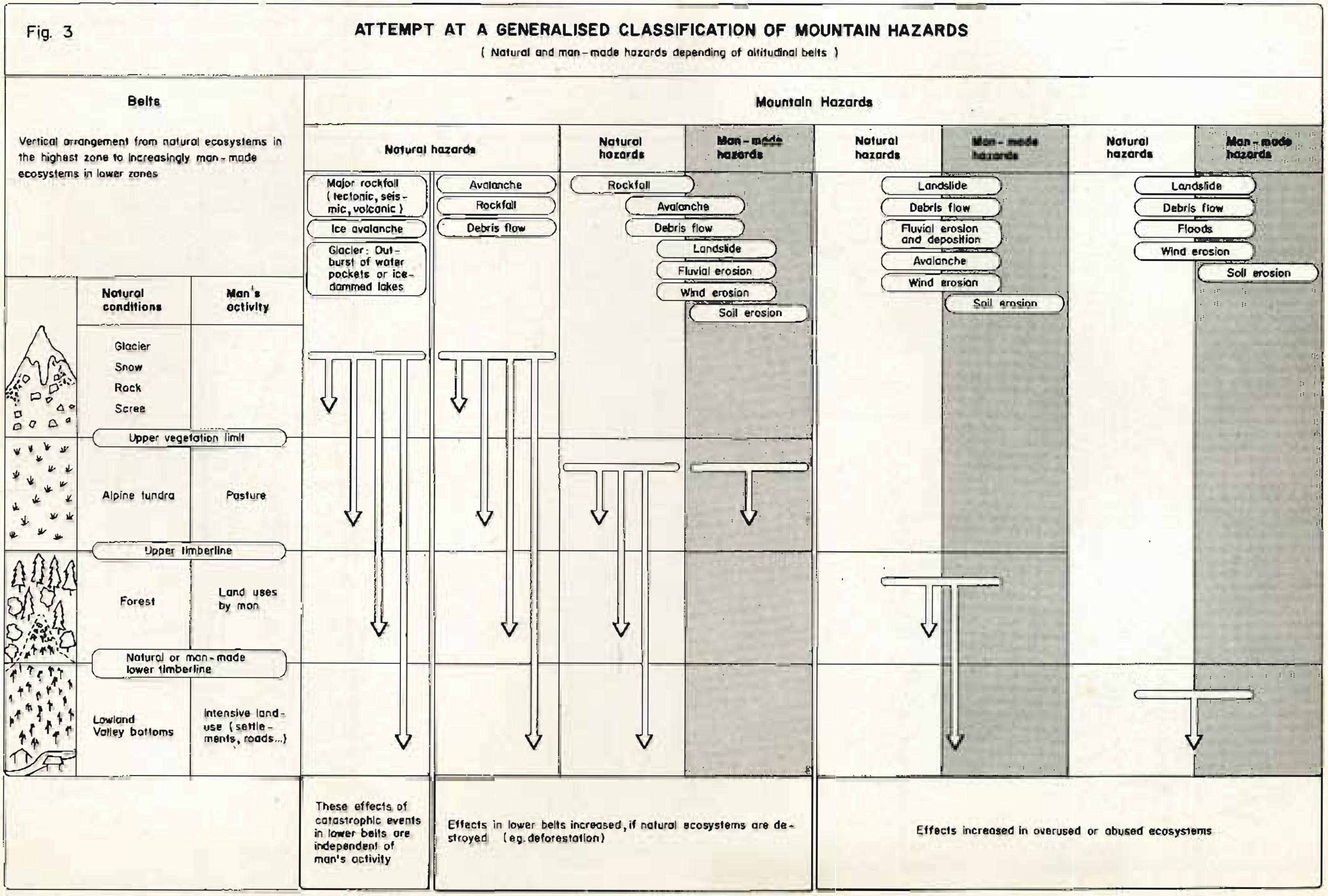
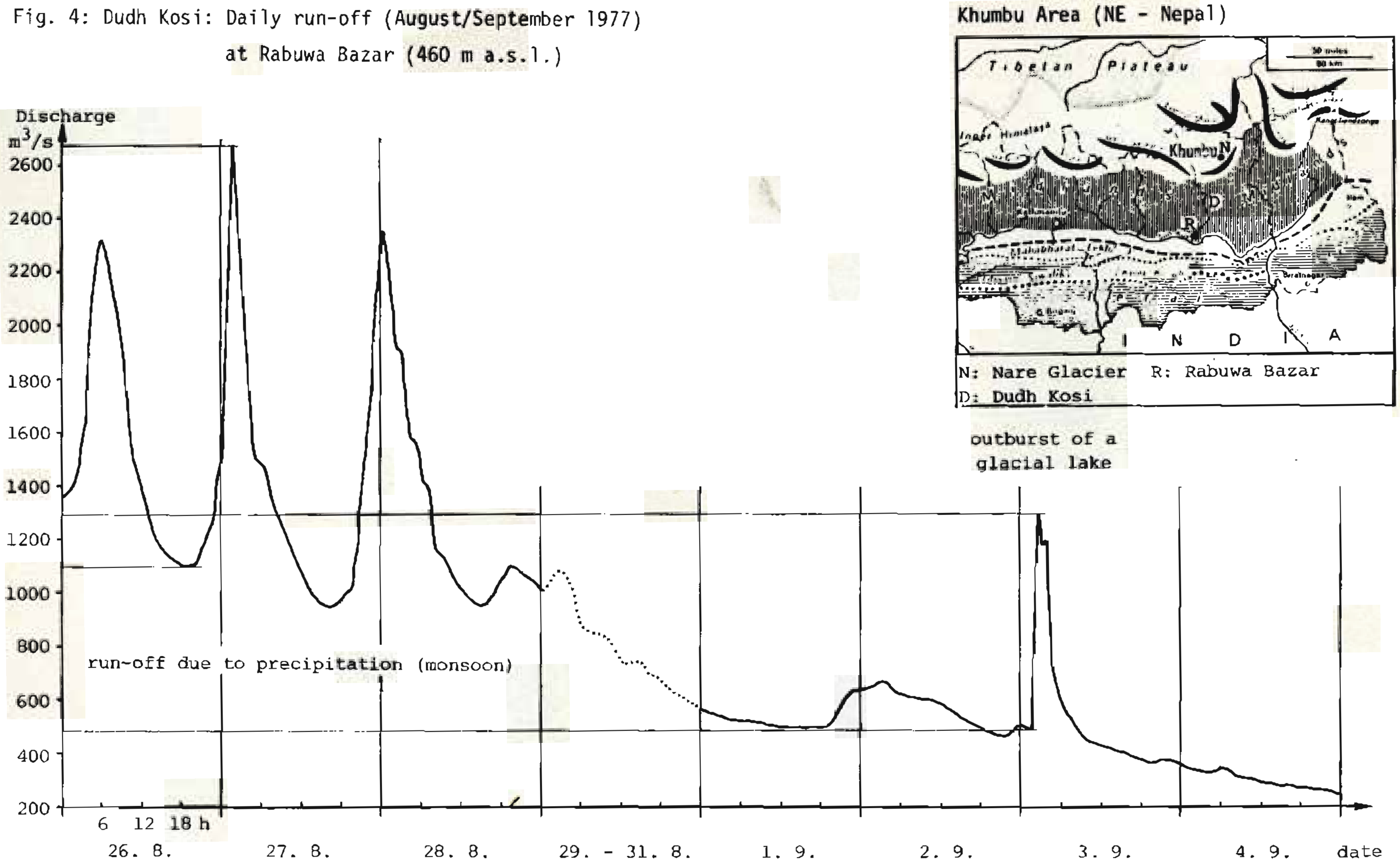

ATTEMPT AT A GENERALISED CLASSIFICATION OF MOUNTAIN HAZARDS
( Natural and man-made hazards depending of altitudinal belts )
Belts
Vertical arrangement from natural ecosystems in the highest zone to increasingly man-made ecosystems in lower zones
Natural conditions
Man's activity
Glacier
Snow
Rock
Scree
Upper vegetation limit
Alpine tundra
Pasture
Upper timberline
Forest
Land uses by man
Natural or man-made lower timberline
Lowland
Valley bottoms
Intensive land-use (settle-ments, roads...)
Mountain Hazards
Natural hazards
Major rockfall (tectonic, seis-mic, volcanic)
Ice avalanche
Glacier: Out-burst of water pockets or ice-dammed lakes
Avalanche
Rockfall
Debris flow
These effects of catastrophic events in lower belts are independent of man's activity
Natural hazards
Man-made hazards
Rockfall
Avalanche
Debris flow
Landslide
Fluvial erosion
Wind erosion
Soil erosion
Effects in lower belts increased, if natural ecosystems are de-stroyed (eg. deforestation)
Natural hazards
Man-made hazards
Landslide
Debris flow
Fluvial erosion and deposition
Avalanche
Wind erosion
Soil erosion
Natural hazards
Man-made hazards
Landslide
Debris flow
Floods
Wind erosion
Soil erosion
Effects increased in overused or abused ecosystems

Fig. 4: Dudh Kosi: Daily run-off (August/September 1977) at Rabuwa Bazar (460 m a.s.l.)




Source: Dept. of Irrigation, Hydrology and Meteorology, HMG, Kathmandu, Nepal

M. Zimmermann, February 1984
University of Berne

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# Current Approaches to Research and Development In the Hindu Kush-Himalayan Region

J.D. Ives

Mr. Chairman and Mountain Colleagues, I would like to introduce myself as a representative of both the United Nations University and of the International Mountain Society. However, I want to speak mainly as an individual committed to the cause of rational development of mountain resources and the well-being of mountain people, because the two are inseparable.

First, in my estimation the ICIMOD Procedural Paper is most comprehensive and the Board of Governors, Regent Gueller, and the analysts deserve fullest congratuations. It is a splendid beginning and it is, therefore, with some trepidation that I, as an outsider and generalist, volunteer any commentary.

I would like to concentrate on three themes:

1. to follow the initiative of our distinguished colleague, Sri John Lall, and to emphasize the importance of what I believe to be ICIMOD's need to engender the correct kind of scientific research, scholarship, and development analysis as a basis for understanding mountain environments and their optimum sustainable use;
2. to call for a courageous evaluation of many of the current, so-called, development schemes, and hence, of development agencies;
3. and, now, to risk an apparent contradiction, to take a leaf, literally, out of the new book of our absent distinguished colleague, Professor Frank Davidson, and recommend that ICIMOD take on the evaluation of a selection of possible, or "futurist" macro-engineering projects within the Himalayan region.

In terms of the first theme, I would like to extend to you my conviction that much of what we may call the theory of Himalayan-Indo-Gangetic Plains degradation is based, at least in part, upon a degree of myth–a quarter-century of emotion and repetition of first impressions–and I am at fault myself as much as anyone else. Is it really correct to assume that deforestation in the mountains causes soil erosion and landslides, with direct impacts all the way downstream to the Bay of Bengal, and to base development plans directly upon such a facile assumption?

We must first ask what are the causes of deforestation. This obviously has a simple answer, but it is the more complex set of answers that must be sought. Fuelwood demands of subsistence farmers, and pressure to farm more marginal and steeper land to produce food for local consumption to feed a rapidly increasing population are two oft-cited causes. But why is the population growing so rapidly? What are the patterns of local and regional migration? What can be done to ameliorate these massive socio-economic and political pressures? Next, we must examine the linkage between deforestation and soil erosion. What are the rates of soil erosion under different cover types and land-use strategies, at different altitudes, and on different substrates? What are the point sources of sediment transfer and how far downstream from point sources can the effects of siltation be detected? It seems to me that we really do not know whether Indo-Gangetic Plain disruptions are caused by sedimentation derived from the high mountains, the middle hills, the outer ranges, the Terai, or the main floodplain itself. At least, we cannot rank these five major potential source areas with any degree of confidence. It is a much larger problem to differentiate between so-called "natural" and "man-made" causes, but this also must be recognized if effective–and costly–countermeasures are to be contemplated.

These questions can be answered, but I think the continued perpetration of large-scale development schemes without answers must be regarded as folly, if not irresponsibility. To tackle such an issue will require a constructive and integrated approach: integrated in the sense of "interdisciplinary", but also in the sense of inter-agency, inter-national, and inter-personal co-operation. An obvious starting point would be the construction of a research design–a model in today's favoured parlance–to test the assumptions that we tend to accept as facts. This, in turn, should lead to identification of additional data needs collection analysis, and refinement of the model. Five years of carefully construed effort should be enough to provide a much more rigorous input into assessment of development projects. Perhaps, more importantly, it should be enough to confirm, modify, elaborate, or replace the theory of Himalayan-Indo-Gangetic Plains degradation.

I am very much aware that it may be considered preposterous for any individual to present such a statement. In an attempt to justify my position, therefore, let me refer to the detailed field study made in the Kakani area on the edge of the Kathmandu Valley. This study has been performed under the sponsorship of the Nepal National Committee for Man and the Biosphere, the United Nations University, and UNESCO between 1979 and the present day. Since the research team, albeit with limited resources, set out to link socio-economic, natural science, hazards mapping, and village level environmental perceptual studies, and, since we had the chance of revisiting field sites over a five-year period, certain advantages accrued to us. Our initial response to the large amount of landsliding and soil erosion was comparable to that of earlier workers and one-time visits of experts. It appeared that the Kakani area was on the brink of catastrophe. What becomes apparent in the longer term is that there exist traditional strategies at the village level for response to the landslide hazards. Areas that I photographed in 1978 and 1979 as unstable landslide scars are today well-tended and highly productive wet and dry agricultural terraces. When the village level reclamation efforts are deducted from the land loss estimates that are often derived from one-time visits, the rate of environmental degradation is seen to be much less than that initially assumed. This does not imply that we can afford the luxury of complacency, but it does mean that there is a little more time and room for more hope, and hope is an invaluable commodity.

Our experience in the Kakani area also led to the realization that the existing destablizing pressures on the local people must be taken into account. These include aspects of land tenure, rent, and tax structure which, collectively, may be a major cause of the on-going deforestation. As a small scale example, it appears that a subsistence farmer may be tempted to continue to cultivate increasingly unstable terraces, rather than leave them fallow, because he fears that fallow land will be repossessed by the govrnment for reforestation. Thus, local actions are influenced by "outside" forces, or perceptions of them, and taken in contradiction to the traditional strategies built up over many generations.

Another related issue: accelerating rates of deforestation are often related to the growing need for fuelwood. Yet, as an example of how unreliable our "data base" is, a recent IIASA study revealed that existing "facts" on per capita fuel consumption vary by a factor of 27. Would an economist draw up his company's next year's budget if estimates of a prime area of expenditure, or income, varied by a factor of 27?

Hence, there is a need for a research design to identify minimum data requirements, and a plan for fieldwork and analysis, at least in a few representative river basins, coupled with a better attempt to understand the landscape dynamics.

At a recent conference in Switzerland (1981) organized by my colleague, Professor Bruno Messerli, an experienced contributor spoke in opposition to more research with what, to me, was an entirely understandable remark: When the scientist doesn't know what to do he collects more data. An equally reasonable response could be that the scientist is sometimes led to think that the developer or decision-maker prefers no research because it is easier to make decisions if there are no facts. I do not wish to be divisive, because these are obviously extreme positions and there is much more room down the centre of the road than is sometimes appreciated (the results of the 1981 Swiss conference, Stability and Instability of Mountain Ecosystems, have been published in *Mountain Research and Development*, Volume 3, Nos. 1 and 2, Volume 4, No. 1; they will be issued in book form under a single cover; Editors, Bruno Messerli and Jack D. ives, 1984).

For my second theme, I will raise an equally delicate topic. It has always astounded me that many development agencies sponsor, for instance, large dams and other vast projects, apparently without taking note of watershed conditions, indigenous deforestation, rates of siltation, and social acceptability. Cases can be cited, not only in the Hindu Kush-Himalayan region, but also in East Africa, Ethiopia, and the Andes. Two examples are described from the Ecuadorian Andes because they are far removed from the Himalayas.

First, there are two important hydroelectric projects being developed in the upper watersheds of the Rio Paute and the Rio Pastaza, headstreams of the Amazon. I was only able to visit the latter briefly. These two projects, vital to the national economy, have begun without collecting data on sediment transfer in the upper stream basins. Current pressure on land from a rapidly expanding highland population, however, is significantly affecting high mountain vegetation cover in the direction of increasing rates of soil erosion and sediment transfer. This affects the Paute project in terms of the useable lifetime of the storage reservoir, and to the Pastaza project, which has no reservoir, in terms of cavitation damage to the turbines.

The second example is a little more esoteric but no less interesting. The growth of Quito, at 2,800 m above sea level, has led to a shortage of water and to a serious lowering of the water table. Population continues to grow, and, as a response to the increasingly pressing problem, a large water diversion scheme is being funded. This project will tap the headstreams of rivers to the north of the city and divert them southward, at considerable expense and not a little environmental disruption.

The main aquifer supplying Quito is believed to be recharged largely from rain and snow melt in the neighbouring highlands which support paramos and sub-paramos vegetation. One of the most important areas is the Cotopaxi highland.

Extensive areas of the Cotopaxi highland (Cotopaxi National Park) are being converted to pine plantations (P. radiata) at the expense of the natural sub-paramos vegetation. It has been hypothesized that the pine plantations, because of greatly increased evapo-transpiration, may be causing serious lowering of the water table.

It could be argued that the two development projects–pine Plantation and water diversion–are in conflict because the decision-makers never asked the fundamental questions nor acquired the appropriate data upon which to base rational decisions. It is conceivable that elimination of pine plantations from Cotopaxi would not only reduce, or even overturn, the need for an expensive water-diversion project, but would result in a much more aesthetically attractive and ecologically appropriate national park. And the much-needed timber could be obtained from further destruction of the tropical rain forest, or from pine plantations established in more appropriate locations.

The preceeding discussion is hypothetical and deliberately argumentative. Clearly, a full cost-benefit analysis is required. Minimum data needed to undertake such an analysis include precipitation data, evapo-transpiration data for pine plantations and sub-paramos vegetation, and determination of rates of ground water recharge and sub-surface flow. Should the more conservation-oriented approach prove practical, then an unnecessary environmental disturbance and the wastage of funds would be averted. Should the current development schemes prove the only feasible alternative, then, at least, the growing numbers of skeptics who are complaining about irresponsible squandering of public money may recognize the need for rational decision-making and international development aid.

My intention is not to be divisive and to provoke development agency response. The broad problem of development wisdom is a complex one that affects us all. The examples are introduced because, together, we can reflect on them and devise a more effective approach. One component of such an approach might be the ensuring of independent and politically neutral assessments of development proposals.

My third and final theme is borrowed from my colleague, Professor Frank Davidson. Despite the more obvious sensitivities within the Hindu Kush-Himalayan region concerning very largescale projects that would transgress national frontiers, a series of feasibility studies could conceivably lead toward collective development for the benefit of the entire region. Here are three examples:

1. the damming of the Brahmaputra near Namche Bawa and the directing of the ponded water from the Yarlung Tsampo basin through a trans-Himalayan tunnel. The results would be hydroelectricity, irrigation, flood control, and multi-national collaboration;
2. the development of a grand canal from the Nepalese Terai to Calcutta or Dacca. The results would be reduced transportation costs for imports and exports, flood control, irrigation, and multi-national collaboration;
3. the construction of a large island in the Bay of Bengal, with the advice of Dutch engineers, and the use of supposed sediment transferred from the Himalayas. The results would be new land for refugees and other migrants, a new granary, and multi-national collaboration.

The foregoing remarks may appear as overly critical of current approaches to research and development in the Hindu Kush-Himalayan region. They can equally be criticized for lacking a sound data base, or that information derived from studies in one area may not be representative of adjacent areas. Nevertheless, the intent has been to indicate that certain obvious weaknesses can be overcome, given an integrated and carefully orchestrated approach. In this same context, it is perhaps appropriate to emphasize that the United Nations University and the International Mountain Society may have much to offer ICIMOD. ICIMOD, in turn, has much to offer them, considering that the combined objectives involve sustainable development and the well-being of the mountain people of the region in the widest sense. The UNU, on limited resources, has nurtured the concept of highland-lowland interactive systems and is a uniquely a political member of the United Nations family. IMS, as an NGO, produces a quarterly journal, has a membership of over 700 in 42 countries, and maintains many close contacts with mountain sceintists, both within and beyond the region.

Both ICIMOD and IMS were really conceived, in one form or another, at the seminal 1974 Munich meeting, and, I suspect, both owe as much to Dr. Klaus Lampe as to any other single person. Speaking from the one to the other, I am hopeful that a natural and rewarding relationship can be developed.

# Conservation of the Himalayan Environment in Relationship to Development

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The International Centre for Integrated Mountain Development was established in 1981 in Kathmandu. It was initiated by a resolution at the end of the Regional Meeting of MAB on "Integrated Ecological Research and Training Needs in Southern Asian Mountain Systems, particularly the Hindu Kush-Himalayas". This meeting was related to MAB Project No. 6, "Impact of Human Activities on Mountain and Tundra Ecosystems", and was held in Kathmandu from September 26 to October 2, 1975. Continuous effort since then by Unesco/MAB and the MAB National Committee of Nepal has produced fruit as an international centre. Its productive activities are hereafter anticipated.

There is a three-man committee on the Himalayas in Japan. It consists of Prof. Kawakita, Prof. Higuchi, and myself. We have been discussing ecological research and development, training activities, etc. at the same meeting up to now. This committee will develop further in relationship to the activities of ICIMOD. I, myself, have been in Nepal several times. Field studies by the members of Chiba University were focussed in eastern Nepal because there are great similarities in the climatic conditions, the biota and vegetation between eastern Nepal and Japan, particularly in the temperate zone.

Japan is a mountainous country, too, and forests cover about 70% of the land. Thus, only about 30% of the land is inhabitable. The population density is 300/km$^2$ as an average over the whole country; however, the population density is 2,011/km$^2$ in Toyko and 1,058/km$^2$ in Osaka. In these two large cities, 38% of the total population live on 7.5% of the land. The degree of naturalness (1–10) proposed by the Environment Agency implemented a national census of vegetation in 1972. The vegetation naturalness ratings are: 9, 10: natural vegetation; 7, 8: secondary forests; 6: tree plantations; 4, 5: semi-natural and artificial grasslands; 2, 3: croplands; and 1: urbanized areas. This kind of national census will be very useful for the conservation of the Himalayan environment in relationship to development.

I pointed out important matters on the conservation of mountainous areas, particularly referring to Japan, at the MAB No. 6 meeting in Kathmandu in 1975. That is, priority should be given to the comparison of man's activities in mountain ecosystems in Japan and in other Asian countries, such as Burma, Bhutan, Nepal, India, Pakistan, and Afghanistan. In the humid high mountains on monsöon Asia, similarities of biota, vegetation, and people can be seen as an extension of similar features in the Sino-Japanese region of flora.

In Japan, major problems of man's interactions with mountain ecosystems include: (1) Effects of tourism and recreation. Mountain areas, such as Mt. Fuji, the Japan Alps, Mt. Daisetsu, and so on, should be studied from the conservation standpoint, particularly from consideration of environmental assessment in relationship to tourism and recreation; (2) Impact of large-scale technology. In Japan, many hydro-electric dams have and are being constructed, as well as are transportation facilities (such as motorways, ropeways, cable cars, etc.) for mountain recreation. The effects of such large-scale technology on the biota and vegetation will likely be studies, applying technology assessment methods. We are trying to develop a system of environmental impact assessment with a matrix of technological actions and responses of man, biota and vegetation, and environment. For this purpose, mountain areas must be studied before, during, and after the application of large-scale technology; (3) The value of nature for man. To give priority to technological development or nature conservation in a given area, not only commercial profit must be considered, as well as the value of nature for human life, human welfare, and the maintenance of the stability of the ecosystems. It should be considered not only from the standpoint of natural sciences, but also from that of the humanities and social sciences. Guiding principles should be elaborated for decision making in integrated natural resource management in a broad sense, particularly related to the value of nature for human welfare.

In addition to research into these problem areas in Japan, we are eager to explore the possibilities of participating in bilateral and multilateral projects with other countries, for example, in projects in the Himalayas on problems of human settlement and land-use alternatives at high altitudes.

In the fourth scientific expedition of Chiba University to eastern Nepal in 1981, I went up to the north from Biratnagar along the River Arun. I was quite surprised not to find a large area of natural forests, observing only small fragments of them and many secondary forests, such as *Alnus nepalensis*, particularly in the area of human settlements. On the other hand, there were varieties of crops, fruit trees, and so on, and the people's living standard has been improved.

My observation revealed the fact that there were many naturalized exotic plants, such an *Eupatrium adenophorum* and *E. odoratum*. We could not see large invasions of exotic noxious weeds twenty years ago. However, there is an experiment of biological control against the spreading of *E. adenophorum* using a gall fly. On the other hand, there is another opinion (for example, that of Dr. T.B. Shrestha) that herbaceous vegetation may be useful for the prevention of the soil erosion on denuded lands caused by landslides. When I saw a picture of the Himalayan area taken by Landsat, I found a lot of landslides in this country. Natural hazard mapping by the United Nations University Project Team is closely related to this matter.

According to MAB Green Book No. 34, the specific objectives of MAB regional meeting held in Kathmandu in 1975 were as follows:

1. major impediments to an ecologically sound development of the area;

2. priorities for integrated ecological research;
3. training needs and opportunities in the region; and
4. documentation and information flow.

These objectives will be persued by the new International Centre for Integrated Mountain Development.

The meeting recommended that a high priority for research should be given to the following problem areas:

1. massive erosion and landslides in mountainous areas;
2. population pressure and migration in mountain areas;
3. changing floral and faunal populations;
4. tourism;
5. planned resettlement schemes associated with over-population and labour demands in various areas.

In regard to the conservation of the Himalayan environment, the felling of natural forests, soil erosion, flooding, and so on, are usually pointed out. However, in my opinion, those phenomena have principally originated due to the rapid growth of the population which requires a large amount of croplands and pastures, fuelwood, and space for houses, etc. In densely populated areas, so-called urbanization and pollution proceeds as it does even in rural areas. As a result, the destruction of nature and natural resources becomes remarkable. To recognize the actual state of the natural environment around us and to establish wise and reasonable counter-measures against the destruction of nature today and in the future, environmental education must be introduced into schools and out of schools.

Conservation strategies, such as the protection and conservation of nature and natural resources, the control of human population growth, the protection of natural vegetation, flora and fauna, the sustainable use of secondary vegetation (forests and pastures), soil conservation, and so on, should be established (Numata 1983).

Among them, I would stress the sustained yield vegetation management for forests and grasslands (particularly pastures), as well as tree planting and grassland establishment. Regarding sustained yield forestry, a standard for cutting trees must be established, and we must determine the size of herds of cattle, the duration of grazing, control of brush and weeds, etc., to achieve sustained yield pasture management. The curriculum for environmental education, including these items, should be recommended.

In Japan, I devised a measure to estimate grassland conditions using an index IGC (index of grassland condition). IGC was derived from the degree of succession (DS). Thus, the grassland condition for cattle raising or mowing based on the degree of succession can be estimated. This method was applied to pastures in Nepal (Numata 1965, 1981). There are many pastures in the Nepal Himalayas, and animal husbandry is an important bio-industry for Nepalese farmers. We must recognize exactly the present state of those pastures using the indices DS and IGC and consider counter-measures for the improvement of pastures, for example, for the proper use of pastures within the limit of their carrying capacity. I spoke on this matter at the Tropical Ecology Symposium (1975).

Next, I'd like to speak about the establishment of biosphere reserves. I wrote about the conservation of nature in eastern Nepal after our scientific expedition in 1963. I sent our report to the Nepalese Government and explained the conservational situation of the area at the 11th Pacific Science Congress in 1966 (Numata 1966). Now there are several national parks, wildlife, and hunting reserves. The biosphere reserve of UNESCO/MAB has core area and buffer zone, etc. zoning. Therefore, the biosphere reserves will be established on the basis of national parks or wildlife reserve as nuclea. The biosphere reserve will be useful for conservation and scientific research.

In conclusion, here are some of my ideas on the conservation of the Himalayan environment in relationship to mountain development. Priorities should be laid on the study of urbanization and its effect on the natural environment, the control of population growth, recognizing actual state of forest destruction and considering the most suitable plantation, the sustainable use of forests and grasslands within their carrying capacity, a national census of land-use and natural hazards, the control of tourism in relationship to the environmental capacity for recreation, and environmental education for students and the public (Numata 1980).

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