A Simplified Framework For Assessing Carrying Capacity In Mountain Tourism

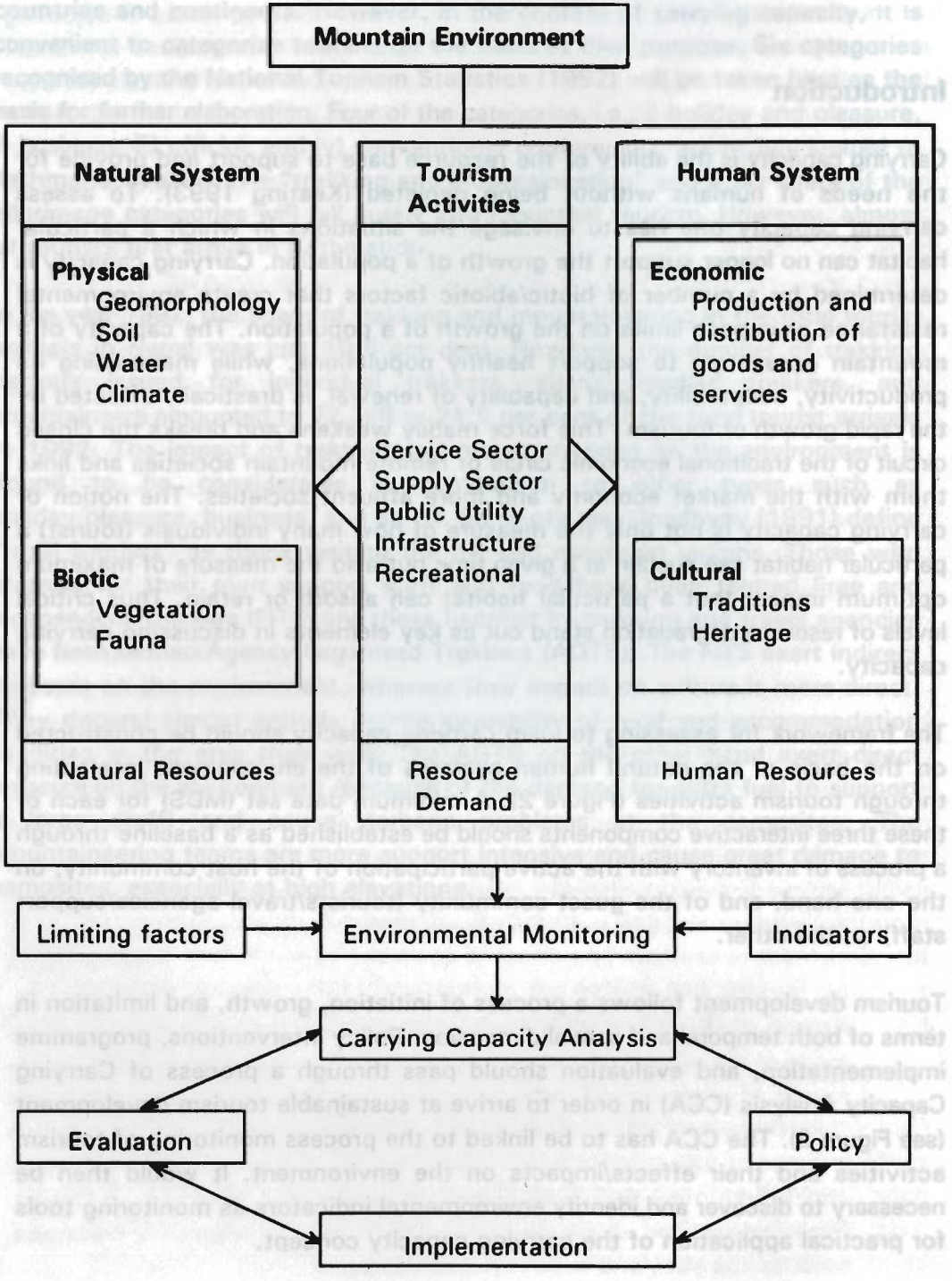
Introduction

Carrying capacity is the ability of the resource base to support and provide for the needs of humans without being depleted (Keating 1993). To assess carrying capacity one has to envisage the situations in which a particular habitat can no longer support the growth of a population. Carrying capacity is determined by a number of biotic/abiotic factors that create environmental resistance or impose limits on the growth of a population. The capacity of a mountain ecosystem to support healthy populations, while maintaining its productivity, adaptability, and capability of renewal, is drastically affected by the rapid growth of tourism. This force readily weakens and breaks the closed circuit of the traditional economic circle of remote mountain societies and links them with the market economy and more affluent societies. The notion of carrying capacity is not only the measure of how many individuals (tourist) a particular habitat can sustain at a given time but also the measure of maximum optimum impact that a particular habitat can absorb or retain. Thus critical levels of resource degradation stand out as key elements in discussing carrying capacity.

The framework for assessing tourism carrying capacity should be constructed on the basis of the natural human systems of the environment interacting through tourism activities (Figure 2). A minimum data set (MDS) for each of these three interactive components should be established as a baseline through a process of inventory with the active participation of the host community, on the one hand, and of the guest community (tourists/travel agencies/support staff) on the other.

Tourism development follows a process of initiation, growth, and limitation in terms of both temporal and spatial dimension. Policy interventions, programme implementation, and evaluation should pass through a process of Carrying Capacity Analysis (CCA) in order to arrive at sustainable tourism development (see Figure 2). The CCA has to be linked to the process monitoring of tourism activities and their effects/impacts on the environment. It would then be necessary to discover and identify environmental indicators as monitoring tools for practical application of the carrying capacity concept.

Figure 2: A Framework for Environmental Carrying Capacity Analysis in Mountain Tourism



Tourism Activities and Their Impact on the Environment

The relationship between tourism and the environment is complex and multifaceted. The range of recreational activities in mountain tourism, such as mountaineering, trekking, hiking, exploration, professional hunting, sight-seeing, horse riding, rafting adventure sports, and recreation through cultural heritage are closely linked to the environment; other activities arising from tourist facility components, such as support and service facilities, public utilities, and infrastructure, exert pressures on the environment, influencing its carrying capacity.

The tourist function of a mountain environment is dependent on the natural system and the accompanying human system. Biophysical assets of the natural environment and the cultural heritage of the socioeconomic environment have proved to be the main attractions for mountain tourism. The framework for environmental monitoring should therefore have a strong bearing upon those two aspects of the environment.

Promotion of tourism in a mountain area quickly creates a lot of demands relating to tourist facilities. The main activities identified by the ESCAP studies (1992) begin to operate and interact with both the natural and the human systems of a mountain environment (see Figure 2). Service sector facilities, such as accommodation, campsites, lodges, tea-houses, and restaurants, exert pressure on natural resources as well as on human resources. Support sector facilities have not yet emerged as a prominent factor in mountain tourism compared to their role in the impact on coastal destinations. Public utilities/amenities in terms of water supply, sanitation, solid waste disposal, communications, electricity and power, and health services are gradually being considered for various tourist destinations. For want of even basic amenities such as toilets, safe drinking water, telecommunications, and general sanitation in the villages, there is an ever-increasing pressure on the environment because of pollution arising from tourist activities. Tourism can also have positive impacts.

Tourism development has become the cause as well as the effect for improved trails and bridges in certain remote areas. Furthermore, there has been an increasing demand for airstrips and air services in remote mountain areas. Infrastructural development impacts both on the biophysical as well as on the socioeconomic system of the environment. Also, the overall resource demand of tourism draws from both the natural as well as the human resources.

Most of the environmental impacts are associated with the loss of natural vegetation; destruction of flora and fauna; and deformation of natural landscapes, cultural landscapes, and pastoral land. Impacts on the human system have been recorded in terms of degradation of historic sites, religio-cultural monuments, and heritage sites; loss of arts and artifacts; and loss of traditional values and virtues.

Tourism development and its associated activities have created negative effects to a certain degree, but some of the pertinent benefits, such as the generation of employment, national income and wealth, and gaining hard currency are quite essential for the overall development of Nepal where the comparative advantage of mountain tourism is very high. Besides, tourism has increased the self-confidence of the mountain population in the global perspective (Boers and Bosch 1994).

Tourist and Host Population Interaction

The growth pattern in tourist volume cannot be captured in the natural growth forms of a population (biological organisms), but the stress to the environment and the resistance created by it may be observed, or even measured.

Since tourism is an expression of externality in the local economy (Gurung 1990), it is expressed in different forms of interaction between the two groups, i.e., host (community) and guest (tourist) populations. The following types of interaction (Figure 3) may therefore take place as has been predicted for two biological species (Odum 1971).

Neutralism

Neither population is affected by association with the other. This phenomenon is generally observed in newly-opened areas which are frequented by self- sufficient organised groups. The cases of upper Mustang, Dolpa, and the Manaslu circuit, where local communities are still insulated from tourism development, come close to this situation. This was perhaps the initial phase of tourism development in other mountainous remote areas some 30 - 40 years ago.

Figure 3: The theoretical interaction types between two groups

Neutralism	Competition	Amensalism
Neither effects the other	Negative interaction	One inhibited and the other not affected
I	II	III

Mutualism	Proto-cooperation	Commensalism
Interaction favourable to both and obligatory	Interaction favourable to both and not obligatory	One benefitted and the other not affected
VI	V	IV

Source: Adopted from Odum 1971

Competition

Mutual inhibition competition: This situation emerges when an area is opened to tourism and local communities are neither consulted nor accommodated in the process. Declaring an area a national park, without the consent of the affected population, leads to a situation in which local people are displaced or are put into distress due to pressures from the tourism sector as well as from government authorities and military personnel assigned to guard the park. The establishment of Rara National Park, Lantang National Park, Sagarmatha National Park, etc, initially created a mutual inhibition competition between visitors (tourists and park authorities) and the local population resident within the park boundaries.

Resource Use Competition: Competition between resident populations and establishments catering for tourists has been a phenomenon commonly observed in most tourist destinations. Massive extraction of firewood from natural areas competes with the demand created by tourists vis-a-vis demand from local inhabitants. It has been estimated that a group of a dozen trekkers consumes as much fuel per day as it takes to keep a Nepalese household warm and fed for 10 - 12 days (Lama 1992).

Amensalism

This is a phenomenon in which one population is inhibited and the other remains unaffected. Longer association of local youth's with incoming tourists and trekkers has been inhibiting the maintenance and growth of traditional knowledge and skill of most tourist destinations. It has been observed that most Sherpa youths have already forgotten the use of mountain herbs in medicine. Loss and degradation of indigenous knowledge has to be viewed as a serious threat to the carrying capacity of mountainous areas in Nepal.

Commensalism

This association of host and tourist allows one population to be benefitted, but the other is not affected. Exploitation of the host population by outsiders for the sale of information is not an uncommon practice in remote areas of mountainous Nepal. Tourists who come as explorers, scientists, researchers, or even tourism promoters are immensely benefitted through the association but the host party is least affected afterwards. The story of "Honey Hunters in Nepal" (Vallie and Summers 1988) and several other stories exhibit a strong flavour of commensalism.

Proto-cooperation

It is a phenomenon in which both of the associating populations are benefitted but relations are not obligatory. The concept of conservation-based tourism or tourism-based conservation as promulgated by the ACAP (Annapurna Conservation Area Project) and other endeavours such as the creation of the Makalu-Barun National Park and Conservation Area (Shrestha et al. 1990) may be examples of this process. This association does not develop automatically but evolves.

Mutualism

Tourist destinations, such as Pokhara, Namche Bazaar, Dhunche, etc, have grown to a situation in which the growth and survival of both populations, i.e., tourists and local residents, are dependent on their association and interaction. However, it should be emphasised here that the hosts would need guests more than the guests need the hosts. To a larger extent, mutualism would be the ultimate stage of tourism growth in which the existence or the survival of one is dependent upon the other. This kind of dependency leads to a vulnerable situation of self deterioration or self destruction for the local populace if the

tourist industry changes its course in response to various factors, *inter alia,* environmental degradation such as national or regional disputes, wars, political crises, shifts in national policies, and so on.

Among the various interactions and impacts illustrated above, "Proto-cooperation" would be the ideal situation for mountain tourism. Tourism should be a favourable factor for mountain development, but it should not be an obligatory factor. Therefore, tourism pressure should be well within the absorptive capacity of the community and within the carrying capacity of the environment.

Parasitism and Predation

In the natural world this phenomenon is active in maintaining the ecological balance. In the context of tourism and local community association, this is rather an indirect phenomenon that is based on economic considerations. Much of it will be a matter of interpretation and it can turn into a sensitive issue.

Key Processess and Indicators in the Mountain Environment

The indicators of environmental stability have to be identified from among various dynamic processes that operate in the ecosystem, such as geomorphological processes, climatic features, weather patterns, vegetation successions, wildlife concentration, cultural landscapes and land use patterns, cultural practices, and tourism development trends. In order to understand these processes, there is a dire need for basic ecological research and also for a much fuller understanding of natural and human systems and processes than is currently available. Over the past years, there has been a remarkable amount of interest and attention focussed on the problems associated with losses in productivity of mountain farming systems, losses in biological diversity, deterioration of cultural assets, and also the possible large-scale alteration of the climate. The International Union of Biological Sciences (IUBS) initiated a collaborative programme of research on tropical mountain ecosystems under a programme entitled. "The Decade of the Tropics" in 1984 (Monasterio et al. 1985). ICIMOD also launched a programme of integrated mountain development in 1983. The International Mountain Society and the United Nations University started to publish research inputs in a journal of Mountain Research and Development. The Mountain Protected Areas' Network, formed after the consultation meeting at the Hawaii Volcanoes' National Parks in the autumn of 1991, is bringing together the prospects, problems, and issues of protected mountain areas around the world (Hamilton et al. 1993). The UNCED

Mountain Agenda has provided a more focussed approach for mountain development. Keeping with and drawing from those initiatives one should move on to identify specific indicators that reflect the overall conditions of the mountains and their capacity to sustain a resident population and visiting guests, i.e., the tourists.

Environmental Monitoring

The mountain environment is more complex than any other terrestrial environment. Various research outputs could produce a long list of possible environmental factors that would contribute towards monitoring. However, to be practical, it is necessary to discover and analyse certain factors that can be monitored easily. A mountain ecosystem is generally fragile and vulnerable to rapid deterioration due to modern exploitative forces such as tourism. Most mountain societies function in a more or less closed system depending upon subsistence agriculture and the traditional use of natural resources. After centuries of interaction with nature these societies have acquired an equilibrium with the natural environment. Outside interventions, such as tourism, introduce rapid changes to the ecological processes, and, in general, more resources are exploited than are naturally produced. Thus environmental monitoring is a key to any process of determining or analysing the carrying capacity of an ecosystem. Tourism development trends and their impact upon the environment should be carefully measured, monitored, and analysed.

Mountain societies and their cultures are the outcomes of a long history of interaction with the environment. Senses and sentiments of traditional societies are the keystones of environmental management. The time-tested knowledge of local people provides accurate and reliable means for environmental monitoring. The coming and going of migratory birds, or the appearance and disappearance of frogs and toads, festival cycles, and the agricultural calendar all are tied in with the agroclimatic dynamism of the environment. Therefore, monitoring the environment through the local people would be more direct and meaningful than playing with an enormous quantity of scientific data. Participatory monitoring creates a relevance to the fundamental agent of the ecosystem, i.e., the local people.

Modern advancement in natural sciences, social sciences, and technology has produced a hoard of tools to detect, measure, and analyse various elements of the environment. The advantage of new data-handling and data processing capabilities, particularly the Geographical Information System (GIS), Global Positioning System(GPS), and Remote Sensing Technology can be used in the

monitoring process. In the context of monitoring mountain tourism in the Himalayas, it should be emphasised that a set of limiting factors and a set of environmental indicators should be identified. The quantitative data of the limiting factors and the qualitative data of the indicators should contribute to the monitoring process.

Limiting Factors

The tourist population needs to be provided with certian essential facilities that are basic to their normal life and comfort, in addition to specific requirements to fulfill the purpose in visiting mountain environments. Basic requirements, such as space, energy, and services, tend to limit the number of tourists in a given situation. Of these, the weakest link in the ecological chain functions as the limiting factor. The maximum limiting effect is most obvious in environmental pollution, i.e., excessive amounts of garbage and solid waste. Thus, analysis of the limiting factor should dwell upon the "law" of the minimum as well as the "law" of the maximum, i.e., the limits of tolerance.

Key factors that limit the growth of tourism in the Nepalese mountains have been identified as (i) deforestation, i.e., extraction of biomass for energy, (ii) campsites, i.e., availability of minimum space, (iii) overcrowding, i.e., inadequacy of service facilities, or higher density of tourists and their activities, and (iv) problems of sanitation and solid waste disposal and management which pollute the environment (Clean Himalaya Colloquium 1991). Quantitative assessment of such factors would prove a useful tool for monitoring the environment vis-a-vis tourism development and growth. Some of these factors are discussed below.

Deforestation: This has become the central theme of discussions on the mountain environment. However, there are few convincing answers to the key questions, for example, how much fuelwood is consumed and how much biomass is produced? In the Himalayan Dilemma, Ives and Messerli (1989) concluded that attempts to determine fuelwood consumption are so clouded with uncertainty that any figure used as the basis of extrapolation into total national annual consumption are meaningless, and estimates of biomass production are even less reliable. Attempts to quantify tourist use of fuelwood or other energy resources are also quite uncertain. Government regulations do not allow tourists to burn firewood. Trekking agencies do carry kerosene for their trek groups. Advocates of kerosene use indicate that there's a minimal extra cost of US $ two to three per day if kerosene is used instead of firewood. Trekking tourists, apart from rucksack tourists, use two to three porters per

head and the porter head increases if kerosene is to be carried along the trek. The scenario of an organised trekkers' camp in a wilderness area consists of a small kitchen with a few kerosene stoves and a large number of small "*chulo*" scattered here and there. If the camp happens to be at altitudes higher than 3,000m, a few campfires will be lit to keep the ill-clothed porters warm. Some "*sahebs*" will then hang around the fireplace. In parts of the high Himalayan valleys, trekking camps are largely determined by the availability of free forest firewood for the armies of porters.

The Case of the Annapurna Region: Popular trek areas, such as the Annapurna-Deothali sanctuary, Langtang, and the Everest region, have developed distinct corridors of tourist movement. They are characterised by chains of tea-houses, hotels, and lodges. There have ben no assessments of energy requirements for these installations. Over 90 per cent of those tea-shops, lodges, and hotels are dependent on forest resources. Therefore, there have been significant visual changes in the vegetation of these sites. One of the often quoted cases is that of Ghodepani *Lekh* on the Jomsom trail.

Examples of the Annapurna Base camp, Ghodepani, the Thorung Phedi, and other high impact areas are very few and far between. In fact in the ACAP region, which is visited by a large number of mountain tourists, checks have not exhibited any significant impact on natural vegetation; rather tourism has highlighted the need for environmental protection. This has been further confirmed by Prof. J.F. Dobremez who revisited the Annapurna area in the spring of 1994 after 25 years. During his first visit in 1969 to prepare a vegetation map of the Annapurna-Dhaulagiri area, Dobremez (1976) had predicted that the area would be completely deforested in 25 years. After visiting the area in 1994, Dobremez confessed that lots of vegetation had regrown and that most mature forests were intact and wildlife improved (Talk given to Nepal Bot. Soc. April 1994). Mr. Karna Shakya and Dr. Linda Griffith made similar repeat visits to the Ghandrung section, i.e., Suikhet-Dhampus-Pothana-Rolkhs-Landrung-Ghandrung-Lumle-Suikhet in the late 1980s and looked into the tourism impact on forest resources. Their observations on forest resources concluded that the environment had not deteriorated -- "*beautiful Castanopsis, oak and rhododendron forests in Dhumpus and Pokhara have retained the same diversity of 10 years ago.*" Recently, an eminent ecologist from Austria, Dr. W. Holzner, visited the Jomsom-Muktinath area. He reported to this author that there were lots of lodges and other service centres for tourists, but that the actual state of the environment was not much affected in areas which are just a few kilometres away from the main trail (Personal Communication). There have apparently been a lot of preconceived notions

among various authors and visitors which exaggerate the situation based upon the conditions of some high impact areas. While such areas do need immediate attention and intervention, oversimplification and generalisation still stand out as risks for planners and managers.

In the ACAP region there are some 700 lodges which have signboards. This does not include farmhouse guest rooms which have great potential for absorbing more tourists. A little improvement in sanitation and cleanliness would suffice to attract more tourists in future. Any discussion on deforestation and fuelwood requirements/consumption due to tourism would not be complete without taking into account the consumption pattern of those lodges, tea-houses, and farmhouses.

The Case of Khumbu: A typical climbing expedition in Sagarmatha used a total of 8,000kg of firewood in two months (Gurung 1993) and much of it came from vegetation close to the tree line for which the regeneration capacity is very slow and sometimes lost forever. Although the National Park regulations do not allow the collection of wood from those park areas, the regulations have never been effective in the sub-alpine forests, such as those near Pangboche where yak-loads of juniper wood are transported to campsites.

If the trend for using firewood is not reverted, the carrying capacity of base campsites will not only reach upper limits soon, there will also be serious changes in the physical environment such as in the snow and ice regimes during winter. However, in some cases, i.e., the Namche-Kunde-Khumjung region, it has been illustrated that the areas have remained relatively unchanged between two photographic events. The first one was taken by Schneider in 1962 and the second by repeat photography by Byers in 1984 (Byers 1987). It is interesting to note that the areas have sustained local populations, park authorities and the army support, as well as the ever-increasing tourist population which had reached over 5,000 during 1983 and 1984. Since then the number of tourists has doubled (12,300 in 1992) and the number of shops, tea-shops, inns, and lodges has increased substantially. For example, 83 lodges existed and 8 were under construction during the spring of 1991. The first lodge came into being in 1971, construction of new lodges demands a great deal of timber, which is nowadays transported from the Jore-Salle-Lukla areas. Firewood, however, is being collected from a nearby forest. Thus, in spite of continued pressure on forest resources, there has been no decline in tourist numbers in the Everest area. Therefore, timber and firewood supplies must come from areas other than Namche-Khunde-Khumjung.

Solid Waste Management: Garbage along tourist trails and destinations has been one of the most reported issues in mountain tourism. Garbage dumps induced by tourism have high visibility and raise immediate concern from both the tourist community as well as from the host community. Public attention is rapidly directed towards pollution, because tourists coming from urban centres of the world are already "pollution beaten" people. It is easy to get evoke their senses and sentiments when media coverage includes catchy headings "Trekking in Wrecking Nepal", "World's highest garbage trail", "The toilet paper trails", "Everest, the highest garbage dump," and so on.

There has been no study to actually quantify the problem, in order to define the limits for use of campsites or trails. Campsites which are away from settlements, such as those at Lobuje, Sagarmatha base camp, Kyanjin (Langtang Valley), Thorung Phedi (Annapurna Circuit), and other base camps for mountaineering expeditions are under greater pressure from garbage. Ten years ago, in 1984, the Nepal Police Association Clean-up Expedition removed 16 tonnes of garbage from Sagarmatha (Everest) Base camp (Stevens 1989). There have been more than a dozen, national and international cleaning teams to Sagarmatha and they range from school and scout groups to fully-fledged mountaineering expeditions (Sherpa 1992). A 1991 survey by the Nepal Mountaineering Association estimated that 16,510kg of garbage had been left from 127 expeditions between 1952 and 1991 between camps two and five. Above the base camp at South Col, approximately 500 empty oxygen bottles have been left since the 1963 American Everest Expedition (Byers and Banskota 1993).

The clean-up expedition organised by the Everest Environmental Expedition in 1990 removed a tonne of trash from the Tibetan side (near Rongbuk Monastery) at the Base Camp (5,180m) and at Advance Base Camp (5,485m) on the main Rongbuk glacier. The clean-up cost was estimated at US$ 65,000. "*Taking into consideration the pressure on the environment*" of upper Khumbu, the Nepali Ministry of Tourism announced (to have been effective from Autumn 1992) that "*each mountaineering team to the Khumbu region will be required to carry back the garbage to their home countries*". Incinerable and biodegradable materials were to be brought down to base camp for disposal, recyclable materials (e.g., gas canisters, tins, jars, and plastic barrels) were to be handed over to the Waste Disposal and Management office in Kathmandu, while oxygen bottles, batteries, and other equipment were to be flown back home.

The WWF-supported "Sagarmatha Pollution Control Committee" launched a clean-up campaign in which local people participate to keep their environment

clean. An endowment fund has been created. This will certainly create a positive impact on promoting tourism. Similarly, experimental incinerators for high altitudes have been built on an experimental basis by a French team

Solid waste, especially faecal waste, is a factor that has a direct bearing on campsite hygiene. At higher altitudes, where the biodegradation rate is rather poor, pits become the only solution. Campsites would, however, need a well-managed faecal waste disposal system. At lower altitudes also, local inhabitants rarely have toilet facilities. This is the main reason that has prohibited local homes from taking tourists in. The carrying capacity of areas would increase tremendously if simple bathroom and toilet facilities were made available for village houses (Uitz 1993). In Salzburg, Austria, almost 40 per cent of the tourist beds offered are so-called private rooms in farmhouses. Thus, improving the quality of life at tourist destinations would enhance the carrying capacity.

Campsite Management: Campsites are major physical constraints for trekking and mountaineering, especially in areas that lie outside the main corridor. In most mountainous areas in Nepal, apart from the ACAP region, the Sagarmatha region, and the Langtang region, camping is the only mode of trekking since traditional villages do not have lodging facilities to meet the needs of modern tourists. Organised tours handled by trekking agencies therefore provide tents and services on open grounds, fallow farmlands, and also inside forests. The factors that determine the selection of a campsite include adequate camping grounds, water supplies, fuel and food supplies, especially for the accompanying porters, and, of course, areas for garbage disposal.

In open valleys and alpine meadows, campsites could be made available easily but in the narrow valleys, such as those in the upper Budhi Gandaki, campsites are limited. Crowding effects on campsites are a severe factor limiting the carrying capacity of an area. For example, the last camp area near Larkya La in the Manaslu Region can hardly support two teams. Therefore, there is a need for more camping grounds before more parties are permitted to trek.

The crowding effect in the Everest base camp area was pronounced in the Spring of 1992. The Base camp area was crowded with 268 climbers and their support staff. Twelve teams were granted permission to scale Everest. A total of 32 people successfully made their way to the summit (Guru-acharya 1993). Agony and mutual conflicts among the climbers remained the main reminiscences of their travel. The other campsite at Gokyo also suffers from overcrowding, and there is clear indication that the carrying capacity has been exceeded (Hutchinson 1987).

Some of the campsites in the Makalu area are constrained not only by restricted camping areas but also due to the lack of rock shelters and nearby herders' huts for the accompanying porters. The campsites on the Manaslu Trail are very narrow and can hardly accommodate two teams of five tents each at most of the camping sites. Thus local people are converting their cornfields into campsites.

Campsite problems on the Imjaje peak (an Icelandic peak, 6,160m) have been studied by the Nepal Mountaineering Association. This peak is climbed by 150 teams a year, i.e., over a 1,000 climbers set foot on this peak. The garbage problem and the crowding problem are exerting pressure, limiting the number of visitors (NMA 1994).

Thus the carrying capacity of a campsite is determined by

- available camp ground,
- water supply,
- fuel/food supplies for local porters,
- capacity to recycle biodegradable garbage, and
- garbage and waste disposal management.

An assessment of the "Preferred Rate of Tourism Development" (Table 2) indicated that international visitors do not like to encourage more tourists because environmental impacts are obvious and the main product is under threat (Gurung 1993). This implies that an increase in tourist number is not desirable without improving the current management system and infrastructure. The local respondents however preferred to attract more tourists on the grounds that tourism has created more jobs and more business for a population who had remained marginalised and whose economy was based on subsistence farming.

Table 2: Preferred Rate of Tourism Development

Respondents	Responses			
	Attract More	Leave as it is	Reduce	No response
Visitors	19.1	65.2	11.3	4.3
Guides	59	14.5	6	20.5
Managers	54.5	36.4	9.1	0

Source: G.S. Gurung: The Role of Tourist Guides and Their Training Needs: A Case Study in Nepal. A thesis submitted to Lincoln University 1993.

Environmental Indicators

Tourism-related activities influence the local community and their environment directly. Monitoring variables should include the pattern of resource use and the rate of consumption Pressures on common resources, such as forests, water, grazing land, and wilderness areas, could be quantified to measure the impact of tourism. However, as a first step one needs to inventorise those resources in terms of both qualitative characteristics and quantitative stock. This should further be complemented by estimates of consumption rate at a given time. The rate of consumption/the rate of depletion of resources in nature need to be monitored for any tourist area in question. The rate of natural regeneration, or the healing process, should also be monitored to determine the carrying capacity of the ecosystem.

The interaction, between tourist activities and the community, results in certain expressions of change. Such changes are often associated with the behavioural patterns of the local people in the use of languages, dresses and customs, employment preferences, traditional methods/technology, and other local resources. Societal structures and demographic characteristics are also subjected to change as a result of tourism. Therefore baseline data have to be established for sociocultural characterisation of the tourist area as a reference point.

Tourism exerts immediate effect on the economic environment of a place. Demands generated due to tourism on the supply of goods and services become evident in various economic variables such as external investments, changes in price levels, and a more organised market economy. In many tourist areas it has been experienced that a subsistence economy gradually transforms itself into a market economy. Trends of change and the pace of change would indicate how a society would sustain the growth of tourism. Data for environmental monitoring should naturally begin from a baseline study supported by previous studies and research. The baseline study should have a broad base to actually characterise all the key aspects of an environment. Follow-up monitoring could, however, be trimmed down to a few key elements from critical factors, in order to develop a surveillance system.

Research data on mountain ecosystems are generally available on the basis of short-term exploratory studies. There is a dire need for time series' data on the physical environment and socioeconomic processes. An enormous amount of data could be generated. In a Nepalese situation, creating a flood of data is neither possible nor desirable. The existing modern paradigms based on larger

data sets would lead to more confusion. Due to tourism, the biophysical diversity of the ecosystem and the sociocultural diversity of the inhabitants exhibit spontaneous changes. Therefore it might be possible to identify simple indicators of key processes in the ecosystem. These indicators are to be sought in the fragile land system, steep slope ecosystems, and stressed economies. In searching for simple indicators it may become possible to identify a limited amount of critical data and a few key processes. It must be borne in mind that such indicators of the key processes should have local relevance in terms of communications. In other words, local people, whether or not formally educated, should be able to perceive them. It is in this context that the following indicators from the natural systems are highlighted.

Communicable Indicators

Changes are also expressed in an environment as a result of indirect pressures from tourism. Loss of biological species, change in species' composition of a vegetation type, change in agricultural cropping pattern and crop quality, change in land use system, and change in certain aspects of human behaviour would be visible impacts of touristic pressures. These indicators are often qualitative expressions of quantitative changes. There are a number of natural indicators that characterise ecological zones in terms of natural vegetation in a pristine condition, i.e., the baseline situation and changes in flora and fauna brought about by human pressure. Increased human pressure on natural resources often results from external factors such as tourism.

Modern technology has provided various scientific tools for environmental analysis. Space science and remote sensing, computer technology, and advancement in various branches of science and technology are available to analyse an environment. Methods of investigation and their results hardly find access to action when they are not interfaced with the people from the environment in question. In the Nepalese context, the economic base of the rural community in the mountains is one of the weakest in the world and the educational base is still weaker. Therefore it is important to find ways and means that would be communicable and acceptable to the rural masses. The rural people of mountainous Nepal are themselves the repository of a great treasure of environmental knowledge. Their interaction with the environment is age-old and their traditional knowledge and wisdom can be a source of accurate information to manipulate/manage the environment. Communicable indicators therefore should have the following three basic features (i) local name (ethnic language), (ii) local measure of numbers/volume/weight, and (iii)

local occurrence. Communicable indicators may be identified through a participatory process of investigation on the environment.

Natural Indicators

Natural vegetation, the fauna, and flora may be used conveniently to determine human pressure on the environment. The natural gradation from mature forest to shrubland and thence to bare grasslands with more thorny bushes is easily observed in mountain environments. Similarly, the change from canopy birds and forest floor birds to berry-eating shrubland birds to grain-eating agricultural birds is observed in accordance with human influences. Presence or absence of wildlife is also a direct environmental indicator.

Most mountain tourism takes place in high Himalayan regions, in inner dry valleys, such as Langtang, and in trans-Himalayan arid zones such as Mustang and Dolpa. A convenient divide would therefore be desirable to identify the Himalayan region as trans-and-cis-Himalayan regions (see Figures 4 and 5).

The Trans-Himalayan Region

Arid and flat, dominated by steppe vegetation consisting of cushion plants and vast stretches of grassland, the economy of the Trans-Himalayas is livestock-based, mainly yaks and sheep. Firewood is the main limiting factor, but campsite space is not a problem. Increased tourism induces increased use of pack animals. Firewood comes largely from the underground woody roots of cushion plants. The only tree species is the poplar which is confined to riverine habitats. Animal dung is another source of cooking fuel. Tourism should be based on sufficient supplies of external fuel such as kerosene. Excessive extraction of root wood directly causes high rates of erosion, due to the wind.

Wildlife is rather rich. Undisturbed areas have snow leopards and blue sheep, mouse-hares and marmots are common. Snow pigeons, gray-headed shrikes, and variegated-laughing thrushes are indicator birds for the undisturbed environment. Crowds of tourists lead to the disappearance of those birds and animals. In very disturbed areas, tree sparrows, jungle crows, and choughs dominate the bird life.

Inner Valleys

Sparse rainfall and fewer clouds would allow high altitude cropping even at 4,000m. Valleys are U-shaped and provide extensive grazing grounds, mostly

Figure 4: Comparison of CIS - Himalayan and Trans-Himalayan Regions

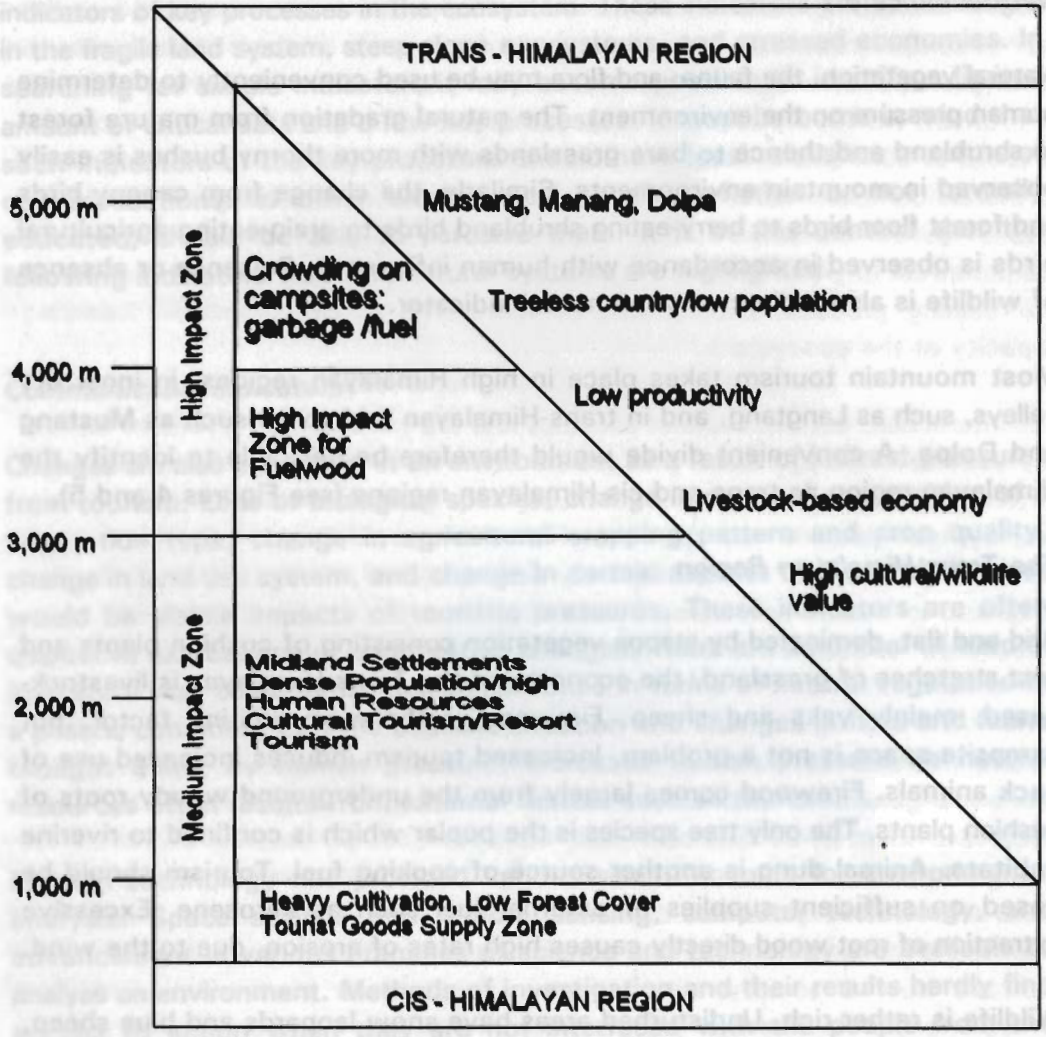


Figure 5: Trans-Himalayan birds and mammals as environmental indicators

Undisturbed Habitat	Disturbed Habitat
Birds	
Gray-Backed Shrike	Jungle Crow
Variegated Laughing Thrush	Raven
Snow Pigeon	Choughs
Tibetan Partridge	Tree Sparrow
Mammals	
Blue Sheep	
Snow Leopard	
Mouse-Hare	
Himalayan Marmot	
Weasel	

Source: H. S. Nepali

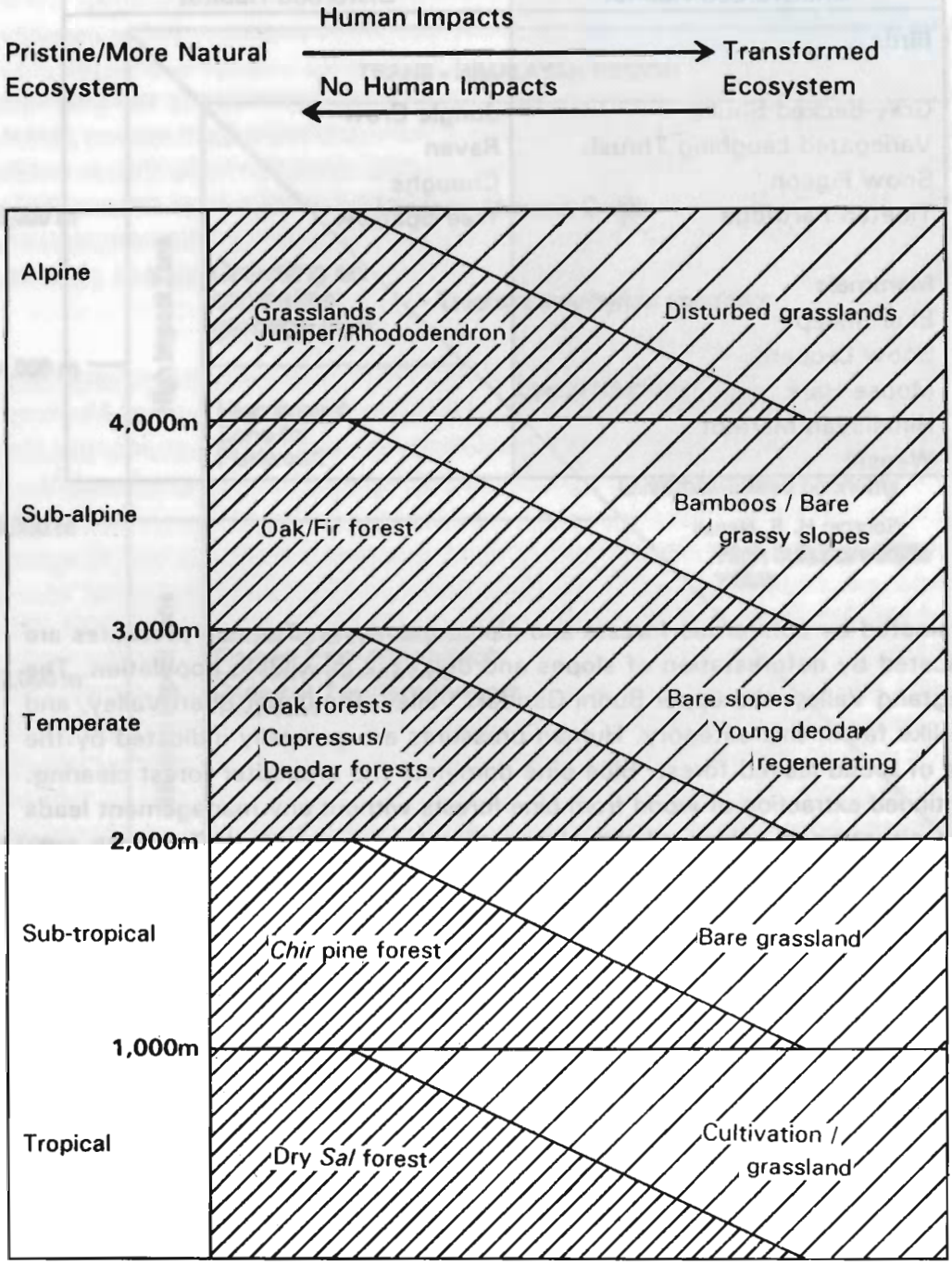
dominated by coniferous forests and alpine meadows. Tourism pressures are indicated by deforestation of slopes and decrease in wildlife population. The Langtang Valley, the upper Budhi Gandaki Valley, the upper Bheri Valley, and the like fall in this category. Human pressures are generally indicated by the loss of broad-leaved forest. Blue pine dominate the area after forest clearing. Continued extraction of wood from pine forests without any management leads to a situation in which all the slopes turn bare and naked. The area near Pansing Village in the upper Budhi Gandaki is a good example of this.

Inner valleys are excellent refuges for birds and animals. Disturbances cause their disappearance. The Red Panda and the Assamese Monkey, for example, are good indicators of a healthy environment.

Cis-Himalayan Region

This region ranges from the tropical zone to the alpine and arctic zones along the vertical gradient of the mountain. The influence of monsoon is rather strong, especially in eastern and central Nepal. In north-west Nepal, e.g., in the Humla - Jumla area, the monsoon is weak and the regenerative capacity of vegetation is, therefore, very weak (Figure 6). Carrying capacity is therefore weaker than carrying capacities in eastern and central Nepal.

Figure 6: Vegetational Changes in the Jumla - Humla Region



Based upon: Stainton 1972; Dobremez 1976; Shrestha 1985

The effects of tourism are more pronounced at about 3,000m. The sub-alpine vegetation is highly impacted by tourism. Fuelwood supplies for high altitude trekkers and also for midland villages come from this zone. Thus, the sub-alpine zone is thinning out from most tourist destinations such as the Khumbu region, Annapurna region, and the Lantang region. Human pressure on natural vegetation and effects in different ecological zones are depicted in Figures seven and eight and described below.

i) Tropical Zone: Wilderness areas have *sal* forest and savanna grasslands. Tropical wildlife tourism exerts pressure on national parks. The pressure is indicated by changed land-use patterns around park peripheries, e.g., the Royal Chitwan National Park (RCNP), because of a high concentration of hotels and lodges, and disturbance to birds and wildlife and loss of wetlands. In the mountainous region, this zone is represented by hill *sal* forest. Disturbances to forests lead to high erosion, however, the tourism pressure in this zone is rather limited. A healthy environment is indicated by the presence of canopy birds and barking deer. Loss of forest habitat induces shrublands and berry-eating shrubland birds replace forest birds.

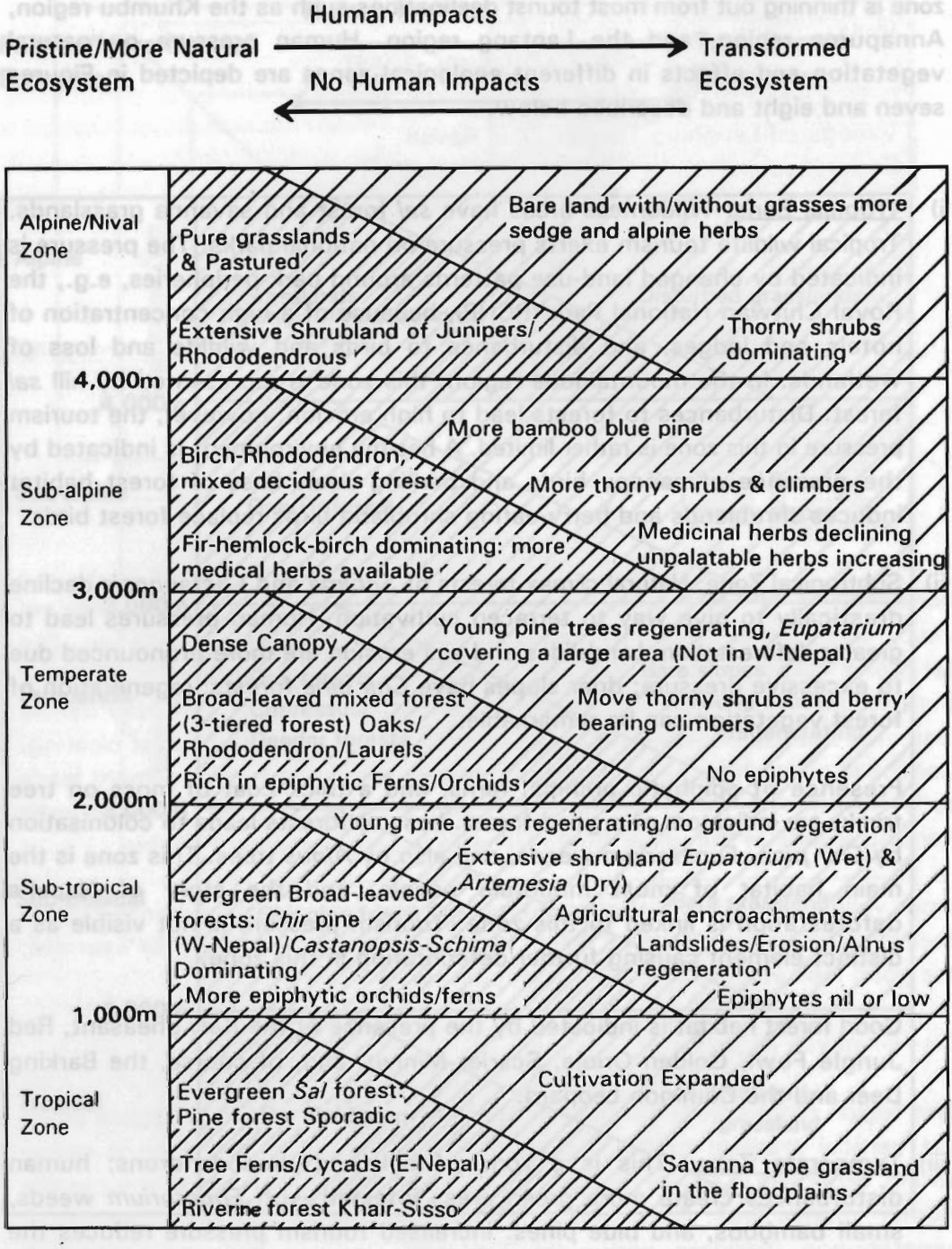
ii) Subtropical Zone: Natural climax forests of *Schima* and *Castanopsis* decline drastically to give way to terraced cultivation. Human pressures lead to greater deforestation. Landslides and soil erosion are more pronounced due to excessive pressure; drier slopes have *Chir pine* forests; regeneration of forest vegetation can be remarkable.

Presence of epiphytic orchids, ferns, and a thick coat of moss on tree trunks are indicators of a good forest. Loss of forests leads to colonisation by *Chir pine, Eupatorium* weeds, and also by *Alnus* trees. This zone is the main habitat of most mountain people, and the story of Nepal's deforestation is linked to this zone. Tourism pressure is not visible as a distinct element causing further deterioration in this zone.

Good forest habitat is indicated by the presence of the *Kalij* pheasant, Red Jungle Fowl, Golden Oriole, Scarlet Minivit, and, of course, the Barking Deer and the Common Leopard.

iii) Temperate Zone: This is a zone of oak and rhododendrons; human disturbances create more green areas infested with *Eupatorium* weeds, small bamboos, and blue pines. Increased tourism pressure reduces the canopy cover of the forest and induces forest degradation.

Figure 7: Vegetational Changes Caused by Human Impacts in the CIS-Himalayan Region (Eastern/Central Nepal)



Based upon: Stainton 1972; Dobremez 1976; Shrestha 1985

Figure 8: Birds and Mammals as Environmental Indicators in the South of the Main Himalayan Range (CIS-Himalayas)

	Pristine/Undisturbed Habitat	Disturbed Habitat	Village/Urban Situation
Alpine/Nival	**Birds** Snow Partridges Snow Cock Danphe (Pheasant Golden Eagle Alpine Accenter **Mammals** Mouse - Hare Snow Leopard Blue Sheep	Great Rose Finch Himalayan Griffin Bearded Vulture	
4,000m			
Sub-alpine	**Birds** Horned Tragopan (Danphe) Pheasant Blood Pheasant **Mammals** Musk Deer Barking Deer Mouse - Hare Wild Dog Himalayan Yellow-throated Martin	Laughing Thrushes Himalayan Green Finch Porcupine	Jungle Crow
3,000m			
Temperate	**Birds** Black-headed Sibia Nepal Cutia Scaly-bellied Wren Babbler Tailed Wren Babbler Common Hill-partridge **Mammals** Himalayan Black Bear Barking Deer Common Deer Red Panda Wild Dog	Nepal Parrot-bill Indian Blue-chat Peking Robin Crested Serpent Eagle White-necked Stork Spiny Babbler	Jungle Crow Upland Pipit
2,000m			
Sub-tropical	**Birds** Kalij Pheasant Red Jungle Fowl, Golden Oriole Great Horned Owl **Mammals** Barking Deer Common Leopard Langur Monkey	Black Partridge Shrikes Bush Chat White-checked (Bulbul) Drongos Jungle Cat Rodents (Mice/Rats) Hare	House-Sparrow House Crow Drongos Quails Paddy-field Pipit Munia Mynas

H.S. Nepali

A very few parts of the interior midlands, such as the lower Barun Valley, have pristine forests which consist of three distinct tiers, i.e., the first tree canopy, the second canopy, and the ground cover of bushes and shrubs. Epiphytic orchids are in plenty. Some case studies, such as those of the Jugal Himal (Schmidt 1990) and in Salme village, Trisuli Valley (Wiart 1983), have clearly indicated that truly undisturbed forests are not found in their study area. The actual process of deforestation is not prevailing and bio-mass production is sufficient to meet community needs. Tourist campers have, however, transformed such areas into more open and bushy habitats. Road access, such as that of Milka *Danda* (Hile-Vasantapur area in the Arun Access Road), has contributed to the total loss of forests in the temperate zone.

The pristine condition is indicated by the presence of birds that inhabit shrubs in the dense forest, e.g., Scaly-bellied Wren Babbler, Chestnut-headed Ground Warbler, Olive Ground Warbler, Tailed Wren Warbler, and so on. The birds residing in mature forests are Black-headed Sibia, Red-tailed Minla, Nepal Cutia, and so on. The Himalayan Black Bear with its juvenile, i.e., the "Tree Bear" are found in the forests. Barking Deer and Ghoral are common. Human disturbances cause them to move away. Tourist camps and heavily used trails disturb the occurrence of these birds and animals. Heavy impact forest edges host a large number of berry-eating birds such as Indian Blue Chat, Nepal Parrot Bill, Black Chinned Babbler, etc. More disturbed conditions are indicated by a beautiful little bird, the Peking Robin. When the land is heavily degraded, wildlife and birds virtually disappear.

iv) Sub-alpine: This is a zone of conifers and birches; agricultural lands are limited to small patches of potatoes and wheat cultivation. This zone has become the main source of firewood supply to trekking parties and mountaineering teams. Pressures from increased livestock are more intensive; environmental stress in this zone is observed in the lowering of the tree line and the growth of thorny shrubs and bamboos.

The upper part of this zone has a treeline vegetation of birch and rhododendron forests. At lower elevation, tall coniferous trees, i.e., fir and hemlock, dominate the forest. The subalpine zone is also rich in medicinal herbs. Human pressure reduces medicinal herbs and induces unpalatable plants and thorny shrubs. Occurrence of large patches of '*nigalo*' and '*malingo*' bamboos (*Arundinaria* spp) is the immediate indication of forest fires and overgrazing in the forest. The subalpine zone is generally subjected

to various pressures coming from excessive livestock grazing and firewood extraction for both tourist camps, lodges, and also local communities.

The presence of the Horned Tragopan (Monal), *Danphe* Pheasant, Fire-tailed Sunbird, Cross Bill, and Blood Pheasant are indicators of good wilderness conditions. The mammals found in this habitat are the Musk Deer, the Ghoral, Himalayan Thar, Himalayan Yellow-Throated Martin, and so on. When the quality of the environment deteriorates, a large number of Common Rose Finches are generally seen. Local people often name this bird "the bird of famine". Other birds, such as the White-throated Laughing Thrush and Himalayan Green Finch, also appear as a result of forest destruction.

v) Alpine Zone: This is a zone of dwarf junipers and rhododendron bushes. Grasslands and meadows are more colourful in late summer. Increased tourism creates excessive demands for firewood. Most base camps and high altitude lodges depend on these bushy vegetations for fuelwood. This results in eroded landscapes. The alpine zone is very susceptible to immediate degradation as soon as vegetation cover is removed. All tourist destinations in this zone need to practice meticulous environmental planning for the purpose of stability.

vi) Nival Zone: This is a zone of snow and ice without vegetation. Signs of negative impacts are overcrowding, garbage (including human waste), accumulation, trail congestion, etc.

Minimum Data Set for CCA

The growing research world-wide in the social and natural sciences tends to use increasingly sophisticated analytical techniques that require larger data sets which are severally lacking in mountain countries like Nepal. The challenges to sort out a set of simple indicators among the complex interaction of environmental factors have, therefore, to be addressed through the integration of traditional local knowledge with scientific facts. The use of sociological and ecological techniques are essential to arrive at a minimum data set for characterising a tourist area and to monitor it in order to assess carrying capacity.

No formula can satisfy the ecological, cultural, economic, and social diversities that characterise each region of a country. In a large number of rural

development-related research projects the Rapid Rural Appraisal (RRA) technique has been in use. It characteristically relies on small multidisciplinary teams that employ a range of methodological tools and techniques specifically selected to enhance understanding of rural conditions in their natural context, with particular emphasis on tapping knowledge through modern scientific expertise, but minimising prior assumptions (Kachondham 1992). More recently Rapid Assessment Procedures (RAP) have been developed as a technique (Scrimshaw and Gleason 1992) in parallel with RRA but focussed more on a rapid assessment of human behaviour. In the context of tourism development in mountain environment, the RRA and the RAP could be combined to generate useful information for carrying capacity analysis. These methods can be applied for obtaining information in a relatively short period of time using semi-structured interviews, focus group discussions, and direct observation.

The RRA and RAP methodologies are more inductive than deductive and the information base is rooted in the community and the environment. Participation with the community will create an awareness that they (the community) cannot dismiss - as they often do with government data. Such methodologies should establish a minimum data set for a baseline benchmark for regular monitoring and also for rapid holistic planning. Protocols outlining such an approach are presented in Table 3.

Table 3: (i) Minimum Data Set - for a Natural System

Variables	Source of Information	Minimum Information Required
Physical Geomorphological features.	Existing govt. agencies, published literature, and geological maps	Special focus on hazardous areas, epicentres, GLOF, slope stability, soil creep, landslide area, etc
Soil	Secondary information, community field observation/surveys	Productivity trends - erosion phenomenon - soil profile - soil biology: indicator species such as earthworm biomass.

Variables	Source of Information	Minimum Information Required
Water	Field observation, community information, government line agency	Water source catchment condition - drinking water supply system - water contamination - presence of fish, frogs, larvae in water bodies - flood incidence
Climate	Line agency information, community information, meteorological station, observation/survey	Rainfall/snowfall pattern and amount of rainfall Thunderstorm events Agroclimatic zonation Natural vegetation zones
Biological Vegetation/ flora	Government line agency and local forestry office, secondary information, community information, Observation/survey	Mature forest types, regenerating forests Pristine areas/forest, grassland types, local medicinal plants Local names of trees and fodder
Wildlife/ fauna	Government line agency and local office of Forestry. Secondary information, community information observation/survey	Common/rare birds and animals, endangered species' information
Agriculture	Local government offices, secondary information, community, observation/survey	Types of crops and their calendar Fruit trees: production and potential; Use of fertiliser/pesticides Poultry/livestock types Production/productivity on household basis Draft/transport animals

(ii) Minimum Data Set for a Human System

Variables	Source of information	Required Information
Sociocultural	Formal interviews, informal interviews, discussions with well-informed group or individuals, participant observation, focussed group discussion	Ethnic composition, local taboos, heritage sites/conditions, population structure, migration pattern, household amenities, construction type
Socioeconomy		Production system, source of cash income, economic status, economic infrastructure facilities, i.e., credit/banks

(iii) Minimum Data Set for Tourism Activities

Variables	Source of information	Required Information
Tourism facilities	Local community Local government offices Local leaders Business community observation	Service sector-accommodation, eating, etc Supporting sector-shopping, entertainment Events-cultural, sports, etc Public utilities Infrastructure (transport & communications)
Main activities	HMG line agency Local Government offices Trekking agencies Airlines Community Observation	Tourist seasons/volume National Park Mountaineering Trekking Hiking Rafting Nature study/exploration, etc