

Encyclopaedia of Environmental Pollution and Awareness in 21st Century Series

HIMALAYAN ECOLOGY

Edited by
V.K. PRABHAKAR



CL

Encyclopaedia of Environmental Pollution and Awareness in 21st Century Series

HIMALAYAN ECOLOGY



Edited by
V.K. Prabhakar

ANMOL PUBLICATIONS PVT. LTD.
NEW DELHI - 110 002 (INDIA)

CONTENTS

	<i>Preface</i>	<i>vii</i>
1.	Introduction	1
2.	Himalayan Ecology	31
3.	Forest Ecosystems	145
4.	Flora and Fauna	203
5.	Wasteland Management	245
	<i>Index</i>	261

PREFACE

Today, the cry of 'pollution' is heard from all the nooks and corners of the world, and pollution has become a major threat to the very existence of mankind on this earth. It is the major challenge of our times.

The pollution of various resources has gone to such an extent that we are unable to breathe fresh air and drink fresh water. On one hand the advancements of science and technology have added to the human comforts by giving us automobiles, electrical appliances, supersonic jets, space crafts, better medicines, better chemicals to control harmful insects and other pests, etc., but, on the other hand, they have given us a very serious problem to face that is pollution. Pollution can be defined as an undesirable change in the physical, chemical, or biological characteristics of the air, water, or land that can harmfully affect health, survival, or activities of humans or other living organisms.

Pollution does not have to cause physical harm, but it may merely interfere with human activities. Chemicals spewed into the air or water from an industrial plant may be harmful to humans and other organisms living near the plant. If expensive pollution controls are required, the plant may be forced to shut down.

India faces serious problems of environmental pollution. Water pollution from untreated community and industrial wastes flowing into our rivers and

streams, increasing use of fertilizers and pesticides, dumping of organic wastes etc., are issues that need to be tackled on the priority. Air pollution, long regarded as the bane of industrialised nations looms large over our country.

Here, we are presenting this *Encyclopaedia of Environmental Pollution and Awareness in Twenty-first Century* in fifty volumes with a view to make people conscious about the seriousness of pollution in the present time and its remedies.

Editor

1 INTRODUCTION

The Himalayan range stretching from Pakistan to Arunachal Pradesh in India must be one of the most spectacular and dramatic areas on earth. Not only does it embrace the highest mountains in the world, but also mighty glaciers and ferocious rivers, huge foothills, and fertile valleys, extensive deserts and dense forests. And it is not only the topography that is so impressive, there is a considerable variety of mountain people with different cultures, religions and language. Four decades ago tourism, as we know it today, was almost non-existent. And possibly that has been the major change in the Himalayan activity—the development of number and quality of airfields in the mountains.

Nowadays tens of thousands of people are walking the hill tracks, floating down the rivers, driving over the great Himalayan passes, landing in tiny airfields in remote valleys, visiting the sacred places in the mountains. The impact of all these people visiting the distant mountain areas has been tremendous. Some of the effects are good and some not; so good.

The standard of living of the mountain people has increased considerably from tourist wealth. But the beautiful tracks and valleys have been littered with rubbish and the forests have been destroyed to provide fires for meals and comfort for tourists. Hundreds of tiny hotels do the landscape but toilets are rare and

completely inadequate. The Himalayan environment has suffered severely, partly from tourism but more importantly from the substantial growth in the local population. Arable land is increasingly rare and the forests are cleaned and the slopes terraced for the planting of crops.

Population growth is a massive problem to overcome—nobody really knows how to deal with it. It is only in affluent countries that the population growth is stable. In the Third World a large family is the only method of social security and there is a constant and desperate race between industries. As the tourist numbers grow, the impact on the most popular areas becomes more and more severe. But in the huge stretch of the Himalayas there are a multitude of beautiful areas and many of these are completely neglected. Energetic efforts should be made to attract people to the less popular places, to spread tourism thinner, so that their negative environmental impact is reduced.

Tourism agencies must be pressurised into ensuring that their customers leave the hills and valleys in as pristine a condition as they were when they found them. One of the great joys of adventure tourism is getting away from the everyday whirl of living, appreciating the peace and contentment of areas, free from public pressure, enjoying the bubbling streams, quiet forest paths, and lonely mountain spaces. We all need to escape from the concrete jungle and return refreshed to the city environment and dream of sparkling waters and icy mountain tops. The Himalayas are good for all of us but we must not let them be abused.

Forests must be preserved, camp-sites must be kept clean and wholesome, and rivers protected from pollution. We must prevent the wanton destruction of all that is fresh and beautiful and enjoy to the full, the superb beauty of nature in the remote mountain areas.

The environmental hazards in the Himalayas are many, complex, and interrelated e.g. landslides, droughts, floods, decline in the forest cover, decline in agricultural yield, soil loss, problem of siltation in reservoirs and rivers, extinction of rare species of wild animals, etc. The natural springs are rapidly drying, domestic animals are less productive or unproductive, the fodder resources are limited and natural forests are fast disappearing in the Himalayas. Blasting of the rocks for the construction of roads, tunnels, dams, colonies, etc. and haphazard method of mining have greatly affected the ecological balance. Mining operations are old and traditional and have eroded the lush green vegetation cover.

The mining operations have also eroded the lush green hill slopes, destroyed leaf mould—a valuable organic fertiliser, polluted streams, and decreased the agricultural production by 60%. In the doon Himalayas, the limestone dust particles from the quarries and lime factories have been estimated at 360 micrograms per cubic meter as against the safety level of 100. Hazardous air and noise pollution have caused many plants to wither away; the forest under-growth has been cleared, the sub-surface water has decreased, and the mountain side resembles a gigantic skeleton due to blasting.

In higher altitudes, frost edging is an environmental hazard. The glaciers do a lot of abrading and scratching and sometime snow streams and avalanches cause a great loss to life and ecology. In areas of moderate relief of the Himalaya, water erosion is a serious problem as it makes the rock naked; consequently, instability of the hill slopes, silting of the river valleys and floods are very common features. Torrential rains cause mass wasting and huge landslides and landslips. Landslides are very common, often blocking the vehicular traffic and sometimes damaging engineering projects. In the low relief alluvial plains, flash floods, soil erosion and sheet

erosion are environmental hazards. The construction of unimaginatively planned and cruelly executed roads is the biggest factor in destroying the ecological balance. Construction of dams on hill rivers to meet the ever increasing demand of irrigation water and power of the plains is yet another environmental hazard. These projects cause destruction of hills, flood the fertile flatland of the valleys, and create the problems of rehabilitation of the oustees.

The Himalayas are the loftiest and greatest of all the mountain system in the world. They have from time immemorial held an indescribable charm, inspiration and spiritual significance for the millions living in and around these mountains. It is well impossible to describe in words the mysticism and the religious aura that surround these mountains. Great Sages and poets have tried to describe the sheer majesty and charm of the Himalayas but could never fully capture in words their majestic; grandeur.

The Himalayan land and water are priceless national assets. The approach of the modern man to explore and exploit its resources is very harsh. If the Himalayan region to meet the increasing demand for fuel, fodder, timber, etc., would be disturbed and it would create environmental hazards in the Himalayas. The question of conservation, regeneration and development cannot be left to chance and the vagaries of political and administrative set-up at the lowest level. Conservation and development should be made mandatory without prejudice to the rights which inhere in the land. In this way, objections or dilatory tactics can be given short shrift.

The Himalayas are an awesome chain of mountains that extend approximately to 2500 km. From north-west to south-east and the width is between 250to 300 km. The

Himalayan system consists of three longitudinal belts separated by faults, their geological and topographical characters are strikingly different.

Immediately north of the plains is the Siwalik Zone. The width of this zone varies from 10 to 50 km. and altitude rarely exceeds 900m. This zone is covered with damp and unhealthy forest. The next zone is known as the middle Himalaya with width ranging from 65 to 75km. and the average height being 300m. This zone is profusely dissected by the major rivers passing across it. The third belt is the Great Himalaya rising to an average height of 5,200m. The great Himalayan peaks are situated in this zone. There are more than 90 peaks having an altitude of more than 8,000m. This zone has two sub-zones, viz, an alpine zone (4800m.) and an upper snow-bound zone (7500m).

The transverse sub-divisions of the Himalaya are as under:

- (i) The Punjab Himalaya—Sutlej to Indus, 590 km.
- (ii) The Kumaon Himalaya—Kali to Sutlej, 350km.
- (iii) The Nepal Himalaya—Tista to Kali, 800km.
- (iv) The Assam Himalaya—Brahmaputra to Tista, 750km.

Dr. Valdiya, an eminent geologist has strongly supported the rise of the Himalaya out of a vast tethys geosyncline that existed where now we see the Himalayas. The soft sediments that lay at the bottom of the geosyncline were pressed, upheaved in several phases. The present configuration and complexity of the structure of the Himalayas is due to the phenomenon of "plate tectonics" and other related orogenic activities.

The Himalayas are very young mountains and constitute less than 1/5th of the total geographical area of India. They control the climate and through the rivers the prosperity of more than one third of the total population

living in the plains of the Indus, the Ganges and the Brahmaputra.

The Himalayas as the name implies are the "abode of snow". The total ice cover of the Himalayas is around; 16,000sq.km. and this amounts to 17% of their area. A very large number of glaciers exist at present above the snow line, most of which are in the Himalayan range. Glaciers provide water to major perennial rivers of the Himalayan system. Glaciers are formed from the accumulated snow which has survived melting; for a glacier to exist, the snowfall should exceed the quantity that melts in a summer. There are around 15,000 glaciers in the Himalayas. They vary in length and majority of them are one to five kilometers long.

The Gangetic glacier in the Central Himalaya is the source of the Ganges. Its ice surface occupies little over 20 cu.km. of ice. Satopath is another glacier which forms the secondary source of the Ganges. The Brahmaputra which ranks among the mighty rivers of the sun-continent of India, rises in the Great Glacier in the Kailash range in the northern most chain of the Himalaya just south of Lake Tasho in the Tibetan region. The Indus, the Ganges and the Brahmaputra are the three major river systems having their source in the Himalayas. They drain the country and provide a large potential for the irrigation and domestic use and also for the generation of hydroelectric power.

In implementing the development programmes it is necessary to ensure that the adverse environmental impacts do not arise. The total catchment area of these three rivers is about 8,00,000sq.km. Out of the total utilizable surface water resources of 666 milliard cu.m. Over 245 milliard cu.m.is accounted by these three mighty Himalayan rivers. Indirectly, the Himalayas play a vital role in replenishing the water resources of India.

They act as a barrier for moisture laden monsoons and enable to precipitate their moisture on the southern slopes. The melting of the snow and enormous rain keep the drainage system of the Himalayas healthy and further enrich the subsurface flow of water. The Himalayan glaciers are the banks of water. Harnessing of the Himalayan water resources should be taken up in such a manner that ecosystem is not disturbed. The productivity of water resources can be enhanced by trout culture in the free floating water in higher altitude areas and by raising mahasir and mirror carp in the standing waters with extensive use of cage culture technology.

Based on practice, there are two distinct agricultural systems in the Himalayas, i.e., "shifting agriculture" and "sedentary agriculture". Shifting agriculture is being done in the eastern Himalayas while sedentary agriculture is very popular in the western part of the Himalayas. Out of the total area (under cultivation), about 80% is under seasonal crops. The area under tree crop is around 12%. The area under tree crops is shrinking, giving way to season bound crops. Land under the crop in the higher Himalayas has shown an increase of about 15%. Double cropped area in the Himalayas was about 33% on an average, varying from 41% in the Siwaliks to 20% in the middle Himalayas. Sector wise, it is 38% in the central Himalaya and 10% in the Western and the Eastern Sectors. Cultivated land holdings in the Himalayas are smaller as compared to the holdings in the plains. In the outer Himalayas there are two distinct cropping seasons, i.e., Rabi and Kharif.

In the Rabi crops are included wheat and barley which are planted in autumn and harvested in early summer. In the Kharif crops are included paddy, maize, etc. which are planted in spring and harvested in late autumn. Agriculture in the Western and Central Himalayas require hard work for at least ten months in a

year. In the Eastern Himalayas, it is an year round affair. Among the crops, rice cultivation starts from lower altitudes and extends upto an altitude of 1800m. Altitudinally rice is followed by maize and wheat which are grown in slopes above the rice fields. At still higher levels, millets and barley take over. The Himalayas are the major suppliers of temperate fruits, which do well in between 1200 to 2000m. However, the gross area cropped under fruits is very small.

Agriculture in inaccessible regions of the Himalayas is difficult and requires considerable hard work. Terracing cultivation is common, even in the steepest slopes. On an average terrace is 3 to 4m long, 2 to 2m wide and 2 to 3m high. Shifting cultivation or Jhumming practised in the north east has very deep roots and very wide ramifications as the tribal groups system of cultural and ethnic types is typical of the area and has resided change for a very long time. The practice is a low energy budget, a low investment system of subsistence husbandry which uses the comparatively rapid mineralisation and recycling of nutrients provided there are sufficient areas available. Now that there is not enough area for the system to function, degradation is rampant.

About 0.542 million hectare area is under shifting cultivation and about 2.64 million tribal population is affected by it. It is now accepted that this practice has to be rationalised. The limited arable land should be utilised scientifically for valuable cash crops which offer a regional and seasonal advantage and for the development of seed industry for temperate vegetables which cannot be produced in hill zones and adjacent plains. Different cash crops need to be determined based on agroclimated suitability.

Horticulture, for which even slopy marginal lands

can be exploited, hold much greater promise than food grains. Instead of encouraging only one product (apple), a mix high value low bulk non-perishable fruit cultivation need to be encouraged and popularised in the Himalayas. The traditional agricultural practices are generally faulty; these should be discouraged systematically and ecologically viable scientific techniques adopted. The low products agrarian land should be brought under agro-forestry, farm forestry and agri-horticulture. Regarding forestry, the forests must be developed beyond the traditional forestry and a significant amount of total demands in terms of fuel, fodder, timber and other tree products can be met from the wastelands and crop fields, if integrated programmes such as social or farm forestry can be implemented at community level considering the needs of inhabitants and site characteristics.

The existing forest land should not be alienated for other land use, particularly agriculture and horticulture. The degraded forest should be enriched by the species already existing in such biotopes as these are well acclimatised to the locational factors compared to the exotic species. Free range grazing as practised in the region is injurious for regeneration of forest. Local inhabitants should be educated about the merits of stall feeding and rotational grazing. Afforestation programme should be encouraged; and popularised as major component of the rehabilitation and conservation strategy. There should be adequate stock of seedlings and seeds to maintain an ecological balance, it is necessary to build up productive assets and to increase the supply of consumer goods, fuel, food, fibre, fodder, and products of resin, etc.

The life and environment in Himalaya is a symbiotic relationship between agriculture, forestry and animal husbandry. The Jersey cow has been found as the best

milch animal for Himachal Pradesh while buffalo for Central Himalaya. The local livestock can be improved; by cross breeding the unproductive animals should be replaced. The Angora rabbits may be introduced as an alternative to local sheep for wool to particular extent. The bovine population may be reduced by castration of local bulls. The existing mode of open feeding should be stopped. The poultries to be encouraged as considerable income is generated through these.

Silvipastoral or Silvo-hortpastoral systems in the Himalayas are more useful and profitable compared to grass development alone. Effective protection of grazing land would increase the herbage cover and herbage yield. Fertilisation and introduction of grass legume mixtures in mid hills and cocksfoot, timothy, personal rye grass and contucky grass in sub-Alpine and Alpine grasslands can regenerate the degraded grass resources. Introduction of plantation of fodder trees on terraces and private lands shall improve the position of green top feed during the lean periods. Thus, planting improved grass varieties or strains coupled; with more efficient management of grasslands is vital in meeting current and future needs of herbage providing protective soil cover.

The Himalayas offer tourists a variety of scenic beauty. To them it is a paradise, its gushing rivers are laden with trout and the varieties of fish. To trekkers and hikers it is a challenge, its canyons, deep valleys and escarpments are eye-catcher. The snow-peaked mountains, gliding glaciers, grass meadows and hot springs invite tourists from remote corners of the world. The ever increasing tourist influx is creating great impact on ecology and environment. The problem of litter, noise pollution and damage to natural assets is causing great anxiety to environmentalists.

The unmanaged influx of tourists destroys the

natural architecture of the rocks and natural surroundings. The development and construction of new hotels involves the destruction of vegetation, felling of trees and erosion of the environment. Tourism should be considered as an ally and not an adversary in conserving the ecology in the Himalayas. It should be in the fitness of the things if master plans are prepared and new areas are developed to meet the unending demand of tourists resorts. There should be a close coordination among the planners and the promoters of ecology and environment of the Himalayas.

The construction of roads and other infrastructure are indispensable for efficient transport and communication system for tourism development, but these unavoidable activities are mainly responsible for destruction of Himalayan land resource along its vegetation and animal wealth. A careful study shows that the construction of 44,000 km. long roads in Himalayan region produced 2,650 million cubic metres of debris and each kilometer of already constructed roads generates; 550 cubic metres of debris by landslides and rockfalls.

Thus nearly 24 million cubic metres of debris slide down damaging vegetation and choking the springs etc. These activities accelerate hill slope instability deforestation, soil erosion, pollution of water and air, etc, especially along the road sides and around the most of the Himalayan tourist resort like Nainital, Simla, and Mussoorie etc. The use of powerful explosives like dynamite and frequent heavy traffic create vibrations which cause cracks on rocks and earth which in turn lead to land slides and erosion along with adverse impact of the flora and fauna. The construction of roads etc. along geologically active zones like at Kaliasur, Satpuli(Garhwal) is also responsible for degradation of land. The construction for accommodation facilities like rest houses, tourist bungalows, buildings and seasonal

accommodation units, recreation centres, etc., have posed the most serious menace to the land resources of the region; not only does it accelerate soil erosion but it also causes damage to crops, animals and plants, housing and public properties. It is also a contributory factor in causing floods with heavy siltation in valleys and adjacent areas. In Chamoli district alone from 1971 to 1978, 48 human lives, 949 heads of cattle, 601 houses, costing nearly about 173 lakhs of rupees, as also the crops, were destroyed by mass movements.

In the year 1972 owing to the landslides, the Gohna Lake was formed and its breaching has resulted in a large scale destruction in the Alaknanda valley and the plains of U.P. The flash flood engulfed 2000 sq.k.m. paddy crop, 10k.m. roads, 6 motor bridges and 24 buses, 366 houses while 138 villages were effected; by landslides alone in the year 1979.

Agriculture is one of the main occupations of the Himalayan inhabitants, but it does not give quick and heavy economic gains like tourism. At present during the tourist season (mainly May-June) tourism has become the main source of income, as a result of which agricultural system has miserably regressed. Enormous agricultural land is being occupied for development of infrastructure facilities. These activities create dependence system in addition to adverse impacts on economy and ecology of the area. These activities create dependence system in addition to adverse impacts on economy and ecology of the area.

The farmers who are living in the vicinity of these tourist resorts leave their traditional farming and either work or conduct different types of business for prompt and easy economic benefits. In many such developing and well developed tourist places, tourism has almost overlapped agriculture. Fields around the famous tourist

places like Mussorie, Nainital, Simla, Darjeeling, etc. are the result of this type of tourism impact.

The beauty of the Himalayan forest, alpine meadows and peaks is the main source of tourist attraction. The continual flow of tourists, mountaineers, trekkers, etc. is likely to have positive as well as negative impacts on these natural resources to a certain extent. Mythological beliefs and traditions which are prevalent in the Himalayan region are also responsible for adverse effects on the flora, especially in those localities adjoining the shrines. Religious tourists habitually collect flowers and colourful herbs to offer to temples like Gangotri, Yamotri, Badrinath, and Kedarnath, etc. Consequently, many species which are part of our cultural and religious heritage are beginning to get wiped out. It was noticed by the authors during the Roopkund trekking in Chamoli district that at the Bedney Bugayal and Roopkund (places of mythological importance along the trek) thousands of Brahmakamal flowers (*Saussurea obvallata*) were offered which were plucked from the vicinity area.

A recent sample study of Surkanda Devi (a place about 25 km. from Mussorie towards Tehri), which is situated at a most picturesque spot in the highest (2750 m) peak of the outer Himalayan range, indicates that about 10,000 people gather there for a week on the occasion of Dashera (celebrated festival of Hindu) and practically every one offers few flowers with twigs of Ronsli (*Abies Pindrow*) to Goddess Surkanda along with their other gifts. Every visitor roughly plucks ten flowers and two twigs. In this way about 10,000 flowers and 20,000 twigs are lost annually, as a result of which a virgin *Abies pindrow* forest and densely grown different colourful flowers which we have seen during childhood (about 23 years back) have nearly disappeared now, and in their place scrub forest and flowers like *Primula denticulata*, *Anemone vitifolia*, etc. are sparsely found. In addition to

this, severe trampling by visitors is also responsible for damage. A recent field survey of the world famous valley of flowers also shows that its flora and fauna was under major attack and influenced adversely after 1975 when this area was opened to visitors. Due to increasing rate of tourism traffic and direct (like trampling and plucking etc.) and indirect activities of tourists, many important and charming species of flowers like blue-scented *Primulas* (most beautiful), red *Potentilla* spp., creamy *Anemone* spp., blue *Meconopsis* spp., etc. are now found in reduced abundance along the treks, road sides and other easily accessible areas. This degradation will definitely occur in the entire area with increasing number of tourists.

In addition to this, other factors like overgrazing, low grazing etc. are also responsible for ecological imbalance. Overgrazing prevents plants from flowering and fruiting willow or ungrazing accelerate the growth of unnecessary weeds and grasses which create hinderence in growth and blooming. The growth of unwanted grass and weed has become a major problem of the valley after the ban imposed on grazing by the government and it seems to be only one reason for low flowers occurence in the valley even in peak season (August-September) in comparison with the situation obtaining some years ago. This fact leads to the conclusion that a scientific and controlled grass cutting or grazing is necessary for maintaining the importance of the valley of flowers.

If the sensitive ecosystem of the valley will not be given proper importance and attentions along with the promotion of tourism, Smythe's silent valley of Garhwal Himalaya may one day cease to show its visual spectrum, of nature's beauty. The damage in the Himalayan environment has reached a critical level and beyond the carrying capacity; therefore, in order to overcome this problem, it is the need of time that certain more

landscapes with unique type of vegetation and wildlife should be conserved as "Biosphere Reserves".

The tourist concentration in the Himalayan alpine pastures is increasing day by day, more than the carrying capacity, while the area under vegetation is decreasing due to accelerated human activities. A considerable area of virgin forest is also being replaced for providing necessary amenities to visitors for tourism promotion. It has been estimated that 234.25 sq.km. forest area has been destroyed only by road construction from 1951 to 1979 in the U.P. hills (forest statistics 1981). Deforestation not only result into resource depletion but also deteriorate fresh and underground water, wildlife and other related resources along with acceleration of disastrous phenomena like heavy soil; erosion and landslides etc., which mainly provoke flash floods.

The forest provides the best shelter and source of food for most of the wild animals, hence the quality of forest affected by vast tourism directly influences the wildlife of the respected area. The ever increasing influx of tourists exerts an adverse impact on the unique Himalayan wildlife. Tourist activities like invasion in wildlife habitat, close view watching and photography, hunting, poaching, and other disturbances etc. have created a problem for wild animals.

Mammals and birds are affected in large extent—more than reptiles, insects and other small animals. Owing to the large interference of man in the habitat and life style of animals specially in national parks, wild life sanctuaries etc., the ferocity of animals is being lost which is the only quality of wildness that differentiate them from domestic animals. The act of providing bate to tiger or lion for close view in national park etc., spoil the quality of wild life and is destruction of wild animals in the name of tourism. These activities further affect the

feeding and breeding habits and ultimately the entire life cycle. The small animals die due to heavy and frequent traffic which affect the food chain in wild life system. The habit of tourists to provide ready made food to wild animals is also responsible for loss of ferocity. During the year 1975 in the Corbett National Park a wild boar popularly known as Buddha (innocent) had become a purely domestic one.

Owing to the availability of ready made food like bread, biscuits, chapati, etc. from tourists he had later on developed the habit of stealing edible items like lunch packets, chocolates, jam butter, even tinned meat and fish, sauce and drink bottles, etc., from tourist tents, kitchen, or even open car, jeep etc. thereby a purely herbivorous wild animal had changed his wild habits. Recently in the year 1987 it has been observed by the authors in Corbett National Park that young chittal (spotted deer) is also frequently visiting the Dhikala complex of the park to eat cooked food material like bread, etc., from the hand of tourists and officials.

It is also noticed that during night time; few wild animals like wild boar (*Sus scrofa*), fox (*Vulpes vulpes*), chittal or spotted deer (*Axis*) etc., reach close to the Dhikala complex and feed on thrown-away ready made food or garbage etc. sometime even together also. So it is necessary to protect these animal habits and habitat alongwith their natural ferocity to maintain the wildness and ecosystem balance of natural food chain system between predator and the prey or between the herbivorous and herbs for total ecological system.

The crowded gathering of people religious places and resorts bring marked change to ecosystem as a whole. The direct and side products of tourists like litter, polythene bags and wrappers, garbage piles and related materials attract rodents and crow, which in turn draw

bigger animals and birds, thus changing the entire habit and habitat. The increasing tourist's craze for the Himalayan wild life and their products is also responsible for its destruction as it increases the demand of stuffed animals, ivory ornaments, furs, tails, quills, feathers, horns, skins, musk and wild-life souvenirs, etc. This demand provokes the curio trade, resulting into poaching and slaughtering of animals.

The musk deer, (*Moschus moschiferus*), blackbear (*Selenaretos thivetanus*), snow leopard (*Panthera unica*), leopard (*P. pardus*), bharal (*Pseudois nayar*) monal (*Lophophorus impejanus*), etc. are few well known animal species which are in great danger due to poaching. To prevent or reduce degradation of the Himalayan natural resources, there should be scientific and well planned growth of tourism in which experts of different disciplines like geology, botany, geography wildlife, environment, etc., and technocrats like engineers, architect etc. along with local people should have close involment in planning. There should be recreation between natural resources and tourism development which should be according to the carrying capacity of particular resorts, so that space action does not affect their ecosystems and ecological balance. If these protective measures are not given due importance in tourism planning and development, the Himalaya would be damaged beyond the limit of repair of regeneration.

Industrial development in the Himalayas is slow but the rapid population explosion and urbanizations has changed the trend. In the Kashmir Himalaya, the Himachal Himalaya, the Kumaon Himalaya, the Assam Himalaya and in many other parts of the Himalayas fruit processing, wool processing cottage industries, cement industry, paper and pulp industries, resin processing and other forestbased industries, such as watch factories, tool

factories, television factories etc., with pollution control devices would be vital for the rapid economic growth of the Himalayan belt.

The Himalayas provides a variety of natural resources to the sub-continent of India, including the life-giving water. These resources have been threatened largely by human negligence and activities. In order to improve and regenerate degraded hill environment, scientific approach involving hazard zone mapping and banning engineering development activities in such zones, drainage control and dewatering measures, protection of slopes through vegetation, modification slopes where necessary, application of engineering technology and improved agronomic practices should be carried on priority basis. The ecological balance can be maintained and improved by reforestation, by checking the illegal felling of tree, controlling the course of floods by construction bounds, retaining walls, schecking landslides, rocketries, sinking of the soils, protecting the watersheds, etc.

Laws should be enacted to stop indiscriminate timber trade, installation of new cement factories, stone crushers, state factories, industries, etc, which in turn cause air, water and noise pollution. The mining operations should be done using modern methods and techniques to minimize the pollution of atmosphere, the ruthless and haphazard mining activities greatly affect the health of the workers and also create ecological imbalance by rock debris, dumps and quarries' wastes.

The greenery of the soils is lost and fertility of lands is decreased. Constructional and developmental works also destroy the natural setting of the scenery and landscape. Soil and land use inventories need to be taken up on priority basis and the Himalayan belt may be divided into viable seacoast for the purpose of land use,

planning and management. Modern techniques of remote sensing and aerial photo interpretations are very vital in conserving the soil and soil programme. Soil maps may be employed to carry out the afforestation programmes and proper land use. Aerial seeding should be carried out to reclaim the barren lands. To prevent or reduce degradation of the Himalayan natural resources, there should be scientific and well planned growth of tourism in which experts of different disciplines like geology, botany, geography, wildlife, environment, etc and technocrats like engineers, architect etc. along with local people should have close involvement in planning.

There should be correlation between natural resources and tourism development which should be according to the carrying capacity of particular resorts, so that the space action does not affect their eco-system and ecological balance. If these protective measures are not given due importance in tourism planning and development, the prosperous heritage and environment of the Himalaya would be damaged beyond the repair of regeneration. To protect our environment we have to protect our wild-life, rare birds and unique plants. Proper education on environmental rehabilitation and conservation must be initiated at the grass root level. Rehabilitation and conservation programmes should include such measures as finding alternative sources of energy, self employment, agriculture, sericulture, horticulture, social forestry, cottage industries, small scale industries, etc.

The human and animal husbandry programmes should also be taken up to improve the lot of the Indian village folks. Women are the backbone of human ecosystem in the Himalayan hills. It is, therefore, necessary to improve their lot. An all-out effort should be made to maintain the enchanting beauty of the Himalaya.

Environmental Management of The Himalayas

It is only during the last few decades that man has begun to exploit the vast and varied natural resources. The great rivers which originate from the springs and the snowfields possess immense potential for a multiplicity of uses. At several places these rivers have been tapped and plugged to generate hydroelectric power, to construct dams and generate power, to irrigate the land, and to transport the material through the rivers. A proper management of these rivers and other natural resources to benefit the inhabitants of the holy mountains is very vital. The problems of environmental management are diverse and require special attention.

The Himalayas extend from the west to the east for about 2,500 km. and they vary in width from 250km. to 300km. These mountains have the world's highest peaks. The diverse landscape soils and climatic sectors, support several types of vegetation. Some of the plants are very characteristic of tropical, sub-tropical, cool temperate, temperate and alpine conditions. Some of the regions also support desert or semi-desert vegetation.

The Himalayan ranges can be divided into three major botanical regions i.e. the western, the central and the eastern Himalayas. Of these, the western region is further subdivided into the western Himalayas, Himachal Pradesh and the north western Himalaya. The central Himalayas more or less, conform to the mountainous region in Nepal. The eastern Himalayas includes Sikkim, Bhutan, Arunachal Pradesh, etc. Considering that the Himalayan region is richly endowed with a wide range of plants and is, in fact, one of the centers of origin of certain important agricultural and economic plants, an earnest need is to survey plant wealth, especially rich in genetic diversity.

The survey, however, should not be merely a

taxonomic one but a dynamic one carried out by multidisciplinary experts with the object of conserving the rare species and those species which are vital in the field of medicine, forestry, agriculture. etc. An effort should also be made to check them growing wild. The exotic plants, e.g. rhododendron, wild roses, coniferous trees, and rare herbs and food crops should be genetically upgraded to meet the requirement of food.

The temperate Himalayan belt offers great potentials for forage grasses and legumes, as such the natural grasslands of low productivity can be replaced with highly productive by farming systems. These untapped grassland resources of the Himalayan region can perhaps make the largest contribution to its economic development. As the prosperity of a nation is chiefly determined by its capacity to utilize and conserve its resources, it is therefore, necessary to undertake the steps based on the physical and biological factors of the region so as to formulate a plan for the rapid development, economic progress and sound management of the Himalayan plants.

The wild mammalian fauna of the Himalayas shows a tridimensional zonation, i.e. (a) Longitudinal, (b) Latitudinal and (c) Altitudinal. In each major zone, number of subzones can be recognized. They show interesting adaptations and extralimital affinities. The Himalayan mammals are provided with long and thick hairy covering, atleast in winter to cope with the severe cold. Several animals resort to migration to lower heights during winter.

Animals confined to the coniferous regions show a darker colouration as an adaptation to increased humidity and also as a protection against ultraviolet radiation, but the animals capable of living above the forest zone tend to be paler: e.g. the snow leopard, the

Horsfield's leopard cat, the Trevelyan's leopard cat, the pillar's cat, the snow bear, the Himalayan ermine and pikas. The member of Artiodactyla which have speed as the chief means of escape from the enemy are well adapted for quick movements on the steep and rocky slopes of the mountains by means of their splayed and pointed hooves.

Some carnivores like tiger, lion, panther, cat, etc., show highly interesting adaptations of stalking the prey on the difficult terrain of the high altitudes. In the case of the snow leopard, the ears are very small and the eyes are placed high up on the head so that the animal is able to reconnoitre for prey and locate it with a minimum possible exposure of head. In the case of the pillar cat, the short ears are set very wide apart and low down on the sides of the head so that their inner and upper borders hardly rise above the forehead which is highly flattened. The adaptation is of vital advantage for stalking the prey without the exposure of the predator from behind the rocks.

The wildlife in the Himalayas has been greatly affected by rapid development and urbanization. The rapid deforestation has also resulted in the extinction of wildlife. The wholesale degradation of the Himalayas, indiscriminate poaching of wildlife for commercial, medicinal, and industrial purpose has greatly reduced the stock of the wildlife.

The illegal trade in protected animals now has higher profits than drug trafficking. A kilo of rhino horn costs about Rs. 2,50,000/- and a kilogram of musk can fetch upto Rs.7 lakhs in the international market. The number of animals killed in laboratories for academic and research work is difficult to ascertain. Cosmetics, shampoos, etc; from big industrial concerns are first tested on the eyes of rabbits resulting in excruciating

pain. The trade in hides, skins and live animals is indeed cruel. The use of pesticides and insecticides to eradicate deleterious insects cause harmful impact on the wildlife of the Himalayas. For an effective and successful conservation of wildlife, it is necessary that deforestations, spraying of pesticides, insecticides, trade in animals and experimentation on animals should be legally stopped.

The number of parks and sanctuaries should be increased to preserve the vanishing rare species. The proper management of the sanctuaries and national parks is very vital. They should be protected from poachers and those who trade in animals. Factors limiting their population should be tackled seriously. Among the pests are fruit bats, rodents, lagomorphs, etc. Their control, conservation and proper management can be done by the agriculturist and the silviculturist. The population of the insectivorous bats can be increased by providing roosting boxes for these highly beneficial animals. A well planned management programme is bound to conserve the fauna of the Himalayas.

The Himalayan region is an intricate ecological complex stretched over an area of 61 million hectares of which an area of 17.8 million hectares is under forests and another of 0.7 million hectares is covered by alpine pastures. The ecosystem ranges from a high humid thick jungle belt in Assam to the dry sub-zero desert wastelands of Spiti and Ladakh.

The entire Himalayan belt can be sub-divided, on the basis of bioclimatology, into three belts i.e. the dry cold deserts of Ladakh and Spiti, the true temperate hills, and the humid and the high rainfall hills. Consistent with this ecological pattern, the livestock resources have developed, having become both dependent on man and independent of him. The Himalayan belt supports 20

million cattle, 10 million buffaloes, 2.9 million sheep, 5.94 million goats, 0.12 million horses, donkeys, etc; 1.27 million pigs. 17.38 million poultry and other birds and other livestock comprising 1.18 million heads which include yaks, charoes. etc. The animal resources are large and can be a source of proteins for human consumption, a source of fibre, leather, dairy products. meat products. etc.

A sound environment requires gradual replacement of animal resources by better stock and through the addition of new highly productive genes. A crop-livestock ecosystem mix which can maximize the yields of animal products without disturbing the environment should be adopted.

The Himalayas act as a barrier for the monsoon and cause precipitation to enable millions of people to carry out agricultural operations in the extr-peninsula and Indo-Gangetic plain. The annual rainfall varies in different ecological frames and structures from 5 cm in Ladakh to 400 cm in Arunachal Pradesh. Precipitation in the form of snow is very common in the higher altitudes.

The soils are mostly acidic at higher altitudes in the eastern Himalaya. They are found in association with nonacidic soils at mid altitudes of the western Himalaya and at low altitudes of U.P. Himalaya. The meadow soil are also acidic in character. An acute problem with the soils is their erosion. The degree or intensity of erosion is very high and is of the nature of sheet erosion, gully erosion, etc. Owing to steep slopes, erratic landuse, indiscriminate grazing, lopping and felling of trees at random, flash floods, silting etc. the problem has become acute. Improper landuse, small and scattered holdings, limited irrigation and old (or conventional) methods of agriculture need due attention.

A more rational land use of the resources can be introduced in the region by carrying out systematic soil surveys and preparing soil and land use inventories. The demarcating lands suitable for agriculture or horticulture or both. The chopping system and crop rotation studies do the least damage to the environment while bring to the farmer maximum returns from his land. Experiments should be initiated to determine the ways and means of aligning the rows of plants and the shape, heights and contours of the terraces to minimize losses of the precious "top soil" due to runoff. etc.

Considering that domestic animals are indispensable to the people of Himalaya, a programme should be launched to develop pastures and suitable leguminous plants, and fodder grasses should be introduced in the region. Keeping in view the spiral rise in population, it is recommended to supplement the food production in the region by encouraging the fish industry and fish-culture. The trout fish is becoming very popular, the economic lot of the people living in the vicinity of the lakes, springs, ponds, etc. where the trout fish is found. There is also need for overcoming Jhuming way of cultivation in the eastern Himalaya.

The proposed management and soil conservation techniques would certainly make the region agriculturally prosperous and self-sustaining. According to an eminent scholar, Dr. M.S.Swaminathan, the regions of the Himalayas should be studied with reference to weed plants, their biology, their relationship with the crop plants, their distribution, control, diseases, etc. There are many medicinal and aromatic plants which need special investigation for making economic use of them.

Studies on orchids, several type of bulbous plants and mushrooms will definitely help to improve the economy of the people in these regions. Studies on the

harvesting, storing and sale of crops is of utmost importance. The problem of rats, bamboo rats and other rodents should also be solved. The feasibility of alternative land use and constraints in the adoption of new techniques should be given priority. It is an opportune time to fight the unholy tripple alliance of pests, pathogens and weeds.

The place of forests in the Himalayan environment depends upon the vegetational and geological evolutionary history, longitude, latitude, altitude, drainage patterns, climatic patterns, and soil conditions. Their role in regulating precipitation, streamflow, subsurface flow, supplying food, fodder, fruits, etc. is vital. Their preservation and maintenance is of paramount importance to maintain the ecological balance. In order to conserve the forest resources and to check their rapid depletion, it is essential to link up forest resources with forest-based industries on the basis of physiographic, industrial and economic catchment concepts. The rural economy can be improved by several schemes of social forestry.

The wastelands and degraded lands be employed for "organized forestry," "multipurpose farm forests," etc. Keeping in view the importance of vegetation cover and sound landuse practices for soil and water conservation, it is felt that there should be a close co-ordination among the irrigation, soil conservation and forest departments both at the State level and at the Centre. This shall help to ensure optimum social and economic returns to the local inhabitants without bringing imbalance in the ecosystem.

The evolving of sound management practices should form the core of all scheme pertaining to afforestation and regeneration. Intensive study should be made to identify the suitable species of trees for wastelands and the degraded lands.

The problem of silt discharge is very acute in the Himalayan streams. An adequate network of gauging stations be established in the hill streams. These stations should be equipped with adequate instruments, equipments, etc., to monitor the qualitative and quantitative analysis of silt discharge and sedimentation throughout the year. An effort should also be made to control siltation in all catchment areas. Recognizing that the utilization of the irrigation potential of the Himalayan region is sub-optimal, it is imperative to survey the irrigation potential for sound water management. Since springs are vital sources of drinking water in large parts of the Himalayas, it is, therefore, very necessary to undertake the hydrological investigations to ensure a regular utilization of the spring water.

To prevent water run off and judicious use for protective irrigation, small reservoirs to suit local conditions, soil, climate, topography, etc. should be constructed. As most of us know the Himalayan glaciers are the source of several streams, it is, therefore, necessary to make an exhaustive study of the Himalayan glaciers and also prepare an inventory of glaciers, glacial debris, glacial moraines, etc.

Managing the Physiographic and Catastrophic Hazards

The geologically young are of the Himalayas, the presence of residual stresses and highly deformed and tectonized condition of the rocks make them highly susceptible to weathering, erosion and damage by structural and seismic activity. The developmental activities in the Himalayas have to face the challenge of these geological hazards, and in some cases the developmental activities, such as the impounding of large quantities of water in reservoirs, tunnelling operations and the addition of silt load of rivers by road cutting, lead to the intensification of the natural dynamic

processes. The weathering is mostly due to block disintegration and thrawing. This causes the production of vast quantity of Scree or talus. The debris or scree slips down along the slopes under the action of gravity. The debris falls on the fertile fields, stops the free circulation of water, roads are blocked and landslides of intense magnitude are caused. The Badrinath area of Uttar Pradesh presents a typical example of subaerial denudation and landslides. Intense grazing has also accelerated the processes of soil erosion and this has made the slopes barren, naked and prone to sheet erosion and gully erosion.

Enormous quantities of silt and sediments fill the river valleys and result in flash floods. The catastrophe of the river Brahmaputra alone annually carries a suspended load of 800 million tonnes and the average sediment yield from its catchment in India is of the order of 26,000 hectares metres. The Siwaliks in the outer Himalaya experience mass wasting and this results in huge landslides. Such landslides are very frequent near Nashri Nala (Kud-Batote) in Jammu, near Poonch (Jammu), Malori on the Batote-Bhadarwah road of Jammu, Mussorie highway on the Chakkir-Dalhouse road and on the hilly regions of the eastern Himalaya.

The landslides have also been observed in the Kumaon and Garhwal Himalayas and they cause a great loss of life and property. Dr. K.S.Valdiya, an eminent scholar of the country, is of the opinion that the tectonic stresses which heaved up the mighty Himalayan mountains have not died down as yet, and provide an additional impetus and vigour for the dynamic processes. These processes are manifested by intense seismic activity, mass wastage, floods, transgressions, sinking, subsidence, regressions, etc. Most of the earth-quakes that have been felt in the extra peninsular region are due to the dynamic forces and till date million of people have

died besides an irreparable loss to landscape and property.

The earth temors also cause huge landslides. The creep movement in the areas of Chamoli district of Uttar Pradesh in early 1968 resulted in a 40 metre high blockade across the Rishiganga river near the village of Reni(U.P). The lake thus formed was silted up by May, 1970 and the blockade was breached during July, 1970, and the floods in the Rishiganga river created environmental hazard. About 0.175km²was reactivated owing to the erosion of the debris derived from a prehistoric slide by the Karamnasa Nadi—a tributary of the Alaknanda, resulting in a debris avalanche, which washed away the motor road built above and blocked a part of the course of the Alankanada river. Major slides occured also in other parts of the Himalayas causing blockades, floods, disruption of roads, etc. Avalanches are also very common in the higher altitudes of Leh, Kargil, Gurez etc. in Kashmir, Spiti in H.P., in the higher reaches of Kumaon-Garhwal and Badrinath area of U.P. These cause disruptions of telecommunication lines, electric poles, destruction of engineering structures, disruption of roads by the accumulation of snow and ice.

A proper appreciation of these dynamic processes and their scientific evaluation in time can decrease the intensity of loss, if not stop it altogether. The rock waste derived from the construction and excavations of the roads, bridges, reservoirs, tunnels, etc. should be placed at an area which may neither affect the cultivated lands nor the flow of a stream. The appropriate use of such a waste is in the construction of rock-filled and concrete dams or in road dressing. The environmental management of the Himalayan landscape is fraught with complex interrelationships between natural entities and the evolutionary processes, and between human activities, government concerns and programmes of

resource management. The human interference for developmental activities in the Himalayas has to be in consonance with the environmental conditions. As the Himalayan terrain has some of the best tourist resorts, e.g. Kashmir, Nainital, Dalhousie, Mussori, Darjeeling, etc., it is essential that the developmental activities should be planned in such a way that their aesthetic appeal is not lost.

The maintenance and development of roads which play a significant role in the ecology of the hill terrains, should be given due attention and Central and State teams should work in close co-ordination for the development of roads. It is finally recommended that long term basic research into the functioning and dynamics of the Himalayan ecosystem should be initiated for an everlasting and sound environmental management of the the Himalayas. The following priorities for research are identified:

- (i) The problems associated with the current massive erosion and landslides occurring in the hilly terrains of Himalaya.
- (ii) The problems associated with the explosion in population, rapid urbanization and migration of masses in the mountains regions.
- (iii) The problems associated with the rapid changing faunal and floral stocks in the Himalayas.
- (iv) The problems associated with tourism and the adverse effects on the environment.
- (v) The problems associated with ecological and environmental awareness and establishment of "Biosphere Reserves".

The intense investigation of the above referred problems would help in achieving the destined objects of an excellent and sound management of environmental problems in the Himalayas.