

NATURAL RESOURCE MANAGEMENT IN THE MOUNTAIN ENVIRONMENT

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Experiences from the Doon Valley, India



Jayanta Bandyopadhyay

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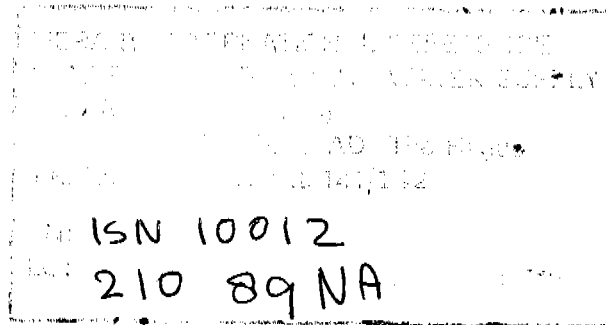
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**Natural Resource Management in the Mountain Environment:
Experiences from the Doon Valley, India**

Jayanta Bandyopadhyay

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1. Hillslope heavily damaged by environmentally destructive limestone quarrying in Doon Valley.
2. Volunteers of the non-violent Chipko movement protesting against environmental destruction from quarrying by resisting the movement of trucks to one of the quarries in Doon Valley.
3. Accumulation of air-pollution within the Doon Valley from a limestone based industry.
4. Panoramic View of Forest Research Institute in Dehradun.

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The suggestion for elaborating upon the interesting case of natural resource management in the Doon Valley came from Dr. Colin Rosser, Director of ICIMOD. During this review his continuous encouragement has been extremely valuable. This occasional paper has emerged from long and intense discussions with Narpal S. Jodha, Donald Alford, Anis Dani, Deepak Bajracharya, and others who have also made important editorial comments on the manuscript. My interest in this review and analysis is rooted in the enlightening experience I had while working on the Doon Valley Ecosystems in 1983. Since that period my understanding of the valley has been enriched by many individuals and organisations -- the list of which is long. Yet, I must mention that it is impossible to forget the rewarding associations with the members of the Friends of the Doon, Save Mussoorie Society, Research Foundation for Science and Ecology, The Rajpur Group, Nehru Yuvak Kendra, Environmental Protection Committee of Thano, Kalpavriksh, Centre for the Study of Developing Societies, and above all, the network of Chipko activists.

Foreword

Urbanization has become a major force in the process of economic development and environmental management across the Hindu Kush-Himalayas and particularly so in the lower altitudes of the mountain ranges. The rapid growth of urban centres throughout the Himalayan foothills has made urban planning a necessary element of mountain environmental management. Such towns initially emerged as trading points between the hills and the plains, and eventually small and medium scale industries were established in and around them, acting as catalysts for further economic expansion.

The issues and challenges of urban growth in mountain areas are broadly similar whether it is in the Kathmandu Valley of Nepal, the Thimpu Valley of Bhutan or the Doon Valley of India. As centres for economic growth these urban areas not only provide major economic opportunities in off-farm employment for the hill people, but are also instrumental in the transformation of traditional farming production systems. At the same time their economic force is also a source of concern for the fragile resources of the hills. One of the major challenges in integrated mountain development is to find the right balance between the economic potentials and environmental pressures of urban growth in mountain areas.

The study on "Natural Resource Management in the Mountain Environment - Experiences from the Doon Valley, India" was prepared by Dr. J. Bandyopadhyay in the framework of ICIMOD's programme on Mountain Environmental Management. It is also one of a series of papers presented at the ICIMOD/UNESCO (MAB) Symposium on Mountain Environmental Management that was held from 12th to 16th April, 1989 in Kathmandu. Through this series, ICIMOD is examining the wide ranging diversity of ecosystems and influencing factors with the objective of determining appropriate development strategies.

The Doon Valley is without question an appropriate choice for the review and analysis of the challenges posed by urbanisation in mountain areas and of the responses by Government and the general public to these challenges. Apart from having a well-recorded history of economic and social development and natural resource management, covering a time span of almost two centuries, the Doon Valley has been one of the leading growth areas in terms of employment in primary, secondary, and tertiary sectors and, resulting therefrom, overall population growth and urbanisation. This has had not only positive results but also important negative consequences such as degradation of land resources, shortages of water supplies, air and water pollution and urban slum development. These, in turn, have led to responses and counter-responses in terms of mass protest action by affected population groups, litigation in courts at local and at the highest levels, and the passing of laws and regulations to remedy short-comings and improve resource management and urban planning. All these actions and counteractions as well as the underlying causes are skillfully reviewed and analysed by Dr. J. Bandyopadhyay who, in addition, has drawn up a future agenda for the integrated environmental management of the Doon Valley. Seen against this background, the findings and recommendations of the study in their applicability go far beyond the geographical confines of the Doon Valley and become relevant to similarly placed urban areas of the entire Hindu Kush-Himalayan Region.

E. F. Tacke
Director

I. Introduction

The management of natural resources in the mountain environments has emerged as one of the most significant challenges to human understanding and organisational ability in the current century. Although the mountains and uplands constitute about 20 per cent of the surface of the earth, it is difficult to find an area not affected by their environmental characteristics. The most important influence that mountains exert emanates from their ability to act as orographic barriers to the flow of moisture bearing winds that result in high precipitation on the windward slopes and create rainshadows on the leeward slopes. Moreover, in the upper regions of many mountains large volumes of water are stored in the form of ice and these provide the necessary melt flows into the rivers during the hot, dry seasons. The vital cultural and ecological importance of these mountain waters further enhance their significance in satisfying the needs of all living creatures. Of somewhat less significance ecologically, but nonetheless of great economic importance, are the uses of the mountains for forestry, agro-horticulture, mineral extraction, livestock rearing, tourism, and recreation.

Over the last several hundred years, and in particular in the current century, the human impact on mountain environments has increased considerably. These interventions have both a stabilising and a disturbing impact on the mountain environment. The negative impact of such interventions is due to the relatively lower level of understanding of the particularities of the mountain society and habitat.

Large scale changes have occurred that have resulted in wide spread human misery. The impact of such changes is not restricted to mountain areas and they have concomitantly affected the plains. Hence, the disturbances in the mountain environment, as well as the urgent need to ensure a sustainable habitat, have attracted the attention of national and international institutions which have made the mountain environment an area of increasing concern.

As a result, the availability of funds for mountain development has increased substantially. Allocating funds, however, is the easier part of the task. It is not so easy to realise the objective for which the funds were provided. In this respect, the proper management of resources within the perspective of a mountain environment can make a positive contribution.

Notwithstanding the contribution it can make, the concepts and methods of natural resource management for mountain environments are in a rudimentary, evolving stage. Serious analytical and integrative contributions are needed to strengthen this vital area. Undertaking analytical reviews of management experiences in mountain development, in various countries, is a vital element in enriching the knowledge and skills in this field. The present review and analysis of the important issues of natural resource management in the Doon Valley, which is in the Himalayan foothills of the State of Uttar Pradesh in India, has been undertaken from this point of view.

Conceptual Framework for Natural Resource Management in Mountain Environments

Words such as environment or natural resource management, in spite of their widespread use, suffer from a lack of conceptual clarity. In a very broad sense, one can describe 'natural resource management' as a method for calculated institutional intervention in the process of both using and conserving these resources, based on updated environmental knowledge. The problems become more complex in the case of mountain environments, due to specific characteristics that have not been systematically analysed. Accordingly, natural resource management in the mountain environments cannot, at present, be a fully prescriptive guide to human activities. It is the accumulation of knowledge from various mountain areas and their several resource strategies that will provide the background for a more comprehensive prescriptive tool in future.

A comprehensive strategy for natural resource management in mountain environments might be based on a holistic and interdisciplinary understanding of both society and habitat within a dynamic framework. The intellectual challenge lies in the fact that the existing knowledge is evolving within specialised disciplines, or even sub-disciplines, while their application should necessarily be holistic and interdisciplinary. The various dimensions of the intellectual challenge, in the evolution of such management strategies for the mountain environments, can be classified as a search for the following types of specific parameters and the characteristics within them :

- specific socioeconomic parameters,
- specific environmental parameters,
- specific integrational parameters.

The framework within which human societies have evolved in the mountain environments has several peculiarities. Due to their relative isolation, limited accessibility, and low level of interaction with the societies in the plains, mountain societies have evolved in a different manner. To many, at the superficial level, these mountain societies appear to be stagnant. Yet, the reality is that most mountain societies have a long history of evolution and change that has no written records. It is necessary to understand the specific human and natural resource contexts of these evolutions.

Against the background of the isolated settlements in the mountains, each area has evolved specific socioeconomic parameters. These parameters are normally rooted in the specific environmental parameters of the mountain areas, because to a large extent they influence the socioeconomic organisations pursued by these societies. Developing further along the lines of the analysis presented by Jodha (1989), the environmental characteristics of the mountain areas can largely be understood through the orographic features, which lead to changes in altitude and variations in rainfall. The altitude and rainfall provide micro-conditions for vegetational as well as agro-climatic characteristics of the mountain areas. On a macro-scale this provides the basis for the rich genetic diversity of the mountains. In a geologically young and unconsolidated mountain range such as the Himalayas, the question of geological instability as another important ecosystemic characteristic

becomes an important element in natural resource management.

The environmental parameters, over thousands of years, have interacted with the socioeconomic parameters in the mountains. Specific climatic advantages of rainfall or cool environment have led to the growth of temperate forests that can appeal to the twentieth century tourist economy. They can also provide a basis that has agro-climatic advantages for the production of fruits and vegetables that have commercial value and can be sold to markets in the plains. The production of apples, potatoes, etc. in the mountains can be taken as an example. On the other hand, orographic characteristics can lead also to difficulties in transportation, thus limiting the potential for marketing these fruits and vegetables at various times of the year. A comprehensive and minute understanding of these specific parameters becomes, therefore, an essential factor in the planning of mountain development and the analysis of mountain transformations.

This leads us to the third set of specific parameters, the integrational parameters essential for evolving a scientific approach to the formulation of a holistic natural resource management strategy for mountain environments. Unfortunately, while the need for integration at the conceptual level has been repeatedly articulated, clearcut identification of the nature of this integration has been conspicuous by its absence. Looking into the most important needs for the integration of natural resource management in mountain environments, at least three levels of integrational need can be classified. They are as follows:

- Integration at the disciplinal level,
- Integration at the geophysical level,
- Integration at the institutional level.

Integration at the **disciplinal level** poses the major intellectual challenge of internalising and utilising the progress made in current scientific disciplines to make natural resource management decisions based on interdisciplinary ecosystemic understanding. This leaves tremendous scope for drawing upon developments in the most advanced areas of the disciplinary sciences, such as atmospheric physics, sedimentology, hydrogeology, plant ecology, soil chemistry, and for the evolvment of decisions based on these disciplines. In terms of its

functional role, natural resource management has several broader spheres of intervention such as environmental policy analysis and innovation, management of research in ecological sciences, monitoring of resource processes and endowments, continuous clarification of the concept of sustainability etc. Sometimes independently, sometimes as a result of some discipline based reasons, minute but significant changes are continuously taking place in these interdisciplinary areas that make natural resource management a continuously evolving concept. (Bandyopadhyay and Shiva, 1985; WCED, 1987; Sachs, 1988). Integration at the disciplinary level plays the central role in this evolution.

Integration at the **geophysical level** is no less a fascinating problem. While every micro-watershed in a mountain environment is, to a large extent, a unique ecosystem on a small scale, it is also necessary to look at the whole river basin as a hydrological ecosystem on a large scale, spanning as it does from the upland watersheds to the plains, to the estuaries and the delta. The integration of the diverse ecological situations in various parts of the basin is important. This is because it not only contributes to the total understanding of geophysical processes, such as floods and sedimentation, but because it provides also an additional perspective to the human geography of urban growth, transportation, migration, and industrialisation. The issues of natural resource management in the mountain environments, therefore, can be analysed in the perspective of an evolving and integrated understanding of a river basin of which the uplands are integral parts.

Integration at the **institutional level** is the third level of integration, and it is vital for the execution of natural resource management strategies. While some serious attention has gone into the first two forms of integration (di Castri et al., 1980), the research on institutional innovations that is needed for more informed natural resource management, especially in the mountain environments, is still in an embryonic stage. The situation demands the conceptual linking of the people, the indigenous institutions at the micro level, the scientists, the scholars, the decision makers, and the formal institutions at the macro level.

Unlike the other two levels of integration, which are more or less intellectual challenges, institutional

integration is a programmatic challenge. The evolution of this process has been restrained by the existing institutions and power structures that oppose the change for obvious reasons. Most integrated development programmes in the Himalaya can be cited as examples. Integration at the institutional level is not a question of mechanically adding two existing departments and making one - or bundling two individual project objectives within one programme. Institutional integration is a practical process, the chemistry of which is governed by a clear understanding of the other two forms of integration mentioned earlier.

These specific parameters and the characteristics within them, together with the three levels of integration, will be used as an elementary framework to review and analyse the experiences of natural resource management in the Doon Valley. In this form it will be identified as integrated environmental management. While in no way is such a framework a comprehensive one, a beginning has to be made, because, in the absence of any framework at all, natural resource management in the mountain environments becomes an extremely uncertain field (Thompson and Warburton, 1985). Summing up the current state of the art, Ives and Messerli (1989) stress the need for further systematic analysis in order to arrive at better scientific understanding and better management of the mountain areas. The main objective of the present study is to review and analyse the experiences in the Doon Valley, in order to enable this evolving framework to guide natural resource management in the mountain environments in general, and urbanised valleys in particular.

Objectives of the Case Study on Doon Valley

With the above objective in mind, the present review and analysis of the experiences in the Doon Valley was undertaken. There are several very important reasons for selecting the Doon Valley for this. The Doon Valley represents an administrative unit called *tehsil* (county) that almost completely overlaps the watershed boundary of the area. This avoids a fundamental difficulty that is always faced in administering an area of environmental sensitivity. The Doon Valley also represents, in the most recent form, the demographic and socioeconomic trends of urban-industrial growth in the valley areas at the foot of the Himalaya. As a result, this valley has evolved as the

most important centre for economic activities in the whole of the mountainous administrative region of Garhwal Division, which is comprised of five hill districts of the Indian State of Uttar Pradesh, namely Dehradun, Uttarkashi, Tehri, Garhwal and Chamoli.

The next important speciality of the Doon Valley is that there is a long, and recorded, history of natural resource management by the formal departments. This new institutional framework started with the establishment of British rule over the valley. At the same time indigenous and informal institutions continued to function collaterally, although in a more subdued form compared to those in more remote hill areas. From the early parts of the 19th century, when the British arrived, to date, there has been a long and well-documented departmental history of natural resource management in the valley that provides us with a very important stock of knowledge for review and analysis.

What probably makes the case of Doon Valley the richest in experiences of natural resource management in the whole of India is the fact that the valley has been the object of an ecosystemic analysis (Bandyopadhyay et al., 1983), and this led to the mobilisation of public opinion. The latter proved to be important, because it culminated in India's first public interest litigation on environment in the Supreme Court of India (Ramamurthy, 1985). The emergence of a responsible environmental movement informed by ecosystems research, and supported by the voluntary participation of the concerned people in activities that shape the future of the valley, provides us with an opportunity for examining and testing administrative innovations that would encourage the participation of these environmental movements in the planning and monitoring of future economic activities.

The Doon Valley has the added advantage of being able to easily attract the attention of senior administrators in the national capital. This is probably because of their close emotional links with the valley where the National Academy of Administration is located. Due to these important and favourable factors, Doon Valley has moved ahead, compared to the rest of India, in facing the main issues of natural resource management, particularly with respect to forests, water resources, mineral resources, and land-use.

The record of the valley in matters related to institutional innovations is no less impressive. Closely following the innovations and trends set by the erstwhile British administrators are the present advisory and executive institutions in Doon Valley. Among the first significant steps taken by the Department of the Environment of the Government of India, following its establishment in 1981, was the formation of the high powered Doon Valley Board. Its purpose is to ensure that economic development activities do not lead to irreparable ecological damages in the valley's ecosystem. The State Government has also risen to the occasion by establishing the Doon Valley Special Area Development Authority, and a Master Plan has been made to internalize environmental expertise in the management of natural resources.

The present review and analysis of natural resource management is made against this background. It is an attempt to examine and understand the issues involved within the matrix of several thematic and sectoral dimensions. The three main thematic dimensions are:

- economic history of natural resource utilisation and management,
- evolution of ecosystemic knowledge and institutions for natural resource management,
- growth of an ecologically informed public, legal, and administrative action;

and the four main sectoral dimensions are:

- management of forests and wildlife,
- management of water resources,
- management of surface quarrying,
- management of urban-industrial growth.

In view of the history of more than a century of discovery and management of natural resources, the review and analysis will be initiated on a sectoral basis. For example, the question of forests and wildlife management will be analysed from ecological perspectives, the pressure from users, afforestation strategies, monitoring of the quality and extent of forest ecosystems, and the question of wildlife protection and conservation. In the same manner, in the case of water resource management, the study will analyse the increasing pressure on the water resources in the valley,

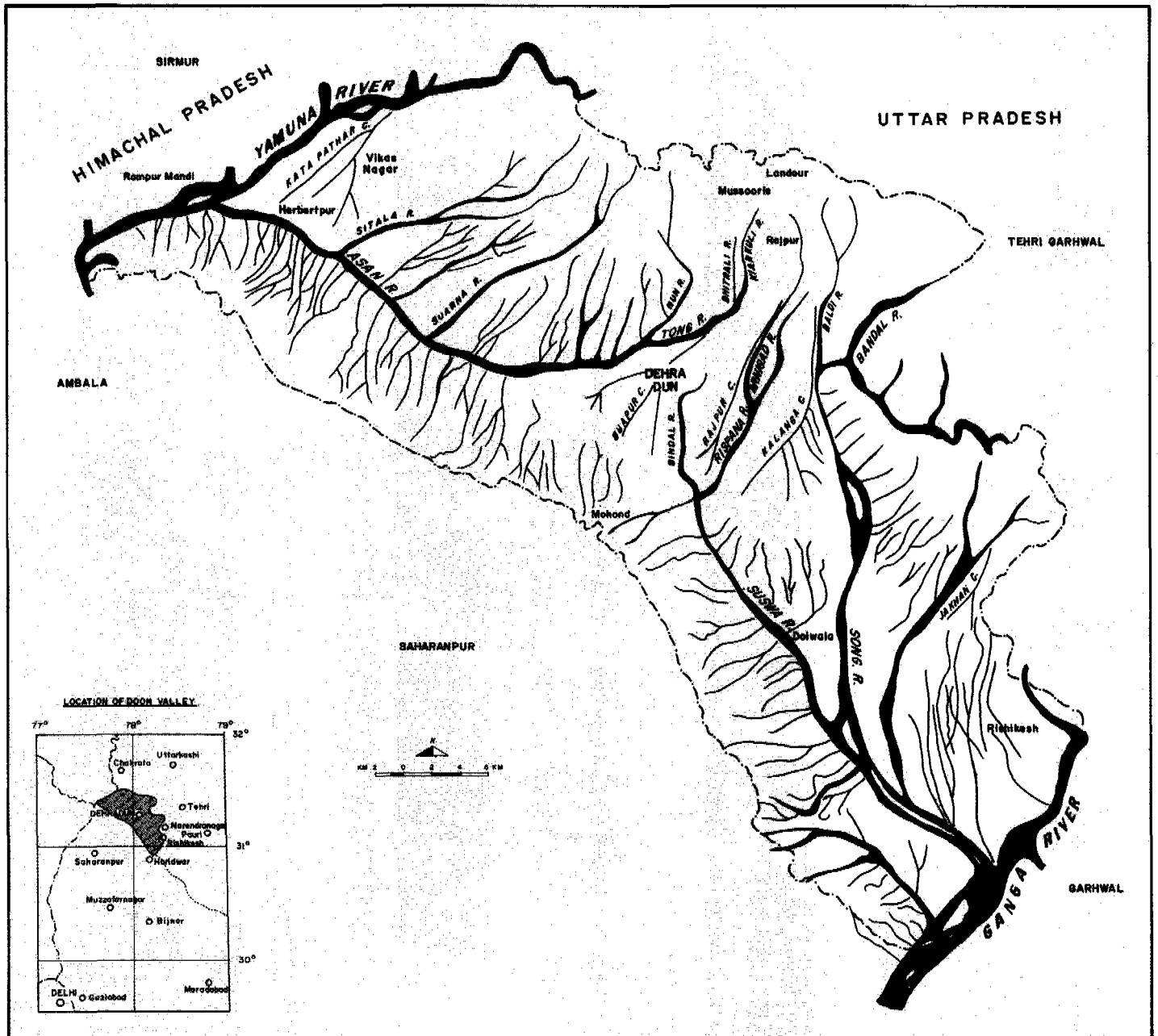
the institutional framework for their transportation, and distribution. It will also examine the challenge of the enhanced understanding of the hydrology of the valley, in terms of the possibility of sustaining higher levels of lean season supply, with a view to satisfying the increasing requirement of the urban, industrial and rural sectors.

Two specific elements in the case of Doon Valley, that add to its importance, are the issues of the management of the surface quarrying of limestone and the management of urban-industrial growth. Both these issues have generated highly informed public protests and legal actions. The public interest litigation has also created a new trend in environmental litigation and has strongly influenced research on law and natural resources in India (Bhagwati, 1988).

The last part of the review and analysis will try to understand the prospect of an ecologically sensitive and a socially equitable ecosystemic approach to natural resource management in the Doon Valley. The study will examine these important innovations and their effectiveness in terms of encouraging management with environmental responsibility.

Most of the factors for such a review and analysis are favourable in the case of Doon Valley. The store of departmental and disciplinary knowledge is extremely large. The possibilities, that now exist in the valley, of using the legal and administrative opportunities for natural resource management largely depend on the possibility of generating interdisciplinary, ecological knowledge from the above-mentioned store. This problem is not unique to the Doon Valley, but in the present context Doon Valley is one of the most convenient areas for the evolution and utilisation of such knowledge. This is more so because, in the valley, there are a large number of insititutions dealing with natural resources. Informed and responsible people's environmental action groups, whose commitments have been tested through years of sustained action, have successfully collaborated with these organisations. This rich multi-dimensional experience of natural resource management in the Doon Valley, therefore, provides a very useful backdrop for the search for a future management oriented strategy for integrated development in the mountains in general, and the rapidly urbanising valley areas in particular.

FIG. I
CASE STUDY - DOON VALLEY
WATER DRAINAGE SYSTEM



II. The Doon Valley

Geography of the Doon Valley

The word Doon represents the bouldery valley that runs parallel to and between the lesser Himalayan range and the Shivalik range. The area commonly known as Doon Valley is a small portion of this geological formation, located between the rivers Yamuna and Ganga, at the north-western limit of the state of Uttar Pradesh and adjoining the state of Himachal Pradesh in India (Fig.1, page 6). It should be mentioned that through common usage two separate spellings have emerged for the name of the valley, e.g. Doon and Dun. The official records in the settlement report written by Daniell (1867) use the spelling Doon, but the settlement report of Baker (1886) uses the spelling Dun, indicating a change somewhere in between. As of now, administrative names, like those of the district, tehsil, or the city, have the spelling Dun, while the valley is commonly identified with the spelling Doon. Accordingly, in this case study, "Dun" will be used to identify the administrative units and "Doon" to identify the geographical unit of the valley. In the same way, of the various spellings of the two rivers bordering the valley, the spellings Ganga and Yamuna will be followed.

The Lesser Himalayan Range, which forms the northeastern boundary of the valley, is part of the Great Himalayan ranges, while the Shivalik range, forming the southwestern boundary of the valley, is a younger formation of debris swept from these mountain ranges. The continuous accumulation of debris resulted in a gentle slope of the Shivaliks towards the Himalayan ranges and in turn formed a longitudinal shallow valley that is higher than the great plains immediately to the south of the Shivaliks. (Fig. 2 Page 8). These valleys are called "Doons" and are often cut by streams that drain the interior mountains. In some places the Doons disappear with the merging of the Shivaliks and the Lesser Himalaya. Because of the elevation of the Doons, and the short distance over which the drainage from the upper parts of the valley meets the water courses in the plains, the landscape is

characterised by deep gorges and gullies that cut through the unconsolidated strata that form the floors of these valleys.

The Shivalik range belongs to a tertiary belt consisting of conglomerates interbedded with sandstones. This belt meets the older pre-Tertiary Himalayan belt at the main boundary fault, and this is a major tectonic feature of the area. The area has recorded tectonic movements of about 2 cm per year. The rocks in this dislocation zone are thus fractured, crushed, and weakened. Much of the ecological instability of the Doon Valley may be attributed to this inherent geological weakness.

On the basis of rock and soil types the valley can be divided into three distinct belts, the Lesser Himalayan belt, the Doon proper, and the Shivalik belt. At the base, the Himalayan belt consists of high grade limestones and shales, and these change gradually into dolomite covered by a shallow layer of topsoil. The Doon Valley proper is covered by unstratified mixed pebbles and boulders with very little matrix. The Doon gravels of the Pleistocene age are covered by a thin mantle of soil, except in the river beds. These gravels are highly pervious and form a poor underground water reservoir. The boulder bed of the drainage channels provides the underground course for most streams originating in the Himalayas. Many of these disappear deep into the boulder bed for long stretches and reappear near the edges of the plateau where they find impermeable clay formations. The natural abundance of water in the valley, particularly in the eastern part, is described in the settlement report of Baker (1886) as follows:

At present the eastern Doon is a vast natural reservoir or feeder of the Ganga. The forests are intercepted with running streams rising from innumerable springs in every direction and the ground is literally oozing with water. The volume of water poured into the Ganga by the Suswa and Song is immense.

An almost straightline from Mohand pass to Dehradun, onwards to Rajpur and Landour, divides the valley into the two sub-water sheds, one draining eastward into the Ganga and the other westward into the Yamuna (Fig.1 Page 6). Except for a small portion at the north-eastern extremity of the Doon Valley the whole area forms one administrative unit, the Dehradun *tehsil*. Accordingly, for all practical purposes, in this study, as well as for reasons of convenience in comparison, the ecological limits of the Doon Valley will be equated with the administrative boundary of Dehradun *tehsil*.

In terms of its economic importance, the Dehradun *tehsil* is the foremost area in the whole of Garhwal division. This is because cities and settlements such as Dehradun, Mussoorie, Vikasnagar, and Rishikesh are situated there. Dehradun is the largest urban area in the Himalayan foothills of India and has emerged as a major centre for trade and, of late, also for industry. Mussoorie is the largest hill station in the State of Uttar Pradesh and it attracts about a million tourists a year. Rishikesh, on the river Ganga, is an ancient centre of religious and philosophical learning. It is also the main entry point by

road to the whole of the Garhwal division. Large numbers of pilgrims, from all over the world, use Rishikesh as the starting point for visiting the famous temples of Yamunotri, Gangotri, Kedarnath, and Badrinath.

The most important physiographical feature of the Doon Valley is the sharp rise in the Himalayan range, locally known as Mussoorie hill, which commences from about 1000m. at Rajpur and reaches about 2400m. at Landour (Fig 2 Page 8). This results in a significant hindrance to the movement of the monsoon wind resulting in heavy rainfall in the valley. About 85 percent of the total rainfall comes from the summer monsoon. The average annual rainfall in Dehradun is about 2200 mm and in Rajpur and Mussoorie it is even higher. The heavy rainfall is drained eastwards by the Song-Suswa river system and westwards by the Tons-Asan river system. The Song-Suswa is joined by large Himalayan streams such as Bindal, Rispana, Jakhan etc., and the Asan by the Tons, Suarna, Sitala etc. (Fig.1 Page 6). Small seasonal streams from the Shivaliks, which meet the two main drainage channels, are dry during most of the year.

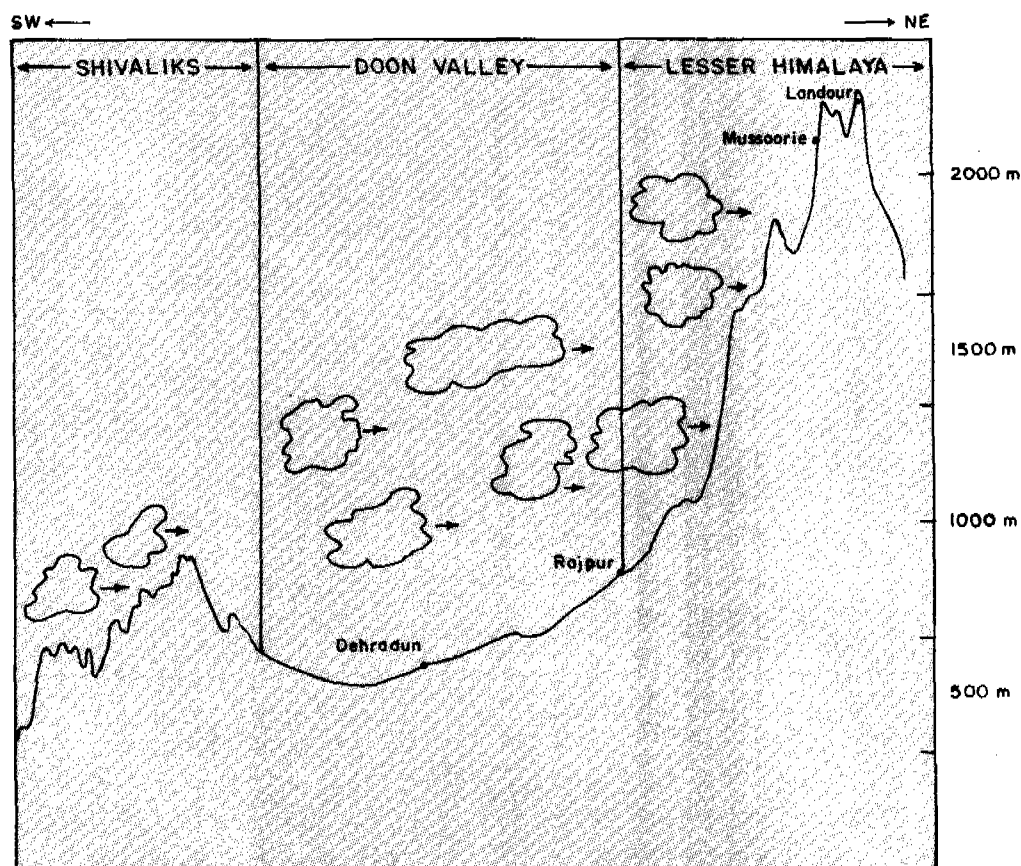


Fig. 2. Schematic Cross-section at right angles to the Doon Valley and the movement of monsoon clouds (based on Munn et al. 1986)

The absence of water on the surface is characteristic of most rivers in the Doon. This is because the water conveniently sinks into the depths of loose boulders and shingle, and then reappears at the bottom of the valley where an impermeable band of clay comes up near the surface. The abundant rainfall and the existence of numerous springs and streams provide the basis for rich biomass productivity as well as a foundation for the valley's scenic beauty. The rich vegetation cover, moreover, contributes to the effective management of the heavy rainfall and the enhancement of groundwater recharge. The quick variation in height (and hence climate) and the abundant rainfall in the northern part of the Doon Valley has created suitable conditions for a great genetic diversity in its flora.

The abundance of water and the rich vegetative cover have induced many visitors to praise the beauty of the valley. Commenting on it Baker (1886) wrote:

The praise indeed is well merited, but its liberal bestowal, to some extent, is perhaps due to the many splendid views which every visitor sees on his way from the vantage points afforded by the hills and mountains by which it is enclosed.... At almost every turn and winding of the steep hill-road leading from Rajpur to Mussoorie fresh beauties of scenery disclose themselves, as a wider and wider view of the valley is gradually obtained. When the summit is reached, many of the houses in Mussoorie and Landour, as well as some of the principal roads, including the Mall, command views of the Dun which can hardly be surpassed in any country of the world.

The rich vegetation cover is predominant in the foothills and the Shivalik hills. Parts of the southern slope of the Mussoorie hill are also covered with rich forests. The frequent changes, within small spatial limits, in the hydrogeological and meteorological conditions of the valley, have provided conditions for the growth of various types of forest cover such as:

- North Indian tropical moist deciduous,
- Tropical freshwater swamps,
- North Indian tropical dry deciduous,
- Sub-tropical pine forests,
- Himalayan moist temperate forests.

The lowest slopes of the Shivaliks, where there is a large proportion of clay and better drainage, provide the best soil for the growth of sal trees (*Shorea robusta*), the predominant forest species in the area. Sal and its associates, forming the northern tropical moist and dry deciduous communities, occur throughout the Shivaliks across large tracts of the valley and also along the lower foothills of the Himalayas. The main species is sal, with associates such as Bakli (*Anogeissus latifolia*), Sain (*Terminalia tomentosa*), Haldu (*Adina grandis*), Bchera (*Terminalia belerica*), Jhingan (*Lannea coromodelica*), Kharpat (*Garuga pinnata*), Dhauri (*Lagerstromia parviflora*), Padal (*Stereospermum suaveolens*), Safed siris (*Albizia procera*), Tun (*Cedreale Toona*), etc. The underwood is light, often absent. It consists of Rohini (*Mallotus philippinensis*), Amaltas (*Cassia Fistula*), Sandan (*Ougeinia dalbergioides*), Pipal (*Ficus religiosa*), Chamaror (*Ehretia laevis*), Aonla (*Embllica officinalis*), Kachnar (*Bauhinia variagata*), etc. The undergrowth consists of Karaunda (*Carisee opacca*), Gandhela (*Murraya Koenigii*), Bindu (*Colebrookia oppositifolia*), and the grasses consist of Gorla (*Chrysoogeon talvus*), Kumeria (*Heteropogon contortus*), Baib (*Eulaliopsis binata*), etc.

The soil and climate of the Himalayan belt support subtropical and moist temperate forests of Chir pine (*Pinus roxburghii*), Burans (*Rhododendron arboreum*), Oak (*Quercus incana*), Kilmore (*Berberis spp*), Dhaura (*Woodfordia fruticosa*), Hinselu (*Rubus ellipticus*) etc. The low lying and marshy areas support forests of Cane (*Calamum tenuis*), Gular (*Ficus glomerata*) Gutel (*Trewi anudiflora*), Tun (*Cedrela toona*), Kala Tendu (*Dyospyros pregrina*), etc. (Fernandez, 1887, Bhola, 1923, Champion, 1932, Sen, 1940, Kubernath, 1958, Mishra, 1968, Singh, 1980).

The valley, thus, has a great potential for forests, particularly in the lower parts. One can clearly visualise Doon Valley as it must have been in the past, covered by dense forests interspersed with swampy grasslands, a situation that must have prevailed several centuries ago. The transformation of the Doon Valley from sparsely populated dense forests and flowing streams to its current state, characterised by a resident population of about 600,000, fast expanding urban-industrial areas and quick disappearance of water, needs a detailed step by step historical description of the growth of human economic

activities in the valley and resultant interventions in its rich natural resource base. Current problems of natural resource management are often ecologically rooted in resource management practices in the distant past. For a complete perspective on the current problems, it is necessary to understand the evolution of both formal and informal management trends for natural resources in the past. In the following section an attempt will be made to present a short temporal account of the growth of human economic activities. It will then be related to the current issues for environmental management against the background of the dynamic socioeconomic changes in the valley, particularly over the last century, which constituted a period of appreciable human economic activities.

Economic History

Early records of human economic activities in the valley are scanty. The famous Chinese scholar-traveller, Hwen Thsang, visited areas near the Doon Valley during 635 A.D. but there is no mention of the valley in his writings. This would indicate that there were few human economic activities in this area at that time. The township of Rishikesh, at the Eastern extremity of the valley, was the gateway to the pilgrim centres in the interior of Garhwal for people coming from the great plains of the south. The famous stone at Kalsi, a town on the bank of the Yamuna at the western extremity of the valley, is inscribed with an edict of Emperor Ashoka indicating important human movement along the Yamuna. Doon Valley proper, in between these two important rivers, was relatively less known or frequented. Generally, the valley was not inhabited to any considerable extent. The earliest settlements were on the southern slopes of the Mussoorie hill. The area was governed by the king of Garhwal but, due to its distance from the capital of the kingdom, it probably didn't get much attention. It is mentioned that among the earliest settlers in the lower parts of the valley were a group of Banjara tribes, people who came from the drier west in the eleventh century and, struck by the lush green forests of the valley, settled on the spot.

The present name of the township of Dehradun owes its origin to the Sikh Guru, Ram Rae, a lineal descendant of Guru Nanak. In his younger days he was taken hostage to the Delhi court of the Mughal Emperor, Aurangzeb, where he became a favorite of the Emperor.

In 1699, on being recommended by the Emperor to Fateh Sah, the King of Garhwal, he finally decided to settle in the tranquil Doon Valley. The king, in turn, gifted three villages to the saint who established a "dehra" or small religious settlement. The saint soon attracted a number of devotees who started settling around the "dehra" and the village sprang up. The rich natural resource endowment led to the flourishing of agriculture in the valley. Soon after the arrival of Guru Ram Rae, Fateh Sah expired and was succeeded by his infant grandson, Pratap Sah. After about 5 decades of continued prosperity under Pratap Sah, the valley attracted the attention of Najib-ud-doulah, the Governor of neighboring Saharanpur, who, encountering little resistance, occupied the valley in 1757 with the help of a Rohilla army. Under the enlightened and benevolent rule of Najib, the valley further attained an unexampled degree of wealth and prosperity, especially with the introduction of an irrigation system by the use of small canals. Mango gardens were established and large scale horticultural production introduced. The mango trees still stand today amid apparently primaevial forest. The death of Najib in 1770 put a sudden stop to this growth of a prosperous agricultural economy in the Doon Valley.

Thenceforth, the people of the Doon Valley faced continuous invasions from the Rajputs, Gujars, Sikhs, and Gorkhas that soon turned the fertile land into an almost depopulated barren waste. The area was ceded to the Marahattas in 1780 and passed from hand to hand until it was recovered by the Garhwal King in 1788. In February, 1803, Umr Singh Thapa and Hustee Dhul Chautra of Nepal attacked Srinagar, the capital of Garhwal, and in October 1803 the Doon Valley also was occupied by the Gorkhas.

Under the rule of the Gorkhas the Doon almost became a desert, because most of the inhabitants migrated out and this led to depopulation. Under the strict fiscal arrangement of the Gorkha rulers, slavery increased in this once prosperous valley, because every defaulter was condemned to lifelong bondage. Soon the Gorkha rulers occupied more territory further westwards and, crossing the Yamuna, their invasion continued up to the Sulej. This expansion drew the serious attention of the other military power, the British, who occupied bordering Saharanpur about the same time. Constant Gorkha aggression against the British occupied areas led

to the war of 1814 in which the Gorkhas were defeated. With the defeat and retreat of the Gorkhas, Dehradun was annexed to the district of Saharanpur in British India and a completely new phase started in the history of the Doon Valley. Consequently the nature of human settlement and management of natural resources in the valley underwent rapid changes of unprecedented magnitude and significance.

Impact of the British Annexation

The annexation of the Doon Valley by the British changed the socioeconomic dynamics of the valley in many fundamental ways. Immediately after the British victory in the Gorkha war, a Government resolution of November 17, 1815, ordered the annexation of the newly occupied area of the Doon Valley to the district of Saharanpur, and the Gorkhas formally ceded the area by a treaty signed a few months later. In 1825 the area was transferred to the jurisdiction of the Commissioner of Kumaon. This, however, was a temporary arrangement and in 1829 it was placed under the Commissioner of the Meerut Division. In 1871, after a series of administrative changes, the Doon was given district status. Almost a century later the district of Dehradun was brought back full circle to the Garhwal Division. An important element of the British administration in the Doon Valley was marked by the painstaking documentation of settlement and assessment reports, the production of maps, and quantified planning for natural resource management. Baker (1886) gives an account of this socioeconomic change introduced by the British in the following words:

Under the energy and perseverance of its first English officials the Dun rapidly recovered its prosperity. Roads and canals were constructed, cultivation spread over the waste lands, and the people themselves, awaking from their previous apathy, began to acquire habits of industry and self-reliance.

In 1816, almost within a year of gaining control, an assessment was undertaken, and this was followed by the settlements of 1820 and 1825, on the lines of *zamindari* (landlords') arrangements. The arrangement was changed to a *ryotwari* (cultivating proprietors) system in the settlements, of 1830 and 1840. There was a great deal of difficulty in following the new *ryotwari* system.

Consequently, in the revised settlement of 1845, much of the *zamindari* system was reintroduced. A 20 year settlement was undertaken by Daniell in 1867, with the help of better maps drawn by the survey department.

The British administration improved and systematized the internal management process of the valley. More important, they established transportation links connecting the valley with the larger economy of the plains south of the Shivaliks.

Following the end of fighting and anarchy, the population of the valley showed a remarkable increase. This was because of older residents deciding to return to the valley and new people wanting to move in. This re-established the activity and prosperity that had existed in the first half of the 18th century. A rough census taken immediately after the British victory put the population of the valley at 17,000. In 1823 it rose to 20,179, in 1847 to 32,083, and in 1865 to 66,299 (excluding Mussoorie). In 1881 the population stood at 98,953, in 1891 it rose to 1,17,438, and in 1901 it was recorded at 1,27,094, an increase of about 650 p.c. in just 75 years.

This increase in population was the result of a sudden spurt in the valley's economic activities. The most important socioeconomic effects of the British entry were the establishment of road and railway connections with the plains, reservation of forests for management, quick changes in land use, improved water distribution by the canals, beginning of a tourist economy in Mussoorie and, at later stages, establishment of important offices, institutions, and schools in Mussoorie and Dehradun. All these set the trend for urbanisation and environmental changes of great importance. Accounts of these provide useful historical perspectives within which to examine the current environmental problems of the valley. These problems will be analysed in detail in the remainder of this case study.

Immediately following the British annexation, Mussoorie became an attractive spot as a sanatorium, and the calm of Dehradun attracted pensioners, mainly of European origin. The first house belonging to non-locals in Mussoorie is said to have been a hunting lodge built in 1823 by two English officers. Within no time Mussoorie became popular with the people in the plains, especially after the rail and road connections to the valley were

established in 1900. Table 1 presents the nature of growth in the two urban centres in the Doon Valley during 1885-1905; the period during which the railway was opened.

The British introduced other fundamental changes such as the draining of swamps and clearing of forest cover for settlements. These were mainly handed over to Europeans as land grants for farming. The first grants were made in 1838 when about 48,000 acres of land were given away. The quick opening up of agricultural land was supported by the expansion of the canals under the Irrigation Department. Referring to the benefits of the Doon canals, Baker (1886) was absolutely correct in saying that "the canals are, without doubt, the making of the Doon". His profound statement is still valid after

more than a century. The canals not only increased revenue but encouraged the introduction of high value crops such as Basmati rice, sugarcane, and tea.

An important element of natural resource management techniques, introduced by the British, is the level of quantification in almost all spheres. Considering the inaccessibility of the main parts of the valley, the prevalence of forests with rich populations of wildlife, and the language barrier, the British officers left their juniors with a remarkably rich information base that was very useful for new officers. The summary account of irrigated agriculture in the Doon Valley during 1865-75 is presented in Table 2 as an example of this level of organisation and systematisation achieved by the British more than 125 years ago.

Table 1: Population and Municipal Income at Dehradun and Mussoorie (1885-1905)

Year	Dehradun		Mussoorie	
	Population	M. Income (Rs)	Population	M. Income (Rs)
1885	18,959	15,173	7,662	32,020
1905	34,039	64,447	14,689	126,207
Growth Rate% (20 yrs)	79.5	324.8	91.7	294.2

Source: Dampier (1907):

Table 2: Area Irrigated By Classes and Revenue Income From The Canals (1865-72)

Year	Irrigated Area by Class of Land (Acres)				Revenue Income (Rs)
	1st	2nd	3rd	Total	
1865-66	896	3,467	2,626	6,989	28,995
1866-67	1,815	1,862	5,175	8,852	34,818
1867-68	1,105	2,922	6,667	10,694	38,737
1868-69	677	2,832	10,508	14,017	38,281
1869-70	723	3,130	6,448	10,301	43,112
1871-72	856	3,814	7,522	12,192	43,854

This choice of agricultural expansion as the main thrust for economic growth during British rule is best articulated in a statement by Ross (1848) who wrote that:

nearly 20,000 ha of land, charmingly suited [for] and all capable of yielding a good return, were lying waste for want of labour, capital and enterprise.

Undoubtedly, the early British officers precipitated deforestation through their commitment to agricultural expansion. The resultant environmental loss, that was invisible to the early decision makers, soon became evident. In the 1880s British administrators started questioning the wisdom of agricultural expansion policies. Baker (1886) argued:

Perhaps no mistake was more common in the early days of British rule than to suppose that the extension of cultivation wherever culturable land could be found, and the clearing of forest and jungle to extend cultivation, must necessarily benefit the country and Government, and should be encouraged and 'pushed on as much as possible. It is now fully recognised that every country requires to have a certain proportion of its area under forests, and that in a tropical country like India, where the heat is so intense and the very existence and well-being of the people depend on a regular and sufficient rainfall, this proportion should be even larger than in European countries... The mere extension of cultivation in itself, at the expense of clearing away forest, is a source of weakness rather than gain to the State in a country where the forest area is admittedly too small already. Forests form a great reserve for the people and cattle to fall back on in years of drought. When they are cleared away, not only are the rainfall and the water-supply of the country prejudicially affected, and the chances of drought increased, but the resources of the country are diminished-evils which a few thousand acres more or less of cultivation poorly compensate for.

This statement is one of the first clear articulations of the need for environmental considerations in the management of natural resources in the Doon. Forest felling for the expansion of agriculture came to a halt with the reservation of forests and the nature of environmental changes in the valley took a new turn. Economic activity ceased to be dominated by the timber trade. Slowly the

Valley started growing as an urban area of touristic importance and new institutions and schools flourished. In spite of this growth, the valley did not face any serious environmental problems until the final days of British rule and it maintained its reputation as a quiet area with a salubrious climate and fresh air.

Changes in the Post-colonial Period

The long history of the transformation of the Doon Valley during British rule left an institutional framework for natural resource management in the post-colonial period. Departments such as Forests, Irrigation, Revenue, Public Works, and local administrative units such as the various city boards remained almost unchanged. The economic aspirations of the people of a newly independent country merely enhanced the activities quantitatively. In the case of the Doon Valley, a sudden increase in both population and economic activities came during 1947 when a large number of people migrated into the valley from the newly formed Pakistan. Later, there was an influx of refugees from Tibet who came and settled in the valley in the early 1960s.

In tune with the inexorable logic of urbanisation, a prominent demographic pattern in independent India, Dehradun quickly grew into a densely populated city (Fig.3). This growth took place mainly around institutions and tourism. At a later stage, approximately from 1960 onwards, quarrying of limestone on the northern periphery of the valley, from Mussoorie to Sahasradhara, became important. The urbanisation trend was further encouraged by financial and institutional incentives that were given to new industrial units when the Garhwal area was given an "industrially backward" identity. Industrial growth, thus encouraged during the 1970s, affected the urban environment considerably through pollution, congestion, and the formation of slums. On the other hand, over the years, limestone quarrying resulted in serious environmental degradation. Increasing demands for fresh water from the domestic, industrial, and agricultural sectors conflicted with reduced sustainable water supplies in lean periods. The growth of urban settlements led to increased pressure on the forests for timber and firewood, while the rich wildlife was exposed to added threats from poachers because of easy access into and from the core areas of the sanctuaries and reserved

forests. Today, the problems of natural resource management in the Doon Valley have all the dimensions of the challenges both of a rural mountain area and of the quick and unplanned growth of an urban-industrial complex. This has transformed the one time tranquil pensioners' paradise into a busy and polluted urban centre and strained the natural resource base to its limit.

The total reporting area of the valley is 2130 Km² and of this the urban area covers 156.5 Km². There are one city, two sub-regional towns, 13 market villages, 38 central villages, and 337 basic villages in the valley (Fig. 4). The forest area managed by the forest department is as high as 68 percent and the net sown area is about 19 percent. Recently plans have been made for the conversion of 644 hectares of land into industrial zones. These are to be located in five areas that are a reasonable distance away from the city of Dehradun.

The environmental impacts of the rapid growth of quarrying and urbanisation resulted in public protests and interventions in several important areas of natural resource management. The Doon Valley can be credited with generating a high degree of dynamism in administrative, legal, and research processes. It is within the framework of this dynamic expression of public concern and judicial-administrative interventions that the review and analysis of natural resource management in the Doon Valley will be undertaken. It will be made against the background of the existing disciplinary perspective and then against a foreground of a prospective interdisciplinary one. Initially, attention will be focussed on the historical evolution of environmental problems, both those generated over a long period of time, such as deforestation, and those that occurred more rapidly such as industrial pollution. Based on disciplinary reviews and a review of institutional responses to the problems, an attempt will be made to outline a viable plan for integrated ecosystems management.

Fig. 3 : Population of Dehradun Municipality Tehsil and District in the Current Century

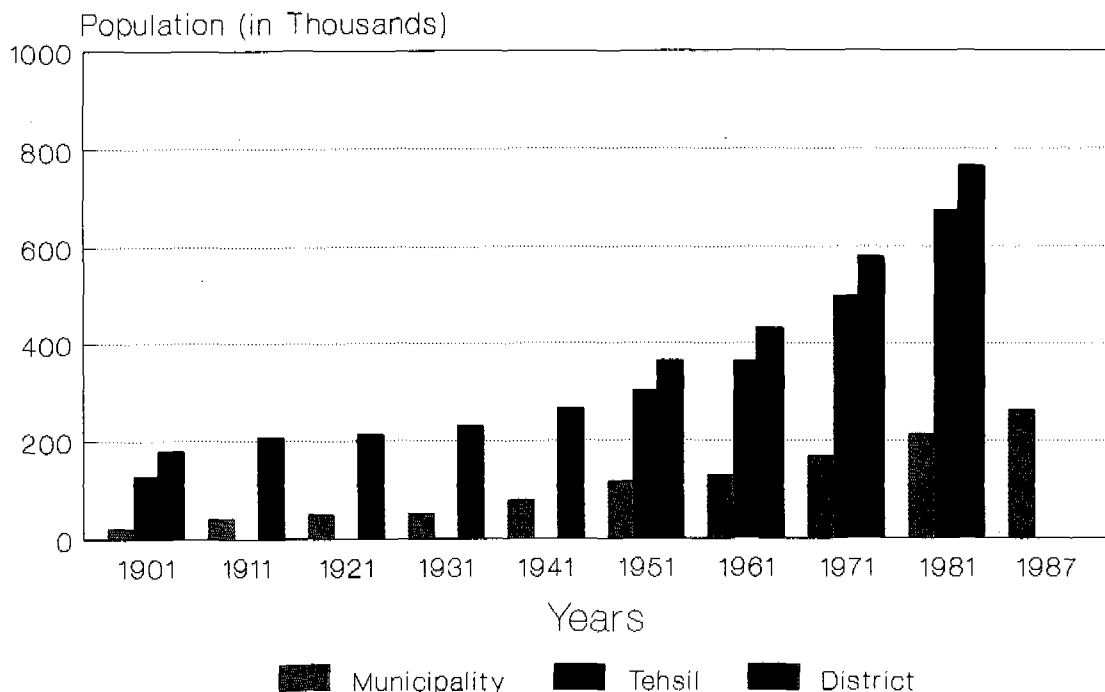
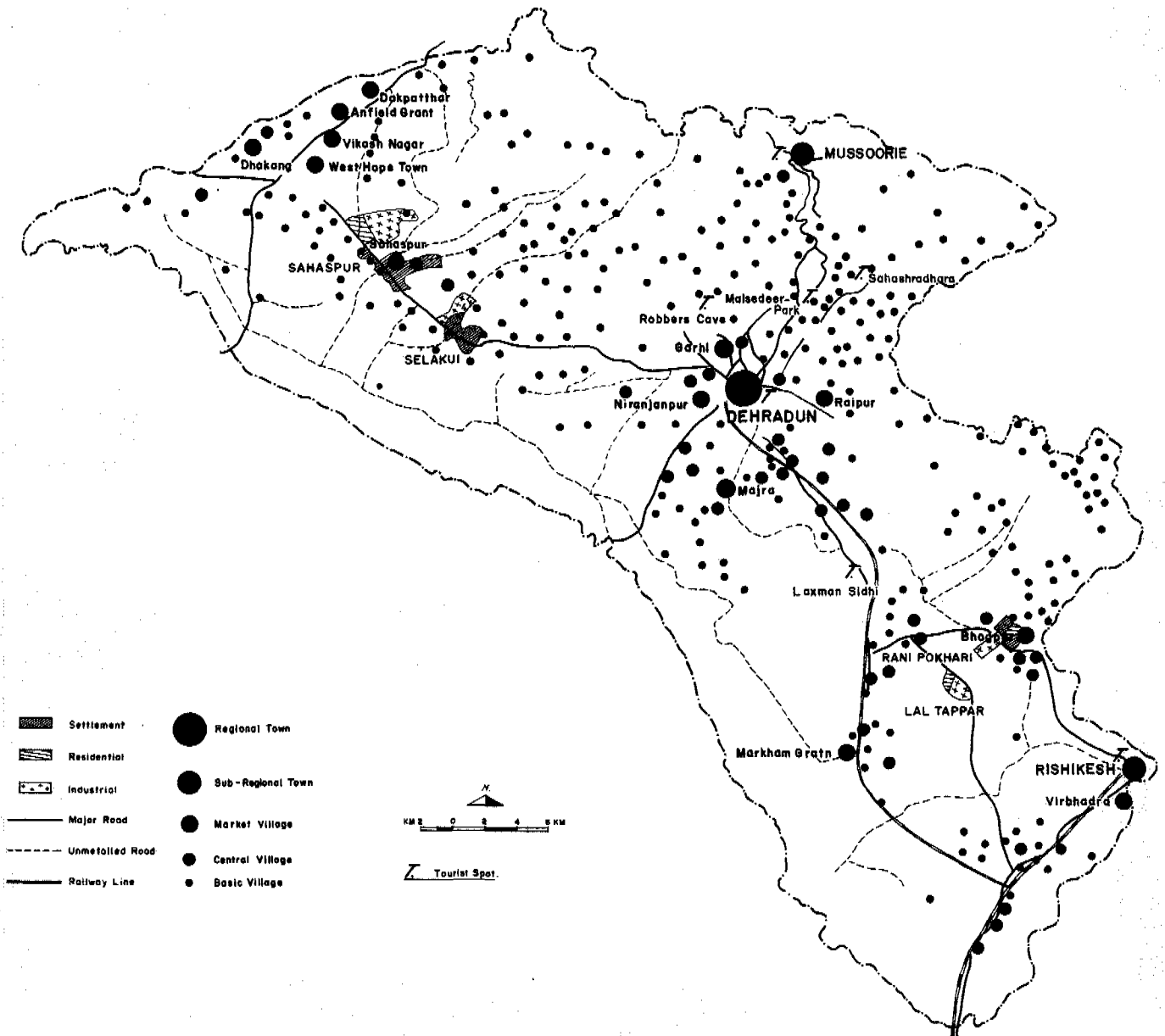


FIG. 4
CASE STUDY – DOON VALLEY
EXISTING HIERARCHY OF SETTLEMENTS
(based on Anon, 1988b)



III. Management of Forests and Wildlife

From the various written accounts of the forest cover in the Doon Valley, it is obvious that the valley was endowed with a rich forest cover. The limited domestic requirements of the sparse population for forest products was easily satisfied without any serious degradation. This rich forest cover motivated both the Garhwal kings and the Gorkha occupants to initiate fellings to sell timber in the growing markets outside the valley.

The stability and richness of any forest ecosystem is reflected in the richness of both its flora and fauna. Similarly, the hydrological stability of the forests is reflected in the aquatic fauna in the streams and rivers. The following description by Baker (1886) amply describes the richness of the forests and the early symptoms of decay:

The Doon is singularly rich in both animal and vegetable life. Wild elephants abound at certain seasons of the year in the Siwaliks, which are also a favourite haunt of tigers, panthers, bears, leopards, and hyenas. Sambhar, chital or spotted deer, four-horned deer (chau-singha), barking-deer (khakur), hog-deer (parha) used to be found in almost incredible numbers, but have much diminished of late years. Wild pigs swarm in the forests, as also monkeys and langurs. Porcupines are common, and several kinds of wild cats..... The rivers swarm with fish, the chief kind being Ganga mahsir, which in the Ganga and Yamuna attains enormous size, sometimes reaching 90 or 100 lbs. Other kinds are trout, saul, chal, giri, rohu, kalabans, and the gunch or fresh-water shark.....the native authorities enumerate in all twenty-four species of fish, but there are certainly many more.

Institutional Encouragement of Deforestation

The above description is that of a rich forest ecosystem in the initial stages of human intervention. The forest felling system, initiated by the Garhwal kings, was further encouraged when excise duty on timber was

discontinued following the British annexation in 1815. It was, however, reintroduced in 1819 and this resulted in an annual revenue earning of about Rs. 4,000. The forests were considered from then onwards to be a source of considerable revenue. Five years later, in 1825, the revenue more than doubled to the figure of Rs. 8500. At this time, the auction system for contracts was introduced to further boost the revenue and it again doubled to Rs. 16,000 in 1830 and by 1833 had gone up to Rs. 25,350. In 1839, the forests were leased to a local contractor and the annual revenue rose to Rs. 33,500, thus increasing the income by a factor of 10 in 20 years. This quick financial gain, however, was not a free lunch because it was paid for by the forests. The picture of the forest degradation that resulted is recorded in the following statement of Williams (1874):

Everyone continued to hack and hew away at the trees as they pleased, only paying certain dues to the farmer, in the event of the wood being exported. The latter made his own arrangements to secure the collections at the different passes. Reckless waste was inevitable, and the fine sal forests began to disappear rapidly. The absence of conservancy was absolute. The district still abounded in fine trees 100 or 200 years old and upwards. All these fell before the axe and probably the rest would have gone with them had the roads been a little better. The consequence of this bad system is most perceptible in Western Doon.... The annual revenue from this source varied from Rs. 80,000 to 100,000, an income dearly purchased, for the destruction was something incalculable.

Surely, the remarkable increase in annual revenue from timber export was dearly purchased. The rapid depletion of timber, resulting from the institutional encouragement of felling, soon became the issue of two major policy debates. The first concerned forest clearing for land grants that encouraged Europeans to come to the Doon Valley and settle down for the purpose of developing agricultural farms. The first nine such land-grants covered an area of about 20,000 ha. The far

reaching effects of this perception of forests as a resource portrayed by this single administrative decision has no parallel in the valley's history. In spite of the fact that the Europeans were gaining from the grants, Baker (1886) did not refrain from arguing against them and in favour of keeping the forest cover intact even from an economic point of view. In his settlement report he wrote:

forests in themselves constituted a property of great value.. There can be no doubt, taking a purely financial view of the matter, that the State parted with its rights in the waste-land grants for a very inadequate return... Had these lands been retained as government forests, far larger sums would have been paid into the treasury on their account... From an economic point of view all forest would probably yield a better return, and forests, not more cultivation... are the great desiderata of the country.

The forests, however, were also unable to sustain the uncontrolled exploitation. The forest department that was established in 1855, mostly remained a revenue collecting body and did not pay any attention to systematic conservancy. The result was obvious when in 1867 forest productivity dwindled and the revenue dropped below Rs. 23,500. Therefore, the strong economic arguments worked in favour of forest conservation. This was finally introduced about 10 years later when reservation of the forests took place following the passing of the Forest Act in 1878.

There was yet another factor operating that led to widespread exploitation of the village forests. This was related to the changing land relations and ownership of the village forests. The village forests were, before the British annexation, managed for local needs' satisfaction by the communities. At the time of the third settlement in 1825 the *zamindari* (landlord) system of land relations was established and this gave the ownership of village forests to the *zamindars*. The arrangement was, however, changed to the *ryotwari* (cultivating proprietors) system at the time of the fourth settlement in 1840. In this way the cultivators, in one fell swoop, became full-blown proprietors of the land and the *zamindars* lost their position. Although from the point of view of ideals and principles the change was good, it did not succeed in practice. In 1845 when a revision of the settlement took place, the

British Government reintroduced the *zamindari* system, and the control of the village forests went back to the *zamindars*. There was, therefore, a reintroduction of a social hierarchy that had not existed for a period of time.

The new inequalities implanted in the region by the British Administration, through the re-introduction of the *zamindari* system, caused rapid deforestation of the village forests. This accounted for over 80,000 acres of forest that had been maintained on a sustainable basis under community control. In this new process the village forests became the property of the *zamindars* of the villages to which they appertained. These *zamindars* became the focus of economic and political power and completely replaced the community organisations and their control over village forests. Thus:

in Malkot ilaqua (region) containing 31 villages the cultivating proprietors lost their power... a disability due to the aggression of the superior sayana (contractor), Surjan Negi, a man of capital and influence (Walton 1911).

Surjan Negi's capital and influence was, in turn, derived from the fact that in 1822 the forests in the valley were farmed out to him. The economic power of the contractor added to the socio-political power of the *zamindar* completely removed the responsibility of the *sayanas* for the sustainable management of common forest resources. Hence, the control of the community was replaced by the control of the *zamindars*, and the *zamindars* were only:

too anxious to make money as fast as possible out of their new acquisitions. In pursuance of this policy they prohibited the tenants from grazing and cutting wood in the village forests and sold the latter to charcoal burners who completely denuded the hillsides (Walton 1911).

Ross (1886) gave a very interesting quantitative picture of the use of the private forests for timber supply and of the mango groves for the supply of packing cases to the tea industry. He reported private timber sales to be about Rs. 750,000 which was more than the entire land revenue of Dehradun tehsil for over two decades.

Management of Reserved Forests

The above picture of the relatively uncontrolled and free felling of trees continued until the beginning of the 1870s. This situation was due to two important management problems. The first was the difficulty of monitoring the forests. It was only during the making of the seventh settlement report (1869) that maps of some professional quality, demarcating forest boundaries to some degree of accuracy, were made available by the Survey Department. This new monitoring ability was invaluable for locating gross encroachments as well as for clearly locating, and accurately levying taxes on, the private forests. The other problem was the institutional limitations to the planned working of the forests to conserve their renewable resources, or at least their timber potential. The Forest Act of 1878 was used to ensure that the reserved forests maintained their revenue potential. It is interesting that no attempt was made to conserve animal life. This was probably because of there being no easy revenue for this other movable forest product. Although conservation of wildlife was generally ignored in the management of reserved forests, Baker (1886), in his settlement report, argued strongly for wildlife conservation:

The whole valley of the Doon forms one of the most splendid natural preserves in the world. Wild animals, and what is termed "game" literally swarmed till within the last decade or so... Allowing indiscriminate shooting as at present operates in regard to animals and game in much the same way as indiscriminate felling on the forests. So long as animals were plentiful slaughter was excessive... European sportsmen, native shikaris, and men of the Gorkha regiment are always in the forest... It is only in Indian Government forests that all are allowed to slay without limit, and that the principle generally acted on is to let nothing escape if possible. I have heard of 20 sambhar stags being shot by a single sportsman in a week, and 70 or 80 chital stags in a fortnight, not many years ago... A good chital stag is now seldom seen. Sambhars are still more rare. Pea-fowl are getting quite scarce, and the black partridge also. At the present rate of destruction there will in a few years be no game left except in the closed forests.

This aspect of environmental management was not, however, of any immediate concern, but in course of time the realisation of the importance of wildlife management led to due recognition with the establishment of the Rajaji National Park. The forest cover of Doon Valley during the time of reservation is given in Fig.5 (page 16). It was published by the Trigonometrical Survey of India in 1887 and in all probability this is the earliest authentic map of the Doon Valley forests notified in the Gazette of February 17, 1879. The reserved forests in the Doon Valley are located all along the north-facing slope of the Shivalik range and some patches are in the Doon proper. The temperate forests on the south-facing slope of the Mussoorie hill may have existed with good ground cover at one time, but the absence of a significant stock of commercially attractive species may account for the lack of interest in their reservation. Consequently these temperate forests dominated by oak (*Quercus incana*) were deforested by heavy lopping to satisfy the fodder requirements of an expanding rural economy.

The Imperial Forest School was established in Dehradun in 1878 to train foresters, throughout the whole of British India, to manage the newly acquired areas of reserved forests. As a result, the Doon Valley forests became its training grounds and the nearly 180,000 acres of reserved forests were brought within its sphere of interest. The first ever working plan for the management of these reserved forests was written by Fernandez (1887) of the Forest School. This fifteen year plan set the trend in forest management and was a prescription for selective regeneration based on the removal of damaged, deformed, and unsound trees resulting from the previously uncontrolled exploitation.

The principle of controlled and selective felling continued to operate, as the only strategy for improving forest stocks, until 1933 when large scale afforestation through plantation was introduced for the first time. In Sen's Working Plan (1942-50) a special plantation working circle was introduced. The system adopted was clear-felling with artificial regeneration. Important plywood species such as semal and tun supplemented by khair and sisoo were to be raised in plantations in response to the demand for timber suitable for the manufacture of plywood and matches. The demand changed in 1962 when the growth of pulp-based

industries led to the propagation of species such as eucalyptus.

The increasing demands of the pulp based industries played a significant role in changing forest resource management. Earlier methods of plantation such as the *Taungia* gave way to newer labour saving processes to simplify management and to reduce exploitation costs, especially in the case of species on short rotation that are suitable for paper pulp, such as *Eucalyptus* (Singh 1980).

The choice of areas for artificial regeneration was not guided by ecological considerations. In the beginning, open patches in the *sal* areas were planted with trials of various species, mostly *sal*, *teak*, and some *bamboo*. Later on, from 1963 onwards, the open miscellaneous forests were used for plantations and this involved little felling of standing trees. Later there were some attempts to replace "uneconomic" species with "economic" ones through clear felling. Historically, therefore, the modern scientific management of forests concerned itself primarily with increasing the yield of species with high market value and demand.

Emergence of Conflicts over Forest Resources

The reservation of the forests, being guided by silvicultural considerations only, instigated important conflicts over villagers' access to the reserved forests. During the early years of conservancy, the forest department denied that villagers had any rights at all to these forests and a conflict arose. The then Superintendent of Doon, H.G. Ross, was called to report on this matter and he took a stand opposite to that of the Forest Department. Citing that the most extensive prescriptive rights of grazing and fuelwood collection had existed from time immemorial, Ross recommended that the villagers "shall have the right",

- to collect headloads of fallen and dry wood,
- to graze a specific number of animals on payment of prescribed rates.

The presentation of Ross led to a long debate on the villagers' access to the reserved forests. The forest department was partly successful in reducing villagers' access to the extent that in so far as the final wording of notification No.702, of July, 1880, stated "villagers shall be

permitted" instead of "shall have the right". It was a privilege for the people and not a right to have these facilities in the reserved forests. The contradiction, not typical of Doon Valley alone but of the whole country, exists even today more than 110 years later, probably in a much more intense form. Over the years the objectives of forest management did not internalise these basic management issues of the biomass needs of the local people. A systematic approach only evolved for the quantification of growing stock and the encouragement of commercially valuable species.

This basic commercial objective of India's forest management, as well as the marginalisation of local needs, was the reason the people of Garhwal started the world-famous forest movement called Chikpo in 1973 (Shiva and Bandyopadhyay, 1988). The impact of this movement was that commercial green felling of the Himalayan forests in Uttar Pradesh, including the Doon forests, was stopped in 1982 for a period of 15 years. Recognition of the ever-increasing biomass needs of the local people has remained marginal in the official working of the forests in Doon. Table 3 (page 20) projects a picture of this commercial bias of forest management by presenting the relative amounts of wood and firewood extracted for commercial and local (free and concessional) requirements during 1959-78. The lack of recognition given to the increasing needs of the local people, both urban and rural, for forest biomass is reflected in the relative proportion of commercial and concessional wood and firewood extracted from the Doon Valley forests.

A more realistic appraisal of the challenges facing forest management in Doon Valley will clearly reveal that over the century there has been a fundamental change in the main use of the forests. How the scene has changed, within a 100 years, under the compulsion of specific situations, becomes evident upon comparison of two statements, one from the first working plan of Fernandez and the other from one of the latest working plans drawn up by Mishra. Referring to local requirements, Fernandez (1887) wrote:

Local requirements are comparatively insignificant, and are to be of great extent met from private forests, the aggregate extent of which is very large. In the Reserved Forests grazing is generally light, and except

within a radius of 10 miles round Dehra and inside a belt of about eight miles along the Ganges, the demand for firewood is insignificant, and even within those areas the supply is far in excess of the demand.

On the other hand Mishra (1968) presented a drastically different picture when he wrote:

Grazing is extremely heavy all over the forests and the pressure is increasing from year to year. The areas neighbouring the habitations are the worst sufferers, having been reduced to a stage of irreversible ruin.... Mornings and evening one can see endless processions of these decrepit cattle all along in the Doon Valley vanishing into the nearest tree line and emerging after an indifferent browsing and grazing in the forest floor. Along with them there is another procession too, even more pathetic than that of the beasts. This is the procession of "head loaders" men, women and children, old and young, firm and infirm, carrying outsize burdens of firewood and fodder down to their villages. The small farmer and the landless labour supplement their income by working in the slack

season with forest contractors, in departmental forest works and by selling headloads of firewood or fodder to the more affluent farmers or to the urban dwellers in the new colonies and settlements. The latter has become a popular and profitable employment with the rise in the costs of firewood and the steep rise in its demand.

Both the above quotations end-up with the same word "demand" but with different connotations. This precisely summarises the changed requirements forest management faced in the Doon Valley over the last 100 years, during which period the basic challenge of management in the forests changed from that of limiting the internal felling process for timber to limiting the external collection of non-timber biomass and grazing.

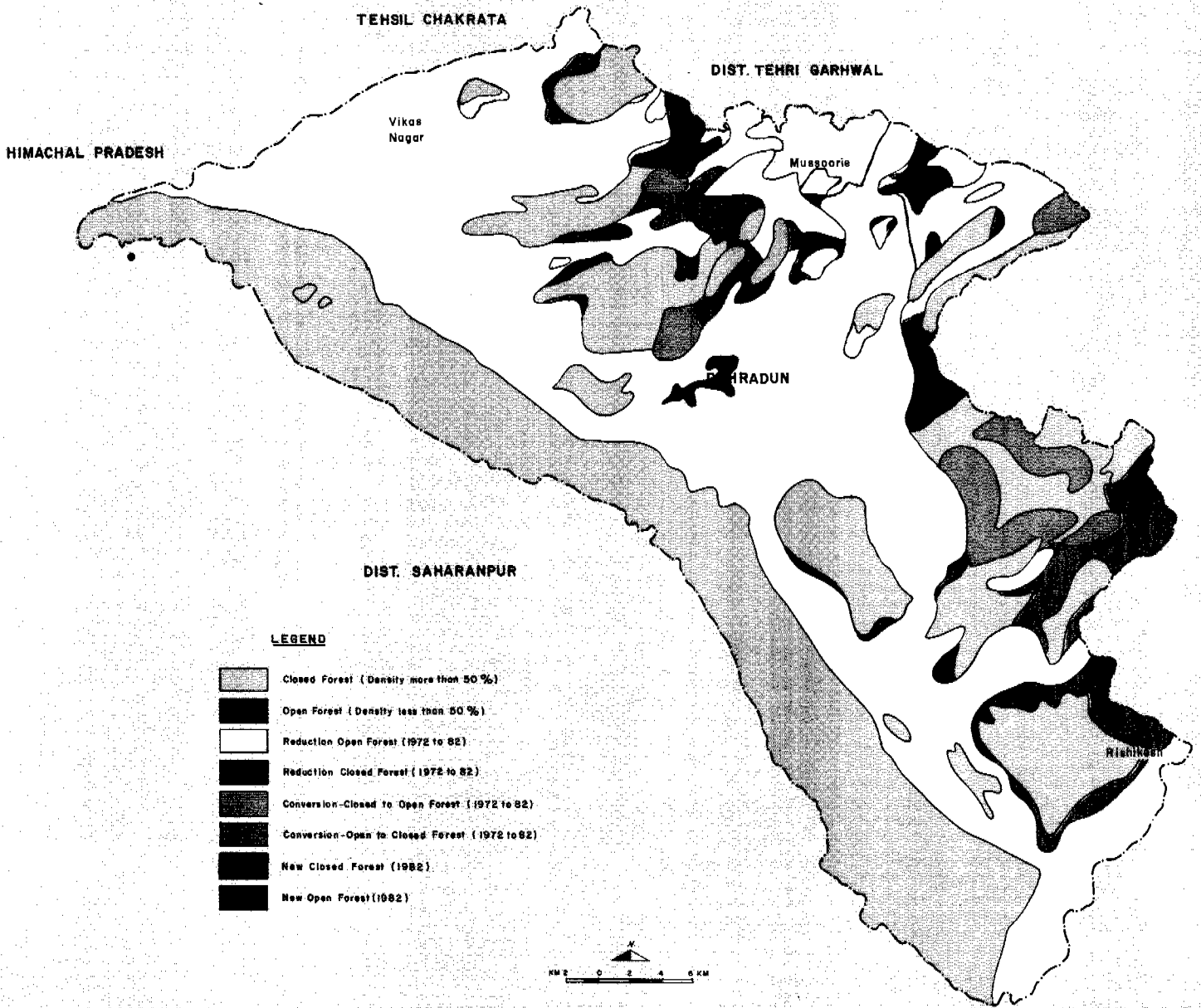
Over and above the issue of biomass collection by the local people, there is one more important external parameter and that is migratory grazing. Doon forests have been the traditional winter-camping place for the Gujar community of migratory graziers. The Gujars annually migrate to the forests and grasslands of the

Table 3: Extraction of Forest Produce in Dehradun (in m³).

Year	Commercial		Free & Concessional	
	Wood	Firewood	Wood	Firewood
1959-60	26698	9515	6	4376
1960-61	20654	29181	13	2532
1961-62	19514	56056	52	3414
1963-63	13111	62564	150	3166
1963-64	15456	51326	135	3232
1964-65	34772	63490	111	3155
1965-66	37359	37359	0	983
1966-67	32788	76067	2	28
1967-68	26926	54303	N.A.	N.A
1968-69	41864	187493	115	166
1969-70	41864	411380	125	693
1970-71	45620	176002	175	8
1971-72	51855	125025	129	378
1972-73	34043	115746	108	142
1973-74	31023	91556	35	97
1974-75	31342	83434	126	84
1975-76	40777	89706	50	530
1976-77	34053	85089	85	173
1977-78	39737	N.A.	108	563

FIG. 6
CASE STUDY - DOON VALLEY
STUDY-FOREST COVER

(based on Anon, 1988b)



upper Himalayas in the spring, that is April, and return to the forests of the valley at the beginning of winter, in November. With the exponential increase in the urban population of the valley, there has been a tremendous increase in the daily milk requirement. More than 100 milk vendors make daily trips to the interior forests and collect milk from the various Gujar camps. The demand has been so high, and the business so lucrative, that a part of the Gujar population now stays in the forests all the year round. This close link-up of the urban milk demand and the interior forests of Doon has become a matter of great significance and concern in the management of the forests.

The existence of the Gujars in the Doon forests was always recognised as an integral part of the working of the forests, although to what extent such considerations have succeeded in protecting the forests from excessive damage is an open question. Like the headloads of firewood, the huge amount of milk has become a product that is extracted daily from the forests. To accommodate the pressure exerted by the Gujars, grazing circles have been kept separately for them in all the forest working plans. However, the famous forester Champion (1932), while making his working plan for the Doon forests, lamented that:

The management of this (grazing) circle was not very successful. There was insufficient grazing of leaf fodder for the Gujars, who therefore spread all over the neighbouring forests and did a great deal of damage by illicit lopping. Lopping rules were laid down but were often not followed.

The problems of monitoring the lopping by Gujars multiply because they stay in all the remote corners of the forests and they do not have any direct dependency on any particular forest area. The buffaloes belonging to the Gujars produce much more milk than those of the local villagers. Berkmüller et al., (1987), who studied the local pressure and people's dependency on the forests of this area, indicated that:

the incentive to run livestock in excess of subsistence needs is high because an additional milking buffalo yields a net benefit of about Rs. 175 per month while the additional effort expended per animal is comparatively low.

According to him:

increase in stocking density may not always be shown in the range register and even the recorded stocking density is often above the prescribed limits of safe grazing and lopping capacity.

It is thus very clear that increased urban industrial growth has direct material dependence for its survival on the forest resources of Doon Valley. The current problems of forest management and threats to the forests are very different from those of the early British days when strategies for forest management were developed. Another important element in this respect is the takeover of the private forests. This happened with the abolition of the zamindari system in 1952, when large areas of forest were cleared in an attempt to prevent them from being taken over by the department of forests. Thus, the little buffer that existed between local pressure and the reserved forests disappeared. Forest land was also cleared for a number of projects, and this led to a total loss of 15,322 hectares of forest between 1973 and 1983 (Anon, 1988b).

The situation became even more tight with the formation of the Rajaji National Park to which almost half of the Eastern Doon forests were transferred. In addition to this clear and quantitative loss, there have been serious changes in the quality of the forest cover, Fig.6 presents the state of the forest cover as of 1983 and important changes in the period from 1972, and it exemplifies the destructive impact of the urban and rural domestic pressure on the forests and the nibble-effect (Moench and Bandyopadhyay 1986). The study of Berkmüller et al. (1987) further exemplifies the nibble-effect on a much higher scale in the case of the Rajaji National Park, that encompasses the whole of the Eastern Doon forests on the North slope of the Shivaliks, (Fig.7 page 28).

The co-existence of large urban settlements and rich forests creates problems for forest management in yet another way. Lured by the huge profit in wildlife poaching and fire wood smuggling, armed robbers, reportedly with influence in the social hierarchy, made the Doon forests their area of operation. The situation took a serious turn for the worse in the early 1980's. Incidences of the murder of, and grave injury to, forest

guards came as a severe blow to the morale of the protection staff, while forest offences went on. This constituted a significant challenge to forest management. Table 4 presents a break-down of recorded forest offences in four forest blocks as reported by Berkmueller et al. (1987).

These offences and the geographical and social isolation of the forest guards have resulted in demoralisation and this has serious implications for forest management. The isolation has further reduced the scope for the traditional participation of the villagers in fire fighting activities, something that was spontaneously available just a few decades ago. The overall picture would have been gloomy but for instances of exemplary courage shown by groups of unarmed village women who were inspired by the spirit of the Chikpo movement. In December 1983, in the forests near Rishikesh, one such group of women challenged a large gang of armed wood smugglers and captured felled timber worth Rs 1 million along with the whole transportation system. This spirit of ultimate identification of the people's interest with the safety of the forest seems to be the only way to save the situation in the Doon Valley forests. The narrow silvicultural basis in the working of the forests needs to be replaced by a broader human understanding of the links between local forest resource needs and local forest resources, and the linkages between these and the

interests of the rural people. In a free and democratic society local people should be involved in sharing the responsibility for the proper management of natural resources, but this can be achieved only by giving them both responsibility for and access to these resources. New experiments in forest management in the neighbouring district of Tehri can provide insight for this (Bandyopadhyay and Shiva, 1988a).

In highly urbanised and populated valleys such as the Doon, forests cannot be preserved and improved without paying serious attention to the resolution of all the above mentioned conflicts. Thus, the enlightened participation of the local people in the enhancement and protection of the forest resources must become a valuable tool in the future management of the Doon Valley forests.

Ever since the British annexation of the valley, there has been a substantial amount of apathy among the common people concerning forest conservation. The current realisation of the vital need for people's involvement in forest management necessitates a reversal of the policies, and it is now necessary to closely examine the achievements in instances where the management of forest resources has become broadbased. In this respect insights gained from the various efforts at forest protection and afforestation are important as a starting point.

Table 4: Number of Offences in Doon Valley Forests by Range, Type, and Year

Forest Range	Type	1982	1983	1984	1985	1986
Asarori	A	5	5	NR	3	4
Lachiwala	A	1	18	9	4	2
	B	NA	NA	10	10	2
Kansrao	A	16	7	4	9	3
	B	NA	NA	44	58	55
Motichur	A	26	33	37	36	24
	B	NA	NA	NA	71	20

Type A includes poaching of wildlife, carrying firearms, laying traps etc.

Type B includes poaching of timber, fuelwood theft, illegal grazing etc.

Probably no other part of India has such a coexistence of large stretches of good forests and highly concentrated human settlements. The fact that the forests of Doon Valley have remained in their present form, which, apart from stretches along the northern slopes of the Shivaliks and pockets in the Rajpur, Malkot, and Lachiwala areas, are in excellent condition, is to the credit of the forest department, and in particular to its forest guards who constitute its lower level staff. The repeated demands for institutional reorganisation of forest administration are rooted in the cognitive limitations of the ideas that govern the functions of the department and not in the limitations of commitment on the part of its functionaries. The institutional alternatives suitable for forest management have been tried out extensively in the afforestation programmes of the valley, an account of which merits separate description.

Lessons from Afforestation Activities

The dependence of the people of the Doon Valley on forests, directly for biomass and indirectly for microclimatic amelioration and hydrological stability, is well recognised. The need to enhance the forest cover has been felt for a long time. However, it was never clearly articulated until the litigation on the environmental impact of limestone quarrying. This practical challenge to afforestation came rather suddenly, in March 1985, with an interim order from the Supreme Court closing some lime stone quarries permanently and advising early environmental rehabilitation of the areas damaged by quarrying. In the context of the overall areas of forest crisis and the location of the main forests, the closed quarries were not central. However, the afforestation activities undertaken in these areas provided a much needed impetus to similar programmes.

Several methodologies, for forest protection and afforestation programmes, have been followed in various parts of the valley, and the individual strengths and weaknesses of these need to be analysed in order to develop optimum methodologies for the successful enhancement of forest wealth on various types of land. These afforestation programmes have been undertaken by:

- the forest department,
- the ecological task-force,

- other government agencies,
- the people themselves.

and an analysis of their achievements is given below.

The Forest Department

Afforestation has constituted an integral part of the activities of the forest department for quite some time. These activities were, however, within the reserved forest areas. Within the last few years social forestry programmes have tried to make new plantations, mainly of Eucalyptus, on the roadsides and government wastelands. The colonial legacy of mistrust between the people and the forest department, generated by the reservation of the forests, still continues to a large extent and makes the task of the forest department much tougher and their work less efficient. However, the forest department embodies the richest silvicultural experience and has the organizational network for raising nurseries that could be of immense value to afforestation programmes. The general observation that the survival rate of departmental afforestation programmes is low is more or less correct. However, there is tremendous scope for success if the antagonism of the people can be converted into cooperation and the factors that contribute to the low success rate of the department's programmes are removed.

The Ecological Task-force

An ecological task-force was raised in 1982. It induced a few retired army personnel, mainly from the hill areas of Garhwal and Kumaon, to undertake afforestation in the Himalayas. Following the Supreme Court order of March 1985, the environmental task force was entrusted with the task of afforestation of the Bhatta-Kiarkuli area around the Mussoorie-Dehradun road that was badly damaged by the quarries.

The discipline and ability to undertake hard work, that is the ethos of the army-culture, were very useful in the functioning of the task-force. The associated tendency to blindly push one's ideas into programmes that involve many other sections of people was, on the other hand, a major cultural obstacle. This led to initial misgivings and friction between the taskforce and the villagers. With the

mediation of advisers, and some restraint on the part of the people, the taskforce has shown a fair measure of success. However, the fact that the unit cost of plantation is abnormally high makes this methodology appropriate only for afforestation in sensitive watersheds where there is heavy seasonal rain. In the case of afforestation for local demands, such costly methods may not be advisable.

Other Government Agencies

There have been a number of organisations active in forest protection and afforestation in the Doon Valley. Under the organisation of the local *Nehru Yuvak Kendra*, students from various parts of the country have been spending a month or more in the Doon Valley, through the National Service Scheme, since 1985. They are involved in fencing, digging, and planting of saplings in an area near Sahasradhara, a well known tourist spot in the Doon Valley. Such programmes, obviously, do not have the same impetus as the task force, nor can they develop a self propelling model for reafforestation. However, the involvement of hundreds of young students is a positive achievement in itself, as well as providing education through practice. The efforts of the National Service Scheme have encouraged local students to take up similar activities.

People's Afforestation Programmes

The above afforestation methodologies have been successful in a limited spatial context. A macromethodology for the greening of the Himalayas in general cannot be developed directly from these experiences. Often these external involvements, however well meaning they may be, lead to an alienation of the programmes from the local people in general. Without the involvement of the local people, who alone can maintain and use the forest resources, the challenge of afforestation cannot be faced efficiently on the scale on which it is required. In the absence of this involvement the local people will only be forced to become an uncontrollable agent of destruction, while the well meaning efforts of others will merely generate non-replicable instances of success.

In the nooks and corners of the valley, people have been involved in numerous, little known afforestation activities, mainly guided by some enthusiastic leaders at

the village level. From the point of view of management, these little known efforts, that have no access to the media, are of fundamental importance. What is not surprising is that, probably due to reasons beyond their control, government agencies often concentrate their funds and efforts on the few external but visible efforts, at the cost of ignoring the many internal and invisible ones. The success of large scale and rapid afforestation in Doon Valley, as in many other parts of the Himalayas, should totally depend upon the mobilization of the ideas and involvement of the local people only, if the problem has to be tackled realistically. Otherwise all efforts will result in expensive and well advertised success stories for afforestation methods that do little to contribute to the control of overall deforestation. This typical problem of the management of plantation and afforestation is summarised in the following editorial from a local newspaper of Dehradun (*Himachal Times*, 1982):

Challenges in the Management of Forests

From the accounts given in this chapter, it is evident that institutions for forest management evolved a century ago and were propagated throughout India from the Doon Valley. The Doon is, itself, in need of innovations to cope with the changed characteristics in the area. Within its limited area a variety of universal challenges in the management of forests have emerged. These various facts have been classified into three categories for the case of India (Shiva et al., 1985). Forest management in the Mussoorie hills is important from the perspective of soil erosion control and regeneration of springs. In Mussoorie, the villages around the tourist town exert another significant pressure on the forests. That is the pressure to provide fodder for the milk producing animals. A quantitative estimate of the milk industry around Mussoorie is available in a study of the *Mussoorie Grameen Vikas Samiti*, (1984).

The important temperate forests, especially the oak (*Quercus incana*) forests, both in terms of socioeconomic parameters and specific environmental parameters have not received due attention in the formal management of the Doon Valley forests. This lack of a mountain perspective runs through all the Forest Working Plans. It has resulted in the exploitation of the oak forests even in ecosystemic conditions that are highly favourable to their quick growth. This potential is visible in the health of the

well protected forests around the Woodstock School in Mussoorie. It is only recently that ecological and local-domestic utility of the temperate forests in the Doon Valley has drawn serious attention.

The success of the tree planting programme on the denuded slopes of the Mussoorie hill, undertaken by the ecological taskforce (Ramchandani 1987), provides an excellent example of institutional integration in afforestation. In this case a major institutional shift occurred when the main responsibility for large scale tree planting was given to the ecological taskforce. The Forest Department supported the activity by supplying seedlings. The interaction of the taskforce with the local villagers, and the gradual evolution of an effective partnership, is an interesting lesson for forest management. The strictness of the ex-armymen and the freedom of grazing enjoyed by the villagers produced conflicts in the beginning. In due course of time, and with the intervention of the local environmental groups, the conflict eased out and the villagers accepted the strictness of the task force in the ultimate interest of the forest resource.

The most significant element in a forward looking forest management plan will be the enhancement of tree-cover on the village commons, farmlands, and degraded reserved forests near the villages in the middle of the valley. Major management innovations are needed to repeat the successes experienced in people's involvement in this whole process. The success of all afforestation programmes, in situations such as that prevailing in the Doon Valley, depends upon the degree of identification of the local people with the afforestation programmes. Institutional changes are needed to accommodate and encourage such initiatives. The Forest Policy (Anon 1988a) of India provides preconditions for such changes. What is needed is to provide, at least, a limited role for the revenue department in encouraging village level organisations, such as panchayats and youth organisations, to take up afforestation programmes. The emergence of strong local citizens' participations, both

from rural areas and urban areas, provides the Doon Valley with the hope that new institutions, with a more effective record of conservation and regeneration of forests, can emerge in a short time. In many respects, the challenges facing forest management in the Doon Valley represent the main challenges that exist throughout the whole of India. The success of institutional innovations and integration in the management of forest resources is expected to become a major trendsetter in India.

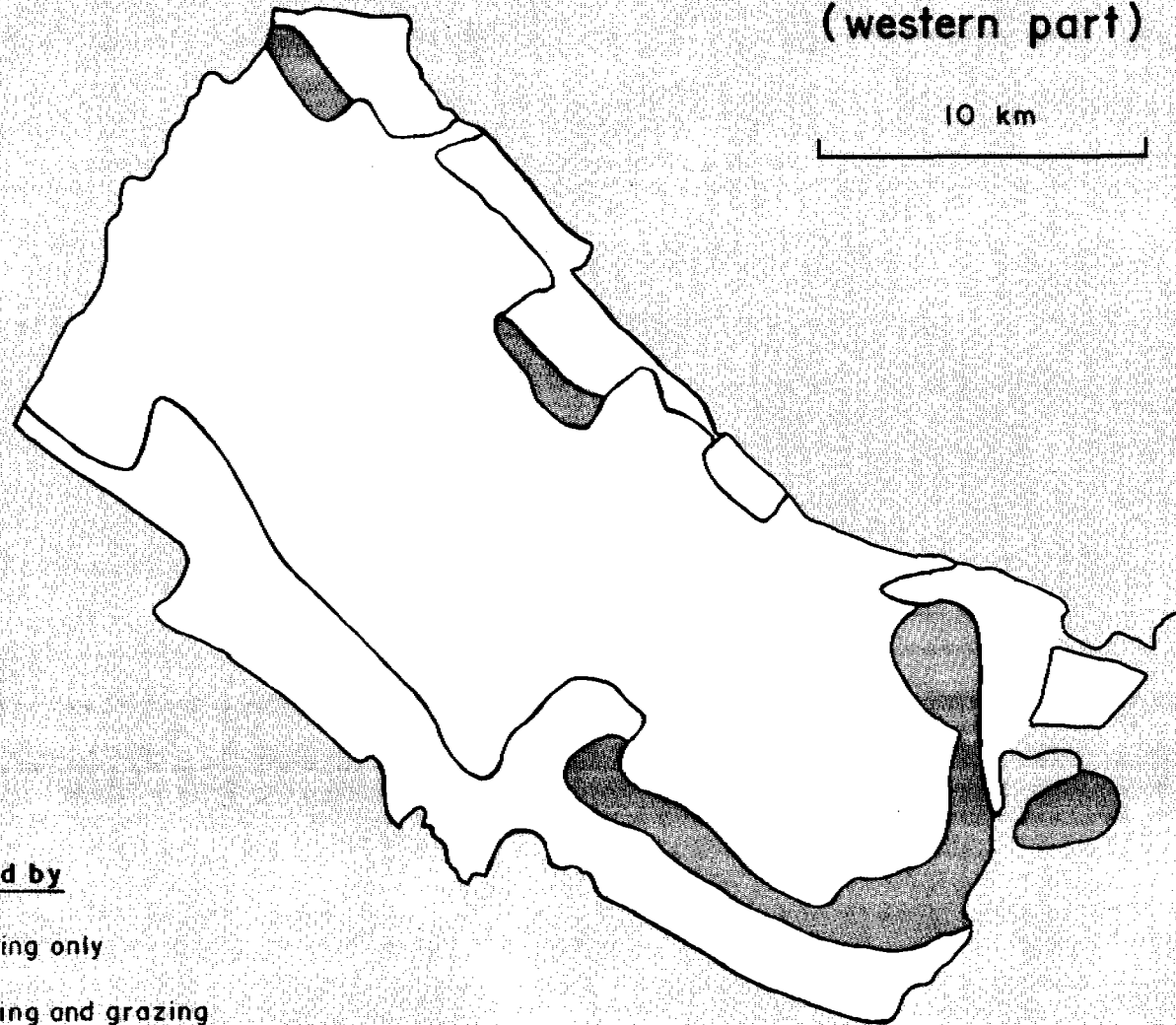
No account of the future challenges in forest management in the Doon Valley would be complete without mention of the management of the rich wildlife potential. Singh et al. (1989) made a detailed analysis of these challenges. The rich forests on the northern slopes of the Shivalik range, as the site of the Rajaji National Park, can play a tremendous role in the conservation of genetic resources and greatly enhance the attraction of the southern parts of the valley for tourists, especially in the post-monsoon periods when the attractions of Mussoorie diminish.

The forest resources of the Doon Valley, therefore, have remained a dominant factor in its economy. However, with time, the nature of the contribution of the forests to the valley economy has changed and has generated new management challenges. Over the last 100 years, the concept of the forests as renewable resources was not central to forest utilisation. In the beginning the land requirement of settlers, and more recently the commercial fire wood and milk requirements of the urban population, undermined the sustainability. The absence of an environmental perspective resulted in the rapid degradation of broad-leaved forests on the Himalayan slopes below Mussoorie. The current management challenges lie in the regeneration and non-consumptive utilisation of the green cover through tourism and wild-life management. The response to these new challenges can be found through the integration of the efforts of the two most relevant institutions located in the valley; the Forest Research Institute of India and The Wildlife Institute of India.



FIG.7

**Rajaji National Park
(western part)**

10 km



Area effected by

-  Firewood cutting only
-  Firewood cutting and grazing

Nibble effect by Firewood Cutting and Grazing by Village Cattle

IV. Management of Water Resources

The Doon Valley is a water-rich valley in terms of the total precipitation. Yet, it has always been a chronically water starved valley in the pre-monsoon months. Conserving the abundant downpour during the monsoon into increasingly higher levels of sustainable and perennial water resources, especially in the pre-monsoon summer months, is the central challenge in the management of water resources in the valley. The actual amount of water needed for domestic, field irrigation, and industrial purposes is only a fraction of the total precipitation.

On an average the annual volume of water precipitated in the valley is about 3400 million m³. Apart from the real loss of water from evapotranspiration, the total volume of water that runs off is about 2,000 million m³ (Korsun et al., 1984). The current real total consumption of water for the Dehradun urban area, calculated on the basis of a recent survey (Shiva and Bandyopadhyay, 1985), is about 0.2 percent of this enormous volume. Even if one adds the industrial consumption of water to this figure, it does not change in any meaningful way. The amount of water needed for irrigation has never been quantified in spite of it being the largest consumer of water. A gross estimate of the total annual water requirement would be about 100 million m³, which is approximately a negligible five percent of the annual run-off. This clearly indicates that in terms of the annual water balance there is no reason for a shortage of supply from the internal sources in the valley, even if consumption increases considerably.

In this respect the temporal changes in water supply, in the Doon Valley, are representative of many parts of the Eastern and Central Himalayas that have a heavy monsoon rainfall. Even in places like Cherrapunji, located in Eastern India, receiving an average annual rainfall of more than 10 metres, water shortage in the pre-monsoon period has become a common problem. The evolving crisis is due to a mixture of meteorological, ecological, and human factors that have led to an increased scramble for a shrinking resource base.

This conflict between high demand and low supply of water in the Doon Valley was noted by Baker (1886) more than a century ago, and he commented that:

water is very scarce in Dehradun itself in the hot months. The canal is the lowest when the demand is the highest

Until today, the history of water resource management in the Doon Valley has been characterised by innovations to ensure an increasing supply to meet an increasing demand. No other sector of resource management in Doon Valley is as essential as water for its continued economic development. Paradoxically, the limits to growth in this rain rich valley do not emanate from the scarcity of non-renewable fossil fuel, but from renewable sources of water.

Resource Management in a Historical Perspective

With time, the demand for water has grown and the technological level of human interventions has changed accordingly. The beginning of this intervention started with the tapping and canal transportation of water from the springs originating in the Mussoorie hill area. The existence of a number of springs in this area is normally attributed to the karst limestone belt that acts as an aquifer.

Almost every village on the southern slope of the Mussoorie hill had developed their own irrigation facilities by tapping these mountain streams; many of which carry a lot of water. This technology was not applicable to the villages at the foot of the Mussoorie hill. The geology of the valley is such that as soon as these streams reach the level of the foot hills, and touch the Doon or the boulder bed in the valley, the surface water disappears, percolating through boulders, and shows up again at the bottom of the valley where it oozes out to form rivers such as the Suswa or Asan.

The earliest settlements in the valley (e.g. Nuwada) grew around sites where drinking water from dug wells was easily available. The wells at Nuwada are centuries old and are still a source of domestic supplies. At that time the wells did not hold sufficient water to be used for irrigation. To have access to higher volumes of water the inhabitants of the valley employed an ingenious method of diverting the water through masonry channels just before it enters the boulders at the foot of the hill. The oldest canal constructed on this principle is the Rajpur canal and it supplies drinking water to Dehradun from the head of the Rispana torrent. Rani Karnavati, who administered the valley from the village of Nuwada, on behalf of the Garhwal King, is usually credited with the construction of this canal.

The British were quick to understand the potential of masonry canals for tapping the Himalayan waters. In 1837 the newly formed canal department commenced construction on a new canal using the water of the Bhitarli and Kiarkuli rivers from the village of Bijapur downwards. It was completed in 1839. The next project was the restoration and improvement of the Rajpur canal during 1941- 44. To irrigate some excellent farms and tea gardens in the far-western parts of the valley, a canal diverting the water of the perennial Yamuna at the village of Katapathar was designed in 1941 and constructed a few years later.

During the 1850s and the early 1860s, two other canal systems were constructed. The Kalanga canal was drawn from the upper Song river near Raipur, and the Jakhan canal was drawn from a Himalayan stream of the same name near the village of Bhogpur about 25 km east of Dehradun. Besides these government canals, several small, private canals also provided irrigation. There has been a continuous increase in the area irrigated by canals but the five canals built by the British still continue to be the backbone of Doon's irrigation and provide, even in the 1980s, about 80 percent of the total irrigational needs of the valley. They provide water to 15,608 ha of land out of a total of 19,500 ha under irrigation. The area irrigated has increased continuously from the early days of British rule to the 1980s, and the relative augmentation of irrigation from these canals is shown below.

Year.	1845	1860	1870	1910	1980
Acres.	7500	10,500	14,000	20,000	47,500

Until the 1860s, the expansion of irrigation facilities was based on the tapping of major streams and the physical expansion of canals, while during the last 130 years the growth has been more dependent on better distribution and management as well as the tapping of smaller sources. Baker (1886) aptly described the economic role of these canals:

these canals, insignificant though they appear at first, are the greatest blessing to the district. In fact the people depend almost entirely on them for water for drinking and domestic purposes and for the cultivation of all the more valuable crops.

The Crisis of Urban Water Supply

As the urban areas increased, water supplies to these areas became an important element in water resource management. The story of urban water supply is that of a continually growing unsatisfied demand. With the rapid growth of urban areas in Dehradun and Mussoorie, separate arrangements for water supplies became the responsibility of the respective city boards. The Nalapani springs were the first to be tapped for Dehradun in 1889, reportedly to supply water to the European settlers. When the city requirement increased in 1895, the Kolukhet spring below the town of Mussoorie was tapped for piped water supplies. During 1935-36 Dehradun needed more water and this was provided by diverting the flow of the Kalunga canal. Until that time Dehradun had been fed by gravity sources. On the other hand, Mussoorie was fed by pumped water right from the beginning due to its location at the ridge. In 1908, the Murray pumping station was started and, in 1913, as the demand for water in Mussoorie kept on increasing, the Mackinnon springs were pumped up. In 1925 the Bhilaru pumps were installed and in 1929 the Koltikhala was pumped for the Landour area. The much older town of Rishikesh, being located on the river Ganga, never had any serious problem with water supply. During this period the Irrigation Department, which was responsible for the management of all surface flows, was able to supply sufficient water for domestic use to the township of Dehradun.

The use of water resources, however, went up in keeping with the pace of urbanisation, the extension of the canal system in the valley, and improvements in their linings. After the drastic increase in the urban population,

following the events of 1947, requirements could not be satisfactorily met and the irrigation department was torn between pressure from the rural sector for irrigation supplies and the demand of the urban water supply systems. It became clear that the requirements had exceeded the limits of perennial (lean) surface flow in the valley. This led to the search for larger amounts of water from underground, and the realisation that, unlike with other supply systems, a specialised knowledge was needed. This created the need for hydrogeological information on the groundwater potential of the valley.

The geological origin of the Doon Valley has provided it with a high quality aquifer called the Doon Gravels. These occur below the surface at varying depths and are recharged by the annual rainfall. Probably a certain amount drains out along the flows of the Suswa and the Asan into the Ganga and the Yamuna respectively. The Doon Gravels provide potential aquifers that can substantially augment the water resources in the valley. During 1961-62 the "Dehradun Water Supply Reorganisation Scheme" was prepared and one tubewell was constructed. This, however, was not successful. In the years to follow new source finding, based on the use of tube-wells, was continued, and the conjunctive use of surface water available in the canals and groundwater from a few successful tubewells was somehow capable of satisfying the basic needs of urban areas and irrigation.

In 1971-72, the responsibility for water supply was taken away from the City Board and given to the Jal

Sansthan, an organisation dealing with water supply alone. More recently another organisation, Jal Nigam, was established with the objective of source finding and constructing water works, while running them has remained the responsibility of the Jal Sansthan. In a period of increasing environmental consciousness and holistic management, the management of a single resource, water, has thus become the business of three independent executive organisations, namely, the Irrigation Department, the Jal Nigam, and the Jal Sansthan.

The Jal Nigam has tried to plan to meet the future water requirements of the growing urban areas of Dehradun and Mussoorie. On the other hand, since only about one-fifth of the total agricultural land is irrigated, there is constant pressure on the irrigation department to expand the facilities and the water supply over a larger area. It now seems certain that groundwater potential needs to be tapped as the main resource, at least for urban supplies. The Jal Nigam has attempted to determine the urban water requirements for the coming decades and has proposed various projects to make up the shortfall. Table 5 gives the projections made by the Jal Nigam for Dehradun.

Challenges in the Management of Water Resources

The shortfall in urban water supplies, as described in Table 5, may not seem very significant quantitatively when compared with the total water precipitated in the valley. Nevertheless the scarcity, especially during the

Table 5: Projected Water Requirements and Shortfall in Dehradun Urban Area (Million Litres per day)

Requirement	Y E A R		
	1995	2001	2011
Domestic (200 lpcd*)	84.20	100.00	127.00
Industrial	10.00	15.00	15.00
Total	94.20	115.00	142.00
Supply from Existing Sources	72.04	62.15	45.75
Deficit projected	22.16	52.85	96.25

* Litres per capita per day.

months of May and June, may soon be a limiting factor to continued economic growth. The scarcity of water may be the dominant factor for a ceiling in the carrying capacity of the valley. The challenge of improving water supplies during the lean period has to be understood and approached through the three specific parameters listed earlier.

The specific socioeconomic parameters of the valley are such that the demand for water has increased in leaps and bounds, over the last century, at a rate that is orders of magnitude higher than an average rural mountain area. The historical trend of irrigated agriculture continues to demand more and more water. In fact, during the months of acute scarcity, distribution of water for irrigation invariably becomes an issue of social conflict for which the Irrigation Department has few coping mechanisms. The increasing demands of urban-industrial areas further complicate the problem. In the absence of clearcut priorities in water supplies, it is reported, political pressures often become the basis of decisions. The solution lies in long term water planning and budgeting by all the dominant sectors using water.

The question of long-term budgeting for water comprehends all the ecological characteristics of the Doon Valley. Before the specific environmental parameters came into focus, the solution to the decrease in water supplies was found in supply augmentation. A proposal for water resource augmentation, from 1995-2011, to the extent of 200 million litres per day has been made. This proposal involves the construction of a dam, on the perennial river Yamuna, on the boundary of the valley at Lakhwar. This idea of making a rainfall rich area depend on the scanty snowmelt flow from an external river was criticised, on the grounds that augmentation of water supply to the valley, from outside sources, is not feasible at all and will lead to a negative economic impact (Bandyopadhyay et al., 1983). This set the trend for looking into ecological characteristics to enhance perennial watersupply to the valley from the sources within.

This inward looking quest has emerged in two directions. Firstly, in the improvement of the hydrological characteristics of the southern slope of the Mussoorie hill in order to reduce run-off, enhance recharge, and increase the perennial stream flows. The efforts of the

scientists at the Central Soil and Water Conservation Institute, at Nalota Nala, have shown that, by proper land management in the catchments, the base flow of streams can be substantially improved. Scientists, particularly geologists, of the Oil and Natural Gas Commission, are attempting to locate suitable sites for small dams in the foothills, in order to facilitate groundwater recharge and surface water storage.

Both these efforts can make major contributions to the management of water resources in the valley. In the decades to come, with an increasing demand for water, the valley's dependence on water will shift from surface flows to groundwater. However, the close ecological links between precipitation and surface flows, surface flows and recharge of the groundwater, should be examined from the perspective of specific environmental parameters to ensure that higher rates of groundwater exploitation remain within the limits of sustainable water supplies. The basic challenge, then, lies in introducing new processes or strengthening the existing ones for the storage of rainwater in the natural aquifers. The upper aquifers in the Mussoorie hills seem too small compared to the total requirements, and the idea of using the Doon gravel aquifer deserves serious attention (Jones, 1989).

This naturally leads to the specific institutional parameters as a background for identifying the innovations needed in the institutional framework for water resource management. Bandyopadhyay (1989) has stressed the urgent need for ecological management of water resources in India to avoid fresh water scarcity. The Doon Valley provides an excellent testing ground for initiating the process of institutional integration to address this challenge. There is a lack of coordination in the management of Doon's water resources, as there is in many other areas. If institutional integration is to be comprehensive, the management of water resources should have only one single administrative structure. At present, the irrigation department manages the canals, the Jal Nigam manages the augmentation of domestic and industrial supplies, and the Jal Sansthan looks after day to day water supplies. There are chances of frequent inter-institutional conflicts over the sharing of water and over the division of responsibilities. This is particularly so in the case of surface water sources because they are easily accessible.

The nature of the institutional conflict is exemplified by two news items in the local newspaper. In one, it is reported that the Jal Sansthan wanted the Union Department of Environment to take over the water treatment plant in Dehradun to ensure better service and appropriate handling of the machinery. In the other, it is reported that rivalry between Jal Nigam and Jal Sansthan is the main cause of water crises in the Doon (Himachal Times, 1983).

The future agenda for water resource management in Doon Valley could be very interesting and important. At the level of specific socioeconomic parameters, long term projection of water requirements is a necessity. Agriculture being the biggest consumer of water in the valley, efforts to use it more efficiently will help in

extending supplies to more areas. At present the area covered by irrigation constitutes about 44,000 acres only and there is scope for much more. At the ecosystemic level, a quantified ecological understanding of the hydrological cycle in Doon Valley is necessary to examine the prospects of ecological intervention in conservation. At the institutional level, amalgamation of water resource management into one administrative framework, linked effectively with research on hydrology and hydrogeology, has great prospects. If these challenges can be faced by the local people, as well as the administration and the research institutions in the valley, this will constitute a major contribution to water resource management in the Doon Valley and to the Himalayan region as a whole.

V. Management of Surface Quarrying

As well as renewable resources such as forests or water and the advantages of a salubrious climate, the Doon Valley, during the last few decades, had some important non-renewable mineral resources that have played an increasingly significant role in the valley's economy. Limestone, marble, gypsum, and phosphorite of high grade are located in the krol formation within the Mussoorie hill at the northern extremity of the valley. Starting from Hathipaon in the north-west, and stretching to Ranipokhari in the south-east, they form part of a 50 km long mineral belt. Through the process of natural erosion during the monsoon, limestone boulders are found in significant quantities on the beds of the Himalayan torrents coming down from the Mussoorie hill.

For a long time, limestone boulders coming down from the Mussoorie hill were collected and burnt to make lime. This became an important commodity for export to the plains. With the arrival of the railways in the early 1900s, the mineral deposits formed linkages with other diverse requirements in the plains of British India. At this stage there was no organised process for mining or quarrying, and the forest department used to sell the collection rights for lime bearing boulders, from the streams passing through the forests, at the rate of Rs. 5 per 100 cu. ft. The local landlords, too, started selling limestone boulders rolling on to their land. The economic potential of Doon limestone encouraged the Government to claim legal monopoly over this resource by defining the collection of boulders as mining. However, the legal validity of this official order was challenged by the landlords in the law courts. The court upheld that collection of boulders rolling on to someone's private land was not tantamount to mining and could not be controlled accordingly. In this way, right from the beginning, the courts became involved in the management of limestone extraction in the Doon Valley, a tradition that has been creditably and creatively maintained until today.

The Growth of the Quarry Economy

In the interim revision of the settlement report in 1904, all minerals were declared to be government property. Thus, all minerals and quarrying came under the control of the Government. By 1910 two quarries in the Eastern Doon and two in the Western Doon were under operation. Until that time the main use for limestone was in lime making and around the 1900s Doon Valley was exporting about 6,500 tons of lime.

Slowly but steadily the use of Dehradun limestone became diversified. In 1936, more organised attempts at quarrying were made, when marble deposits were opened up near Bhatta village on the Dehradun-Mussoorie road. However, due to several reasons, including the opposition of the rural people, quarrying operations remained small scale. In 1947, with the partition of India and the formation of Pakistan, supplies of high grade chemical limestone, from Pakistan, to the sugar and textile industries in North India stopped and the high grade limestone of Doon Valley replaced them. A number of refugees from Pakistan, who had been involved in limestone quarrying there and possessed extensive knowledge of the market, came over to Dehradun through a process that can be called the "lime rush". The scale of quarrying instantly increased as did its contribution to the economy of the valley. At this point there was no organised and strict methodology for monitoring the quarries that were located mainly on the hill slopes.

In 1949, the Government of India passed the Mineral Concessions Act, under the Mines and Minerals Regulation Act of 1948. According to this Act applications were subsequently submitted to the State Department of Industries for 20 years quarrying leases in the Doon Valley. The leases were not granted immediately, probably due to lack of dependable information on the total economic potential of the mineral belt.

In 1959, after examination of the potential of the limestone belt, the Geological Survey of India estimated that a total deposit of 400 million tons in the Doon Valley could be quarried. It was in 1960 that the Government of U.P. passed the Mineral Concessions Rule, according to which 20 year leases were granted. Initially 17 leases, covering an area of 450 hectares, were granted. In the early 1980's there were about 100 leases covering an area of about 1400 hectares. During the 1970s, because of this expansion, limestone quarrying became the central economic activity of the valley. This growth is reflected in the fact that the total extraction of limestone and marble from 1977-82 was at least two orders of magnitude larger than the total extraction in the 1900s (Table 6).

Problems of Environmental Impact Monitoring

Because of the considerable increase in quarrying activities in the Doon Valley, over the space of a few years, the environmental impact of the quarries became a source of criticism. There were no clear guidelines for monitoring this environmental impact, and the history of the knowledge and laws on mining had been largely dominated by coal mining experiences in the relatively flat plains of eastern India. There was no adequate knowledge for the supervision of mining in ecologically sensitive areas such as the Doon.

The incidence of quarrying in the mountains is not great. Yet, the Himalayas have a variety of rich mineral resources which could be of economic value. It is in this context that the experiences with mineral exploitation in the Doon Valley become more general than local, the

most important element being the use of law in the management of natural resources.

As the scale of quarrying in Doon Valley expanded over the years, the cumulative environmental impact became prominent, and the issues of environmental management and monitoring became increasingly urgent. The quarry operators tried to maximise their profits and often resorted to irregular quarrying processes that rarely attempted to minimise negative environmental impact. The administrative structure was inadequate to embrace the problems of environmental degradation within the framework of its existing rules and regulations. As a result debris from the quarry sites covered large parts of the hill slopes, damaged agricultural and pasture land, choked the riverbeds and canals, upset both urban and rural water supplies, and left ugly scars on the hillslopes that were injurious to the scenic beauty of the tourist town of Mussoorie.

The environmental impact of quarrying on the hill slopes most directly affected the agro-economy of the villages, but the rural people were not strong enough at that time to launch a campaign against it and hence their early warnings were inaudible to the decision makers. The State Government, however, was not totally insensitive to the developments. In 1974-75, a survey examined all the quarries in the Doon Valley and erring quarries were issued "show cause" notices on the basis of the results of the survey. This was not, however, totally effective in rectifying the working style of the quarries and consequently some leases had to be discontinued.

Table 6: Extraction of Limestone in Dehradun Tehsil During 1977-82 (in Metric Tons)

Year	Limestone (Major)	Limestone (Minor)	Marble	Total
1977	323753	101010	103213	527976
1978	436561	100515	106996	644072
1979	520454	114760	134774	769988
1980	390572	121879	136321	648772
1980-81	430278	132202	139015	701495
1981-82	471196	166962	123278	961426

Source: Directorate of Geology and Mines (Uttar Pradesh)

For the first time, the scientific, legal, and ecological issues related to the management of limestone quarrying came to the fore most dramatically in a Supreme Court Case in 1977. In 1970 an application was made for a lease to open a quarry on a piece of land bordering the main road connecting Dehradun and Mussoorie. There was a rival contender for part of the area. For whatever reasons, the lease was not granted and after a number of litigations the Union Government directed the State Government to execute the leases. In a dramatic turn of events, the State Government disagreed with the order of the Union Government and stressed that the granting of the leases would "affect the natural beauty and ecology of the region". Whether such a stand was a result of a genuine understanding on the part of the State Government, or whether it was inspired by the rivalry between the two contenders, is not clear but it decidedly opened up many significant issues related to the management of surface quarrying in the Doon Valley.

The objections of the State Government were rejected, and the case went to the Supreme Court of India through a special leave petition. The Court ordered the formation of two committees, one on environmental impact assessment of quarrying in Doon Valley and the other on technicalities of quarrying operations. It advised the Union Government to make a final decision only after giving due consideration to the reports of these committees.

The report on environmental impact was prepared by a group of eminent scientists holding senior positions at various national institutions dealing with natural resource management. They were not strictly mining engineers. The report on mining technicalities was prepared by very senior officials of the Indian Bureau of Mines (IBM), a group that was highly competent in the field of Mining Engineering. The difference in the recommendations of these two reports clearly underlines the influence of different disciplines in understanding and evaluating the impact of limestone quarrying in the Doon Valley. The interdisciplinary report on environmental impact pointed to the environmental sensitivity of the region and indicated that granting quarrying leases would accelerate slope instability, soil erosion, siltation, and debris accumulation on the riverbeds. It also argued that quarrying would generally destroy the scenic beauty and that this might have

negative effects on tourism in the hill-station of Mussoorie. The disciplinary report from the Indian Bureau of Mines reported that:

there was no major structural disturbances within the area, which may cause instability to mines working. The hill slope is fairly stable.

The Union Government must have found it difficult to moderate the differences in the absence of a clear understanding of the meaning of the word "ecology". The lease operators argued that:

The composition of the officers (committee) which has given the report of the environmental impact of limestone quarrying is such that they cannot give authoritative findings as far as the geological and structural factors of the Dehradun-Mussoorie road are concerned and the IBM's report should be accepted in this regard.

The absence of a well-articulated law or working rule to assess "environmental impact" was a major obstacle preventing the Union Government from taking an environmentally informed stand. On the other hand, a clear understanding of the term "ecology" was equally lacking on the part of the State Government who had initiated the case and the debate on it. Indeed in the 1970's, after the 1972 Stockholm Conference on Human Environment, "ecology" became a widely used and little understood word. Ill informed use of such words will ultimately be counterproductive, as is evident from the following sentence; an order of the Government of India, further recommending the issue of leases in the above case, explained:

although the representative of the State Government was at pains to stress the point regarding the "beauty of landscape" yet it has not been satisfactorily explained by the State Government's representative as to how the ecological and environmental factors would be disturbed.

The Supreme Court, however, was sensitive to the ecological issues. When the Union Government ordered that leases be granted, this order was followed by the appointment, by the Supreme Court, of a senior advocate as a Commissioner to make an on-the-spot enquiry. He

recommended that the lease applicants be granted leases, not in the area applied for, but within an area already leased to a State owned mining company. In a surprise move, when the Union Government's order and the report of the Commissioner came up for final hearing, the State Government withdrew the case. The use and misuse of the words "environment" and "ecology" are best demonstrated by the following order of the Supreme Court, dated October 3, 1979:

We are surprised at the turn of the events in this long protracted litigation. Early in the day when the Central Government passed an order directing the leases to be granted for mining in an area which was supposed to be ecologically precious for the country, the State of UP came up in appeal and we were led up the garden path in believing something extraordinarily injurious to the country was taking place if the leases directed by the Central Government were to be issued... When expectations had risen high and new rights were being crystallised a new light dawned on the Government of UP that there was victory in retract. Quietly, the State represented that the State was seriously considering to withdraw the appeal filed by it and forgot about the apprehension of ecological catastrophe which brought it into this Court.

The above episode clearly points to the real confusion in the management of quarrying. Indeed the case in the Supreme Court, though finally withdrawn, was a meaningful indicator of the seriousness of the situation. By the end of 1980, another important administrative issue related to the environmental impact of quarrying cropped up. This was the policy for renewal of quarry leases that were granted in 1962 and would complete the stipulated 20 year period from 1982 onwards.

In 1978 a committee was formed, headed by the District Magistrate of Dehradun, for the purpose of examining the environmental impact of quarrying and, if needed, for recommending closures. The committee's recommendations led to a government order in 1979 closing quarrying in Bhatta and Kiarkuli villages along the Dehradun-Mussoorie Road, Gagoli power house, and the Sahasradhara spring. In the Bhitarli and Kiarkuli valleys the granting of new leases was to be based on merit. The Hathipaon-Banog area was available for lease on the

basis of suitability. All leases lying above the forest road along the Song Valley were not recommended. Reclamation of land left derelict by mining was to be concomitant with mining.

In 1981 the Department of Industries (UP) appointed another committee to determine the renewal policy for a number of quarrying leases expiring in 1982. This committee decided to discontinue quarrying in the Sahasradhara area because of the impact on the Baldi Nadi and the consequent impact on tourism. In the Arnigad Valley quarrying was to be continued except when mining rules were violated. All quarries on the Dehra Dun-Mussoorie road were to be closed. In Bhitarli Valley leases were to be renewed on merit. It was recommended that quarrying be discontinued. In Banog, block quarrying was permitted to continue as long as the Kempty Fall and the water pumping station of the Mussoorie Municipal Board were not damaged. In Song Valley complete closure was recommended, because of the dip-slope mining that had placed the stability of the entire mountain in danger. On these bases, renewal was recommended for nine out of the eighteen leases. The others were not recommended for renewal on the basis of ecological factors and the absence of safe mining conditions. However, another wave of ecological sensitivity must have overwhelmed the Government of U.P. because, instead of taking case by case decisions as per the recommendations of the technical committee, it put a blanket ban on the renewal of quarrying leases.

The decision was immediately challenged in the High-Court by the lease operators who, including those whose renewals were not recommended by the technical committee, all procured stay orders from the High-Court to continue quarrying. The stay orders led to more severe and environmentally reckless mining because the lease operators tried to maximise returns during this period of uncertainty about future opportunities and policies. Moreover, official inspection, monitoring, and control became, reportedly, marginal as the stay order was sometimes interpreted by the quarry operators as immunity from government interference.

Although the earlier case in the Supreme Court was withdrawn in its final stages, it had a positive impact on the environmentally sensitive minds within the Government. To enable a better informed

decision-making process and to increase their knowledge about various environmental problems in the valley, including the impact of quarrying, the Union Department of Environment commissioned an ecosystems evaluation study of the Doon Valley (Bandyopadhyay et al., 1983).

The report on the natural resource utilisation in the Doon Valley, submitted in May 1983, not only provided the officials with a better ecological understanding of the Doon Valley so that they might undertake environmental monitoring on a more scientific footing, but also, as a result of its participatory methodology, it enlightened the local rural and urban population on the state of their own physical environment and the problems arising from its continued deterioration.

During the same period, another publication by a group of socially aware journalists provided an account of the sufferings of some villagers affected by the negative impact of limestone quarrying. (Prasun et al., 1983). At this stage ideas about the negative impact of limestone quarrying evolved from vague feelings to objective writings and began to provide realistic inputs for an ecological approach to natural resource management. The credit for this does not go to any one individual. However, the pivotal roles played by individuals in important administrative positions should not be forgotten. The ecosystem study had, as its most powerful supporter, N.D. Jayal, the then Joint Secretary in the Department of Environment, Government of India, and undoubtedly the environmental research and action in Doon Valley would have been very difficult without such support.

From Ecosystems Research to Public Interest Litigation

The report of the ecosystems study on Doon Valley (Bandyopadhyay et al., 1983) brought out the unique orographic, geological, and meteorological features of the valley that led to its ecological instability. It pointed out that ecology cannot be equated merely with scenic beauty. Ecological linkages are a complex of active relationships and an interdependence of natural resources and resource processes. Human beings are active elements in the ecosystem. The study provided details of the nature of the hydrological destabilisation, caused by the quarries, to which was attributed the increased flood-plain inundations and droughts in the

valley, as well as the accumulation of huge amounts of rejects and debris in the riverbeds from the quarries. The loss of agricultural production and the reduction of pasture land caused by the impact of quarrying was minutely studied and quantified for the first time. The study projected a major water crisis in the valley if environmental regeneration was not undertaken in time.

The main findings of the ecosystems study received wide public attention through the press, and in these the residents of the valley found scientific support to some of their criticisms of the functioning and impact of the quarries. All these were extremely important from the point of view of generating ecologically informed public opinion.

Initially intervention and initiatives to stop environmental damage were discussed. Without waiting for the Government to act, the Rural Litigation and Entitlement Kendra (RLEK), an organisation supported by the Legal Aid Programme of the Supreme Court of India, came forward to file a public interest writ petition (RLEK and Ors. vs. State of UP and Ors., 1983). On July 14, 1983, within a few weeks of the completion of the ecosystems study, the Supreme Court of India admitted the writ petition. In another expression of public protest on July 18, 1983, the citizens of Mussoorie brought a petition against quarrying to the Upper House of the Indian Parliament on the basis of the above findings. The litigation was also supported by the interventions of two important citizens' groups, the Save Mussoorie Society and the Friends of the Doon. Later, a students' environmental group in Delhi, *Kalpavriksh*, together with a number of villagers supported by the famous Chipko movement, filed another petition against limestone quarrying. This was later heard by the Court together with the earlier petitions. The importance that the Supreme Court gave to this public interest litigation was clear from the following statement in its interim order of March 1985:

This is the first case of its kind in the country involving issues related to environment and ecological balance and the questions arising for consideration are of grave moment and of significance not only to the people residing in the Mussoorie hill range forming part of the Himalaya but also in their implications to the welfare of the generality of the people living in the

country. It brings into sharp focus the conflict between development and conservation and serves to emphasize the need for reconciling the two in the larger interest of the country.

The court based its acceptance of the case on a much broader and deeper understanding of the people's right to life. The concept of life was not restricted to the narrow concept of mere biological survival. It was described as:

the right of the people to live in a healthy environment, with minimal disturbances of ecological balance and without avoidable hazards to their cattle, homes, and agricultural land and undue affection of air, water, and environment.

Such clear articulation, from the highest court in India, of an ecological right to life encouraged new legal steps to institutionalise the concept of a stable and healthy environment as an essential requirement for exercising one's right to life. In the interim order the court restricted many of the quarrying activities to smaller geographical areas, and in August 1988 it handed down the final judgement closing all but six quarries and banning any renewal of quarrying leases in future.

This public interest litigation is a trendsetting case in the judiciary's intervention in natural resource management. The success of the case has several unique foundations. It is important to understand the step by step development that led to this intervention, from an ecosystems research to a trendsetting judgement from the Supreme Court of India. It is also important to identify the main actors in the process.

The ecosystems study (Bandyopadhyay et al., 1983) was undertaken in a participatory manner so that it was able to solicit objective information on the environmental impact of quarrying. It also enlightened the individuals affected about the ecological base of their sufferings. In this manner the study liberated the meaning of ecology from the fashionable concept of scenic beauty and connected it with fundamental human rights of access to basic natural resources, such as water, pastures etc. (Bandyopadhyay and Shiva, 1984). The scientific information generated by the ecosystems study was competently used by the public interest litigation.

However, notwithstanding the scientific competence, the litigation would probably have had difficulty in being accepted even if "right to life" had not been interpreted correctly by the court in a holistic and ecological perspective. In spite of being admitted, the case would not have drawn the interest of the Government if it had not been patiently pursued by the coordinator of the RLEK, Awadhesh Kaushal, and a large number of local citizens. Another important element in the success of the case was the people's expression of protest right from the beginning of the case until its completion.

On November 11, 1983, a massive public protest against quarrying was organised in Mussoorie, when, following the petition, a parliamentary enquiry committee came to the valley. It must be stressed that during this process the people of the valley had become so well informed about the basic ecological arguments that any government official, who tried to extend unjust and unscientific support to the destroyers of the Doon Valley ecology, was soon cornered by the people who did not shy away from scientific debates. The people of the Nahikala area of Doon Valley organised a sit-in on the hill road leading to one of the quarries that was later closed following the final Supreme Court judgement. This unique and courageous non-violent protest was organized by the Chipko activist, Dhum Singh Negi, with the support of the local villagers. All these, together with a fair amount of press coverage, laid the foundations for a real public interest litigation related to environment. (Iliste and Goranson, 1984; Bandyopadhyay and Shiva, 1987).

Challenges in the Management of Surface Quarrying

The experiences related to the management of surface quarrying in the Doon Valley provide important information on the policies and strategies that should be adopted for quarrying in the mountain regions. The experiences go far beyond the scope of simple departmental management. On the one hand they relate to ecosystemic research, on the other they relate to informed public action and the law.

In view of the fact that rich mineral deposits are available in the Himalayas, and that there will be continuous pressure from the industrial sector of the country for these minerals, it is important to analyse the

challenges that these issues of quarrying in the Doon Valley present. It is particularly so because, whereas in the specific case of the Doon Valley, due to unique circumstances, quarrying has been largely restricted and regulated, the restriction and regulation is not applicable to the immediately neighbouring mountain areas of Kumaon, Garhwal, and Himachal Pradesh. Accordingly, the first challenge this case presents is the challenge of extending ecologically informed decisions beyond the geographical boundary of the Doon Valley.

The question is how can an experience emerging from the specific cultural parameters of the Doon Valley be used in other areas? At the same time, this case presents the challenge of extending experiences to areas beyond the geographical boundary of the valley but having similar ecosystemic characteristics, such as slopes, intense rainfall, geological instability etc.

On the level of specific socioeconomic parameters, the experiences of the Doon Valley provide a rare example of informed and sustained public action in natural resource management. In various phases of this action, people took upon themselves regulatory responsibilities, sometimes unilaterally, sometimes in coordination with government bodies. In the remote rural areas, the Chipko activists unilaterally stopped the movement of trucks to and from the quarry sites by peaceful means. The urban residents of the valley spent long hours at a large number of quarry sites to regulate the collection of minerals following the closure of these quarries by the Supreme Court. This was done under the co-ordination of a senior government official. In this way the Doon experience exemplifies a delicately balanced collaboration between informed citizens and concerned administrators. In this respect, the contribution of another senior official should be mentioned. D. Bandyopadhyay, the then Rural Development Secretary, Government of India, who was

chosen by the Supreme Court to take up responsibilities in connection with the Doon Valley litigation, facilitated the close involvement of local residents in the monitoring of quarrying activities.

The challenge lies in making the most of these experiences and extending them to other mountain areas. Firstly, ecologists should identify the ecosystemic characteristics of particular valleys and of the Himalaya in general, to provide a scientific background to the various dimensions that may be involved in the environmental impact of mineral extraction. Secondly, the law-making bodies should internalise these ecosystemic characteristics and introduce new regulations, rules, and monitoring systems related to quarrying in the Himalaya. The perspective should include not only outer hillslope impacts, such as increased run-off due to debris, but also hydrogeological impacts on the storage and flow of groundwater in the parched aquifers. The direct impact of the Doon Valley case is seen in the changes in mining laws to include mandatory environmental reclamation by mining agencies. It has induced official circles to consider the optimum method for monitoring the environmental impact of mining in the hills.

Thus, a single case in the Supreme Court has brought home the fact, to all concerned, that the mountain perspective in mineral exploitation in the Himalaya has so far been conspicuous by its absence. As long as this perspective is omitted from impact assessment, administration, and monitoring, the legal authorities will be pressured to take actions that normally lie within the jurisdiction of the administrative bodies. The society has to be responsible for the stability of the mountain ecosystems and the socioeconomic survival of its people. Learning from the Doon Valley experiences, the Government and the society must ensure the timely introduction of a new administrative framework to give popular initiatives their rightful place in natural resource management.

VI. Management of Urban-Industrial Growth

From a small beginning as a quiet pensioners' settlement, Dehradun has now emerged, over the last 100 years, as the 12th largest Class One city in the State of Uttar Pradesh, the largest and most populous State in India. The Dehradun urban (regulated) area spans over 27,190 hectares and, according to the 1981 census, has a population of 416,430. The population of this urban area is projected to go up to 500,000 in 2001 and to 635,800 in 2011. The quantitative as well as the qualitative nature of this expansion is no different from that of other fast growing towns and cities in India. Nor are the environmental impacts of such spontaneous urban growth absent in this well-endowed valley.

A distinct expression of the environmental decay and crises associated with this mode of urban growth can be found in the Dehradun municipal area which houses, at present, an estimated population of about 330,000 on 3108 hectares of land, a density of about 10,000/km²*. In this one time paradise of pensioned settlers, today, slum areas are providing shelter to close to half of the population of the city. The population of the urban agglomeration of Dehradun grew at considerably higher rates during the last few decades and this trend is expected to increase (see Table 7 below).

The nature of the urban crisis is slightly different in the case of Mussoorie, which has not grown to such a significant extent, in terms of permanent residents, compared to Dehradun. However, the pressure of tourists and summer holiday makers has generated a different type of problem for the management of urban growth in this hill station. In spite of both being established in the early 19th century after the arrival of the British, and in spite of the similarity of their early growth as peaceful and tranquil towns, the basic characteristics of the two settlements have evolved in very different directions. In 1905, the population of Mussoorie was reported to be 14,685, and in 1981 the latest census puts the population figure at 18,241 showing very little increase in the permanent population. The crisis of Mussoorie is brought on by the tourist population which reaches more than 100,000 in the season. In contrast to the level and extent of urban growth in other settlements, the growth of Dehradun has been more significant. In fact the demographic scene throughout the whole of Doon Valley is dominated by Dehradun, where the issues of management of urban-industrial growth are most important for this study.

Table 7: Decennial Population Growth Rate in Dehradun

Year	Decennial Growth Rate (p.c.)	Comments
1941-51	78	high due to post-independence in-migration
1951-61	8	low due to epidemic
1961-71	30	higher than national average
1971-81	44	"
1981-91	56	projected
1991-01	70	"

* The author acknowledges the help of M. Kothari in the analysis of urban growth problems in Dehradun.

Stages of Urban-Industrial Growth

The process of urban-industrial growth, that brought the valley to its present state, can be divided into several distinct stages. In the earliest phase, this growth was characterised by official encouragement to Europeans to settle in the valley and take advantage of the healthy and salubrious climate. This was supported by the opening of a number of schools in Dehradun and Mussoorie, mainly for children of European origin. In fact, British Officers liked the climate of the Doon so much that as long ago as 1853 Sir George Campbell, in his *India As It Might Be*, selected the Doon, "as the most fitting spot for the future capital of India".

Though the Doon Valley did not become the political capital of India, the British encouragement of institutional growth made it the capital of natural resource management in the country. The establishment of the headquarters of the Survey of India and the Imperial Forest School initiated a particular type of urban growth that was maintained for a long time. The new urbanisation process did not gain the aesthetic approval of the then residents. The process was, however, so invincible (and it still is) that urbanisation continued, and along with it arose an intense concern about congestion. The following comment by Baker (1886), made more than 100 years ago, could easily be taken as that of a present day environmentalist in the valley:

The Dehradun of the present day is a long straggling collection of buildings from south to north... fresh houses are constantly being built and land and house properties have increased very rapidly in value in the last twenty years.

The second phase is characterised by more rapid growth of the settlement and the tourist industry caused by the opening up of the railways connecting Dehradun in the 1900s. At this stage a large number (40,000) of European settlers were staying in the valley. The area also grew as a major market centre for the hinterlands of Garhwal having easier connections through Mussoorie. With easy transportation, industrial growth commenced, although on a very small scale. The industrial history of the valley started in 1904 with the establishment of the Himalayan Glass Works. A relatively higher level of economic activity, mainly based on tourism and

institutional growth, characterizes this phase of urbanization.

The third phase of growth started in 1947 when India and Pakistan became two independent countries. The influx of population, described earlier, drastically changed the nature of the settlement and the dominant economic activities. While retaining its central place as a market for the whole Garhwal hinterland, with much higher volumes of trade, small scale industries and lime stone quarrying changed the face of the city. Another important aspect of the post independence expansion of Dehradun was the continual establishment of new institutions, and this was epitomised by the opening up of the mammoth national headquarters of the Oil and Natural Gas Commission (ONGC), the Central Soil and Water Conservation Research and Training Institute (CSWCRTI), Wadia Institute of Himalayan Geology, and Forest Survey of India, that resulted in the in-migration of about 100,000 people to the valley.

The fourth distinct phase started in the late 1970s and can be identified with the quick growth of large-scale industries. During this period, the district of Dehradun and many other districts in India were declared "industrially backward". This opened up opportunities to obtain liberal funding for establishing industries in the region. During the process of ushering in a period of industrial growth, environmental considerations were of least significance. As a result, environmental pollution from industrial growth soon became a major issue of conflict. The extent of this industrial growth is shown in Table 8 in which the yearly breakdown of industrial units set up in the valley is given for the 1980s.

Table 8: The Number of Industrial Units Established in the Doon Valley in the 1980s

Year	Number
1980-81	105
1981-82	110
1982-83	157
1983-84	202
1984-85	250
1985-86	312
1986-87	336
1987-88	351

Among the new units established there were sixteen large industries of which seven were chemical, three mineral based, three engineering, and the other three agricultural. These large industries provided 2700 jobs and the small industries provided 10,000. This placed extra pressure on the limited urban facilities. To coordinate the fast expansion of urban settlements in and around Dehradun, and to control the establishment of industrial units in proper locations, the Town and Country Planning Organisation of the State Government had prepared a Master Plan for the urban (regulated) area of Dehradun. Bandyopadhyay et al. (1983) noted certain problems in this plan from the environmental perspective and also clarified the fact that three obnoxious and polluting industries were spot-zoned in the upper parts of the valley. Normally, they pointed out, methodology for regional planning in the valleys would not include such industries because of environmental concerns.

The fifth, and the current phase, of urbanisation and industrial growth is characterised by environmental criticism and modifications in the plans. The beginning of a citizens' movement against the proposed Master Plan was actually sparked off by the inauguration of a cement factory that had been spot-zoned near Rajpur. Several leading citizens of Rajpur wrote to the Chief Justice of India about the environmental problems caused by industrial pollution, and they requested that their letter be treated as a petition. It was the second time in approximately two years that environmental conflicts in the Doon Valley had reached the Supreme Court of India (Rastogi et al., 1985).

Industrial Pollution in the Valley

There are some physical limitations, imposed by ecology, to industrial growth in valleys such as the Doon. Throughout the year, the limited water supply and the inversion effect of air renders water intensive and air-polluting industries unsustainable. Pollution measurements reported by Bandyopadhyay et al. (1983) were the first quantitative information processed on the high particulate matter suspended in and around the numerous lime kilns of Dehradun. They reported an ambient particulate content of 350 micrograms/m³, while the permissible maximum of a sensitive area such as the Doon Valley is only 100 (Panesar and Deepak, 1983).

Air pollution hazards in the Doon Valley become extra critical due to the characteristic valley winds and the phenomenon of temperature inversion. The valley winds are caused by the topographical effects of the valley-mountain system. Air tends to flow down the valley at night since the air is cooler at higher elevations. The driving force for the air flow is a result of differential cooling (katabatic wind). During the day, the opposite flow occurs as the heated air, adjacent to the sunwarmed ground, begins to rise and flows up the mountain system (anabatic wind). This regularly changing wind pattern can keep the emission from industries trapped in the valley. During the day the plume moves up the valley only to return at night as the wind shifts. Concentrations of pollutants can build up to dangerous levels under these conditions. The legally maximum permissible pollutant in ambient air is given in Table 9.

Table 9: Maximum Permissible Pollutants in Ambient Air Quality (microgram/m³)

Category Area	Pollutants			
	SPM	SO ₂	CO	NO ₂
Sensitive	100	30	1000	30
Residential	200	80	2000	80
Industrial	500	120	5000	120

Even when there is no wind, warm air currents will carry away and dilute pollution. During a warm day the sun heats up the ground, which in turn warms the air near it. This hot air rises until it cools to the temperature of the surrounding air. On a typical summer day warm air currents can travel up to several thousand metres, greatly diluting the pollution they carry with them. Sometimes this natural mixing of the air is blocked by what is known as temperature inversion. Normally, the warmest air is near the ground and the air above it is progressively cooled. In an inversion this process is reversed and a layer of cool air is trapped underneath the warm air. Inversions are quite common in valleys, especially at night. If pollution is caught underneath an inversion the normal dispersion and dilution of emissions is prevented. This forces the concentration of contaminants into the lower parts of the valley which, in the case of Doon Valley, happens to be the highest density pocket of the urban settlement hazard for the citizens of Dehradun.

The advance caution concerning the serious threat from air pollution that was given in the ecosystems report emanated from anxiety about two sources of pollution. Firstly, the obnoxious and hazardous industries spot-zoned in the Rajpur area and secondly the large number of kilns and crushers distributed in many nooks and corners of the city. A third important source of pollution from the large number of automobiles was noted. However, their quantitative contribution was not ascertained until recently. Later, the Pollution Controls

and Research Institute (1988) made detailed studies on ambient air pollution in various parts of the city. The results of these are shown in Table 10. These figures, when compared with the legally maximum permissible levels, speak of the situation in the valley.

In tune with the environmental protests against limestone quarrying, concerns about the uncontrolled growth of polluting industries received equally serious attention both at the State and Central Government level. The environmental review of the proposed Master Plan of Dehradun City, made by the Department of Environment (Anon 1984), commented that:

A large number of lime kilns exist in DehraDun which have polluted the environment. Their location has unfortunately been spot zoned and provision made for further expansion of industry in the same area. This is going to further pollute the environment. A chemical industry is proposed to be established in the vicinity of the Cement Plant. It is feared that this industry will gradually affect the water, air and flora and fauna. Besides, the Master Plan proposed a total of 845.00 ha. (11.21%) of land for industries. This appears to be abnormally high landuse. The recommended percentage for industrial cities with a population of one lakh and above is 1.25 to 2%. The existing industrial area which is 2.98% itself is on the higher side compared to new industrial towns being developed in the country.

Table 10 : Results of Ambient Air Monitoring in Doon Valley (microgram/m³)

SAMPLING SITES	SPM	SO ₂	NO ₂	CO	HC
Hotel Drona Stand	723	60	102	3432	5.0
Parag Dairy Raipur Road	972	41	29	458	1.0
U.P.C.C.L Mussorie Road	786	29	13	1144	N.D.
Venus Cement Rani Pokhari	409	46	38	1030	N.D.
FRI Kaulagarh	266	8	4	114	N.D.

The Ministry of Environment and Forests of the Government of India, after these various contributions, finally introduced severe restrictive measures on the growth of polluting industries in the valley (Geethakrishan, 1989). According to this notification, only selected non-polluting industries are to be permitted in the valley. Further, these Industries should be established in five industrial areas at Majri Grant, Chharwa, Ranipokhri, Shyampur and Selakui (Anon, 1989). These measures are creditable and will surely go a long way in controlling industrial pollution in urban settlements such as Dehradun. The impact is already visible because the cement factory in Rajpur, a major source of pollution, has stopped functioning.

Emerging Conflicts Over Land in the Doon Valley

The irresistible impact of the present pattern of transformation and demographic change in the Himalayan areas of the State of Uttar Pradesh has been quick urban-industrial growth in the foothills. The Doon Valley epitomises this process of urbanisation in the relatively even or level valleys with a pleasant climate and easy accessibility to the plains. The urbanisation of Doon Valley has taken place extra quickly due to its easy and quick links with Delhi by rail, road, and, more recently, by air. The existence of good schools for children has been another favourable factor, especially for the wealthy and educated Garhwali families who migrated into the Doon Valley from the interior of Garhwal. The arrival of the rich draws in the poor, the establishment of industries attracts vast numbers of the unemployed from far and near. The case of Doon Valley is no different from many other cases of growing cities in the Himalayan valleys, as for example Srinagar, Kulu, Kathmandu, and Thimphu. In fact, the review and analysis of the case of the Doon Valley can surely be of significance in the management of mountain urbanisation in general.

While considering the management issues of urban growth in the valleys, the question most frequently raised is that of "carrying capacity". There is a continuous pressure of in-migration, and the response of those who already live among the comforts of the valleys is that the "carrying capacity" is being exceeded and in-migration needs to be controlled.

Because these valleys are relatively closed ecosystems, their "carrying capacity" should be calculated based on the availability of water, land, and other natural resources in order to determine the constraints to proper management. In the case of urbanised valleys, where food or even water can be transported from other ecosystems, it is not feasible to develop a methodology for the calculation of human carrying capacity even though conflicts over limited natural resources will be inevitable.

Conflicts over water resources have already been discussed, and there remains the question of land allocation for various competing uses as an important element of environmental management. How much land, where, and for what purposes should be allocated? This is a management decision that should be based on an intrinsic understanding and long term perspective of the ecology and economy of the valley, elements which do not seem to have received serious attention during the formulation of the 1982 Master Plan for Dehradun. The problem is rooted in both methodological inadequacies and organisational weaknesses. In the absence of a well articulated methodology executed by a strong organisation, the processes of land allocation and transformation tend to be determined by irregular means. These may often include the use of money, power, or influence at higher levels. This makes efforts at serious natural resource management redundant.

Dehradun, other than being a fast growing urban settlement, is both physically and economically the gateway to the Garhwal region of Uttar Pradesh. As such, it has been (and is), inextricably linked with the ecology of the Garhwal region. Spatial planning is the integrating process of linking human activity patterns to natural and man-made resources. Land use planning provides the basic frame for weaving this linkage. In a broad sense, the rural-urban continuum is the hierarchy of this linkage and leads to a land use perspective placing both the urban and rural components within a single framework of overall development. The evolution of scientific criteria for land allocation according to use has become an important challenge for environmental management in the valley.

Conflicts over land use have, in the past, generated development in the agricultural sector at the cost of the destruction of forest resources. The clear-felling of large tracts of virgin sal forests to provide land grants for European settlers has a counterpart in the clear-felling of forests to provide land to resettle people displaced by the local Tehri dam. This trend of sacrificing forests for non-forest uses ceased after the Forest Conservation Act of 1980 came into force. There are, however, other emerging conflicts over land related to the urban transformation of Dehradun. Conflicting demands on the land resources also exist between agriculture and urban settlements and between industries and open areas.

With the establishment of the Doon Valley Special Area Development Authority, the need for ecologically sensitive regional development has been fully recognised. Yet, as with many experiments in the past, this one may also not be effective if future challenges are not comprehended in their totality. The proposed Master Plan for the growth of the Doon Valley is supposed to be a tool for the rational and optimum allocation of all land resources among the competing sectors. In the Doon Valley situation the environmental consciousness of the Valley residents, and the tendency of its administrators to give due weightage to public opinion (Bhargava, 1988), will surely reduce conflicts over land resources.

VII. Towards Integrated Environmental Management in Doon Valley

In the last four chapters various issues of natural resource management in the Doon Valley have been analysed within the framework of individual natural resource utilisation. It may well be that there are other aspects concerning the sectoral management of natural resources which have not been adequately covered here. The need for environmental management of economic activities in the Doon Valley has, in principle, been accepted at the highest administrative level. Search for a comprehensive regional development policy for Doon Valley has started, and this new search is governed by the following decisions (Anon, 1988b):

- Declaration of Doon Valley as an 'Ecologically Fragile Zone'.
- Cessation of mining and quarrying activities in the Mussoorie hills and Sahasradhara area.
- Conservation of forest areas.
- Afforestation of partly/wholly denuded areas.
- Regulation and Planning of urban growth in the Doon Valley.
- Imposition of strict control over the location of new industries.

The above decisions reflect the determined nature of the administration's attitude to natural resource management and regional planning. Whether this determination is universal or specific to Doon Valley, however, will decide whether such perspectives can be extended to other mountainous areas. This means that these decisions must be backed by environmental analysis as the basis of decision making.

The applicability of any measure of integrated environmental management is not straightforward. If it simply becomes speech making and assembling in workshops and seminars, it will be of no real consequence for the actual practical problems of the world. The issue is much wider and deeper because it is involved with the fundamental rearrangement of resource use patterns by human societies and a better

understanding of nature and natural processes (Bandyopadhyay and Shiva, 1988b; Dashman et al., 1979).

Therefore any serious administrative steps, such as the ones listed above for the Doon Valley, will have to be examined in a broader framework. It is not yet proven whether the above decisions will be universally welcome in the valley or if they will be equally applicable in other foot-hill urban areas like the Doon. The success of integrated environmental management in Doon Valley, as in any other area, lies in its becoming a socially acceptable and a transferable model. Otherwise, however well intentioned the measures taken in Doon Valley may be, if they are not applicable elsewhere and the area becomes an island in the environmental crises, rather than a testing ground for all mountain environments, they cannot be accepted as a formula for successful integrated environmental management. Hence, the importance of analysing these decisions within the framework of specific socioeconomic parameters in the Doon Valley, itself, and within the perspective of the general characteristics of neighbouring mountain areas.

Specific environmental issues usually emerge as a result of change, and such changes are brought about by technological innovations and the use of resources for economic expansion. As a result, a dichotomy, sometimes real, sometimes fictitious, emerges in the case of all environmental issues. Conservation is pitted against growth and even against social equity. No major steps can be taken without clarifying this apparent dichotomy between the dominant pattern of economic growth and the requirements of environmental conservation. Though this dichotomy is universal in character, in the case of the developing nations the theoretical and the practical aspects of it become more complex and emotionally charged in the context of parameters such as social equity, unemployment, and poverty. The situation in Doon Valley is no exception and integrated environmental management cannot be successful without considering these parameters. The conflicting and

cooperating aspects of economic growth, environmental conservation, and equity need to be understood if integrated environmental management is to play a role that goes beyond token environmental determination and become a part of the larger social programme.

The Growth - Conservation - Equity Debate

In the last few decades environmental concerns have largely been expressed as a cautionary critique of accelerated destructive changes in the environment. These changes are, almost without exception, the result of activities aimed at economic growth by application of modern technologies or increased resource requirements of an increasing population. Because of various reasons, including the supposed absence of economic alternatives, environmental concern has been wrongly, but predominantly, identified as obstruction to economic growth against the larger interests of the unemployed and the poor. The Doon Valley case is most interesting in this respect because the advocates of industrial growth and the critics of the environmentalists argued that environmental concern is a luxury of the rich that the poor cannot afford. This argument creates the impression that concern for environment and ecology conflicts with concern for economic growth and employment. The former is seen as a pastime of the rich while the latter is seen as the only hope for the poor.

Integrated environmental management cannot be successful unless this conceptual conflict, dominated by emotional outbursts from both sides, is solved. No doubt there are environmental pressure groups for whom the commitment to environment is a tactical step to ensure a better environment for those who live away from the pollution and poverty of the congested urban settlements. On the other hand, there are others who relate to the living conditions of the poor and their access to basic natural resources (Bandyopadhyay and Shiva, 1988b). Their commitment to environment is not tactical and is rooted in their concern for human survival. In addition, there is a third group that is committed to the philosophy of economic growth and attempts to improve the conditions of the poor mainly through industrialisation. Some members of this section harbour an unshakable faith in the ability of industrial growth to provide a better life for all people. For them, the conflict between growth and conservation is the same as that between bread and

beauty. The following statement from Malik (1984) clearly establishes the bread versus beauty argument of this third group, the industrialists of Doon Valley:

A country which is SO MUCH POVERTY STRICKEN, RIDDEN WITH EMPLOYMENT PROBLEMS cannot afford the luxury of BEAUTY alone. No man can afford to lose job. No man can survive without BREAD. No man can afford UNEMPLOYMENT. When we talk of the 21st century, have we ever thought that we will be taking with us thousands of unemployed, half-fed, half-naked and ill-healthed people to the 21st century ? No, we cannot afford to close industry.

Environmental management in Doon Valley has to face this debate both in the theoretical context of a dichotomy between economic growth and environmental conservation and in the practical context of upholding the overall public interest in the Valley as well as outside. This dichotomous situation needs to be properly understood and addressed by determined natural resource managers. Because of the characteristic conditions prevailing in developing countries, a special management approach that is different from those of the industrially advanced countries is needed. In the industrially advanced countries, with much lower levels of unemployment, environmental opposition to economic activities tends to create less intense conflict with the working people involved in the activity. In the specific situation of developing countries where there are high rates of unemployment, the negative environmental impacts of industries are defended by working people also.

This intricate relationship of poverty, unemployment, and environment poses the most difficult challenge to environmental management in the developing countries, especially countries such as India where the values of a democratic parliamentary process are deeply rooted. The complex interrelation of these three parameters is not new to the world of economic development or natural resource management. The basic theoretical dichotomies or confusions associated with the two commitments, of economic growth and environmental conservation, express themselves in almost every practical context. There is no doubt that, frequently, the privileged raise issues that threaten the bread of the poor. Yet it is

undoubtedly true that the long-term interests of the nation as a whole are dependent on the continued productivity and ecological stability of the resource systems (Bandyopadhyay and Shiva, 1988b). Nevertheless, the expressions of environmental concern in the Doon Valley, as in many other parts of the country, were initially ignored and classified as a luxury of the rich. The growth of industries leads to instant and visible forms of employment in the context of the cash economy. The partial overlap of the interests of the job-seeking poor and the profit-seeking employers provided the basis for a common platform from which these two groups could oppose environmental criticism. The concern over the establishment of these very industries and their negative environmental impacts on these very employees were thus made marginal.

When the unemployed and the poor involve themselves in political battles against conservation oriented natural resource use, it creates a situation where the most important issues influencing the potential for long term human survival in a highly polluted environment can hardly be discussed. The possible relocation of about 200 highly polluting lime kilns and some obnoxious industries scattered throughout the city of Dehradun is a case in point. Efforts to bring about this relocation were opposed by a massive workers' rally because they feared unemployment would result. The dichotomy between environment and employment in the socioeconomic parameters of the valley was clearly demonstrated.

In such situations, where emotions run high, it is impossible to talk of long term human interests when the burning issue is limited to bread for tomorrow. In a free and democratic society where poverty and illiteracy is overwhelming, there are these special challenges to integrated environmental management that are not technical in nature and need deeper socioeconomic understanding. Removal of poverty, thus, becomes a prerequisite for integrated environmental management. The daily wage labourer in the lime kilns is not immediately concerned for the environmental impact of the limestone quarries if it means hunger. The destitute woman and child hacking away at the rich undergrowth in the Doon forests are not interested in the need for conserving the forests if this necessitates an end to their meager daily earnings. No strategy for integrated

environmental management can afford to ignore the basic issue that integrated environmental management has to first ensure the satisfaction of the basic needs of all people, because its success completely depends upon popular support.

The whole debate about growth, conservation, and equity has clearly divided the population of the Doon, both rich and poor, into identifiable groups. The influence of these groups is quite balanced, and this is not the case in other parts of India. In fact, the conservationist groups gain the upper hand by virtue of more systematic research and dissemination. The campaign for conservation in Doon Valley was initiated by the more articulate and influential urban groups who were perturbed by the rapid environmental deterioration. Encouraged by this, the rural people joined the campaign for conservation when the adverse effects threatened agriculture and animal husbandry. On the other hand, rich urbanites, who had a stake in the growth of industries and mining, mobilised the support of the urban poor who worked in these industries. The division being complete, the conflict between growth and conservation became acute. Debate about whether growth or conservation necessarily ensure equity slowly faded into the background. It is against this complex backdrop that integrated management of natural resources in the Doon Valley has to operate. This is not an extraordinary situation. Wherever environmental concern has delimited itself from speechmaking and has endeavoured to actually change situations, it has had to face the problems generated by the conflicts involved in the growth, conservation, and equity debate. Notwithstanding these difficulties associated with effective environmental action, by virtue of its montane characteristics, the Doon Valley offers the most promising platform for innovative experiments in integrated environmental management. In the following section an attempt will be made to outline an agenda for these innovations.

Possible Agenda for Integrated Environmental Management

The historical background of natural resource management, and the present dichotomy between growth and conservation in the Doon Valley, should be seen as a convenient point for looking into the future. Though the future will be strongly influenced by the economic and

demographic trends in India in general, its course can also be substantially determined by the consciousness of the residents and the six guidelines that were mentioned earlier and that were accepted by the Doon Valley Board. The overall development policies of a country are largely determined by the national planning institutions, and they attach little significance to the specific needs of small areas such as Doon Valley. Yet, it is also apparent, from the analysis in the last few chapters, that small isolated attempts to change the course of the socioeconomic and environmental future of a region can lead to new types of decisions.

Future projections made in the absence of a clear policy framework can hardly be considered objective. In this section the possible agenda for integrated environmental management will be discussed on the assumption that future socioeconomic policies in the Doon Valley will be based on environmental and, perhaps, some ecological understanding, lay stress on resource sustainability, and will work towards the satisfaction of basic needs for all the valley residents. The strong participatory trend in the valley, and the environmental awareness among many residents, including the administration of the valley, makes Doon Valley a favourable region for such a process. These favourable factors indicate that formulation of development policies based on integrated and environmental perspectives is very feasible in the valley. Yet there are many gaps which need to be bridged, and these constitute an important element in the agenda for integrated environmental management. The initial successes of informed environmental action have increased both the possibilities in and expectations from the Doon Valley for setting a trend of integrated and ecosystemic development. The following sections will try to indicate what steps could be taken from the perspective of integrated environmental management to address these expectations.

Generation of Information on Environmental Parameters

A clear understanding of the environmental parameters was identified earlier as an important element in the environmental management of natural resources. Quite independent of the location of Doon Valley, gathering of extensive information on natural resources

and related processes has by now been recognised as a major task for natural resource management (di Castri et al., 1980; Whyte 1984). There is a growing awareness, as well as published literature, in this direction. This is, however, not a simple task because the conceptual framework for it has yet to be widely accepted. The generation of information on the environmental parameters of any region requires an innovative and creative use of both disciplinary and interdisciplinary knowledge. The nature of these difficulties has been described by di Castri (1984) in the following words:

Much ecological research is indeed of a basic generic character and, to be useful, needs to be supplemented by site specific studies. And the variety of climatic, biological and socio-cultural systems found in the world means that specific land-management programmes just cannot be blindly transferred from one place to another, as one might transfer a piece of chemical technology for example.

But even when geared to practical ends, research may not produce applicable results, because it is addressing what the managers consider to be the wrong questions, because it does not take sufficient account of the needs and perceptions of the potential users of research findings, because the solutions proposed by scientists and feedback procedures are not adequate for shaping future research.

Even when sound data exist, they are often not applied. There may be lack of political interest in receiving objective advice on the ecological consequences of environmental policies. The social and economic costs of application may be too great. Many data remain inaccessible and are not presented in a form that can be readily used by planners and decision-makers.

Despite such difficulties, the situation is hopeful. The presence of a large number of natural resource research and training institutions provides a niche for the growth of interdisciplinary understanding and ecosystemic knowledge. The platform for such an exercise could be the generation of the Master Plan for Doon Valley which is being drawn up by the Town and Country Planning Organisation. The most central challenge is that of understanding the hydrological cycle in the valley in a

quantitative manner. This information will provide the direction for designed human interventions to improve the lean period water supply. Another challenge lies in understanding the dynamics and kinetics of air pollution throughout the valley. The impact of urban-industrial areas on the forests and wildlife must be understood in detail. The hydrological role of good canopy, broadleaved forests on the southern slope of Mussoorie hill, and the role of limestone deposits in water conservation is not known in clear and quantified terms. All these could become major programmes for the generation of vital environmental knowledge. This knowledge is also vital in elevating environmental action from the tendencies of empty speechmaking. A simple coordination of research within Doon Valley can go a long way in this respect.

Research on Institutional Characteristics and Innovations

Every form of economic activity needs a suitable institutional framework for execution. Simonis (1989) points out that:

Economic policy manifests itself in and works through particular institutions. Therefore, the ecological orientation of economic policy requires new institutions and abolishing or redefining old ones.

With the transformation from a purely economic management style to one with integrated environmental objectives, there is a need for new institutions. These institutions may either be governmental or non-governmental, research or functional, executive, or judicial. The continuous evolution of institutions is the indicator of a legal-administrative system that is enriching itself from its experiences. The establishment and the evolution of new institutions, that will learn from environmental experiences and research, are part of the essential process of integrated environmental management. In this task, people's participation can be of immense significance. For example, their participation can ensure the success of reforestation programmes. Experience from the Doon Valley has shown that citizens' participation, in matters such as water resource planning, has led to multidisciplinary interactions being taken by various departments. In the absence of institutional renovations and innovations, environmental decisions cannot be realised in practice. Stressing the need for new

institutions, a local daily in Dehradun (Himachal Times 1983) wrote:

Unless clear cut and long term administrative and legal infrastructure are not set up to actively fight the rampant rape of the valley's flora and fauna the Doon ecology is not going to even get a breathing space to convalesce..... Drastic and unprecedentedly harsh and stringent protective measures are required to counteract the malcontent responsible in bringing about the current ecological state in this valley.

This desired institutional innovation will not occur automatically. Partly due to the inertia associated with institutions, partly due to opposition from vested interests, the external pressure of popular participation and the internal consciousness of the need for innovation are essential. The area where institutional innovation needs to be tested most urgently in Doon Valley is probably that of the land management in urban areas. In the absence of an organic evolution of institutional values and cultures, efforts of integrated management may not be effective at all. It is reported that, although the concept of the Master Plan for Dehradun is certainly creditable, there are confusions within the administrative structure responsible for its execution (Rastogi, Rastogi, 1985).

The most significant aspect of the institutional achievements in Doon Valley is in the field of law. The public interest litigations against limestone quarrying and air-pollution have been mentioned earlier. Their impact, particularly that of the first case, has been far reaching. The case brought to the fore the lack of internalisation of the parameters involved in the monitoring of quarrying in the Himalayas. Bhagwati (1988) described this impact as a new dimension of legal research in India, on law, natural resources, and development. The establishment of a new programme on Law and Natural Resources at the Indian Law Institute in Delhi is a direct reflection of such developments. The new possibilities related to law and natural resources in general, and mineral resources in the mountains in particular, are immense. The direct achievement has been the introduction of preconditions concerning environmental reclamation in the quarries.

The instances in Doon Valley also identified serious gaps in the administrative training and capabilities at the

district level that need immediate institutional response. The National Institute of Administration, being located in Mussoorie itself, could very well undertake this exercise in the Dehradun district on an experimental basis.

This relates to the administrators' grasp of the environmental characteristics of the districts they administer. In the current phase of accelerated economic activities and complex socioeconomic conditions, the district administration may find it almost impossible to make environmentally informed decisions on urgent matters of natural resource management. These matters may relate to quarrying, or to afforestation, or to land slides, or to water scarcity, or to air pollution, and it is the district authorities who have to quickly make decisions concerning these issues. This is simply an impossible task. In districts such as Dehradun, the number of institutions, which deal with environmental monitoring and management, may become useful in this respect. In the neighbouring districts of Tehri, Garhwal, or Uttarkashi, however, basic ecological information for urgent decision making may be totally absent. And if the administrators in Dehradun are hard pressed because they lack adequate information one can imagine the situation in less fortunate districts. Making available environmental information to the district administration becomes an important part of institutional innovation. This requires more exposure to the principles of integrated environmental management at the administrative trainee level and a toning up of environmental information gathering and analysis at the district level.

Realistic Projections for the Future

The record of environmental interventions in Doon Valley, as in many other parts of the world, is dominated by opposition to environmentally destructive economic activities. Where environmental interventions have been weak is in projecting the future situations of integrated environmental development. In fact, the policy guidelines for such projections have also not been outlined clearly. Quantitative statements about the valley crossing its "carrying capacity" are heard here and there. Yet there is no clear articulation of the basis for calculating this capacity. Carrying capacity calculations should be based

essentially on environmental models but as of today there is no model, except that of the current pattern of economic activities.

While the current pattern of economic activities has received very important corrective inputs for the future expansion of the valley, the attention given so far mainly predetermines the industrial growth of the valley. A holistic and multi-dimensional projection of the future is yet to be done for the valley. It is here that public opinion will have to play an important part. The provision of future situations is not merely a mechanical computer-modelling task. The framework needs to come both from the people and the policy makers in terms of what they want the valley to be. In the absence of popular participation in this process there is always the risk of generating an unrealistic supposition that may assume that the Doon Valley is an environmental preserve for the residents. The future situation needs a dynamic framework clearly keeping the valley's resource linkages intact within it and outside.

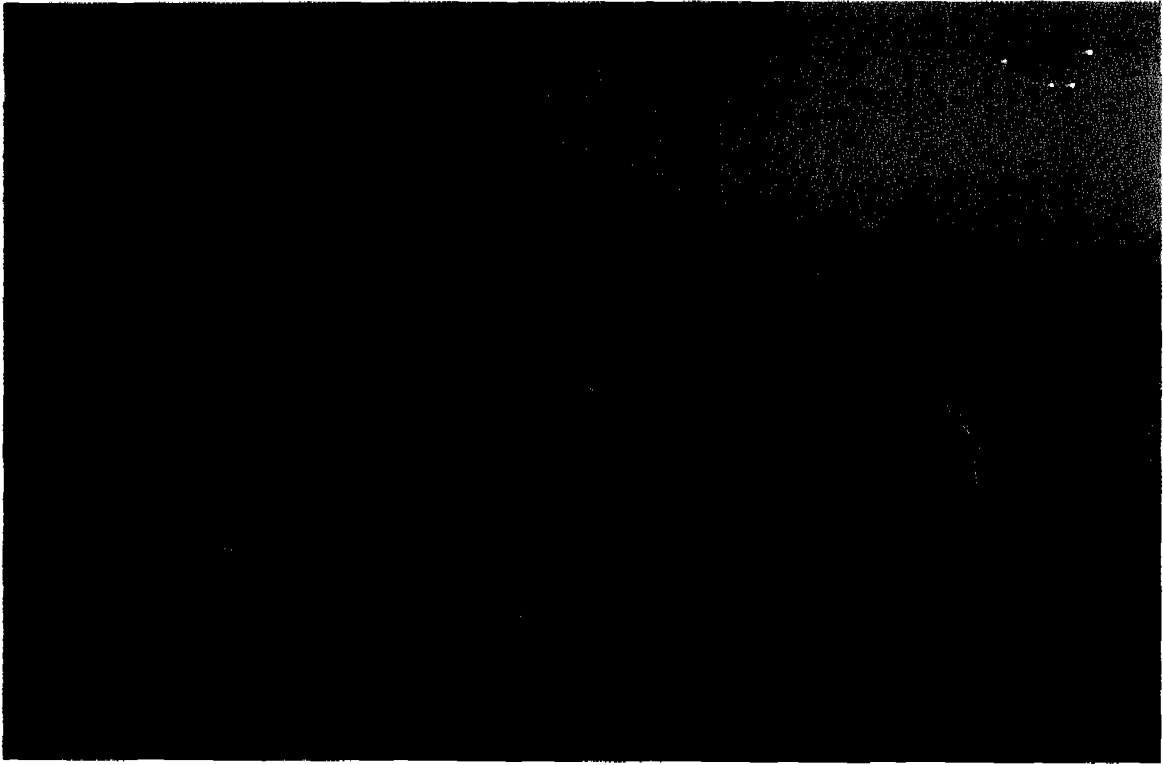
Finally, the future situation, if it is to be realistic, has to ensure that the basic resource needs of all people will be equitably met. All knowledge of mountain environments and all institutional innovations will be ineffective if there are a large number of people whose basic needs will not be satisfied in the future plans for Doon. The programme for integrated environmental management must essentially start from this platform of basic needs' satisfaction. Here the whole issue becomes partly non-local, by virtue of the movement of population to and from the valley, and is closely integrated with the Garhwal region to the north and the plains to the south. Thus, it is connected with issues of natural resource management over a much larger area. The immediate positive aspect of this real integration is that the influences of a small area such as Doon Valley can catalyse consciousness about the need for integrated environmental management over a much larger area. The full potential from the experiences of research and action in Doon Valley cannot be realised unless its impact spreads systematically over larger parts of the country, resulting in major debates and policy changes to enhance the role of integrated environmental management.

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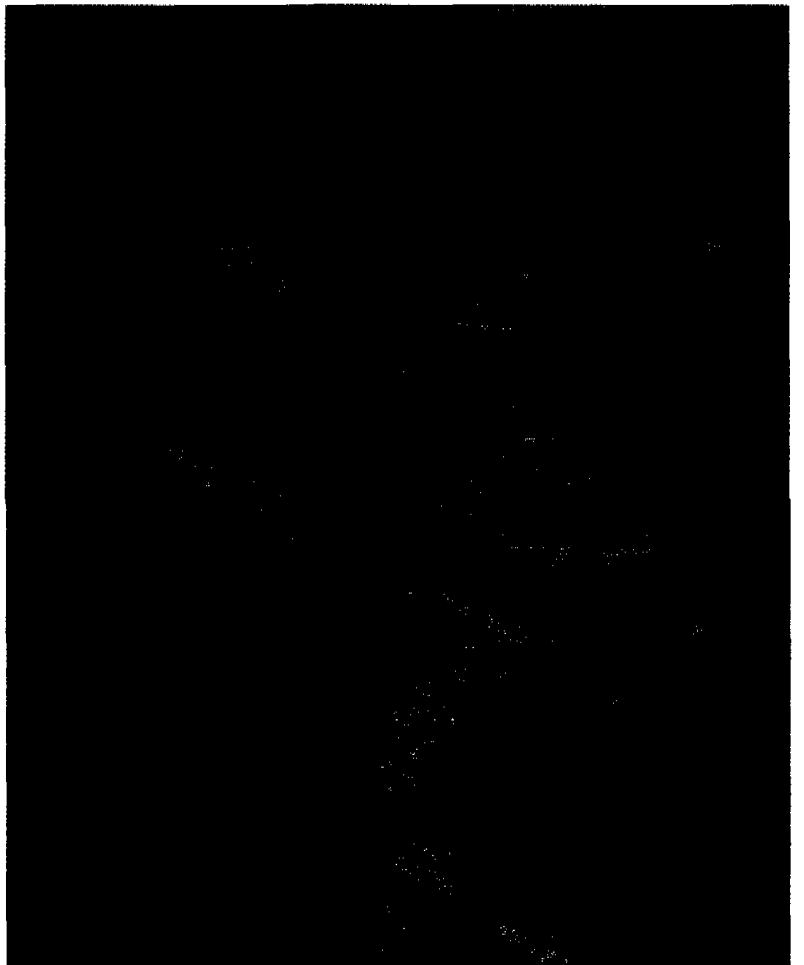
Fertile agricultural land in the northern parts of Doon Valley. On the left is seen land damaged by debris flow along the riverbed. In the background is seen degradation of a hillslope by a road under construction.



Fertile agricultural land in the southern part of Doon Valley. In the background is the rich vegetation cover of the Rajaji National Park bordering the farmland.



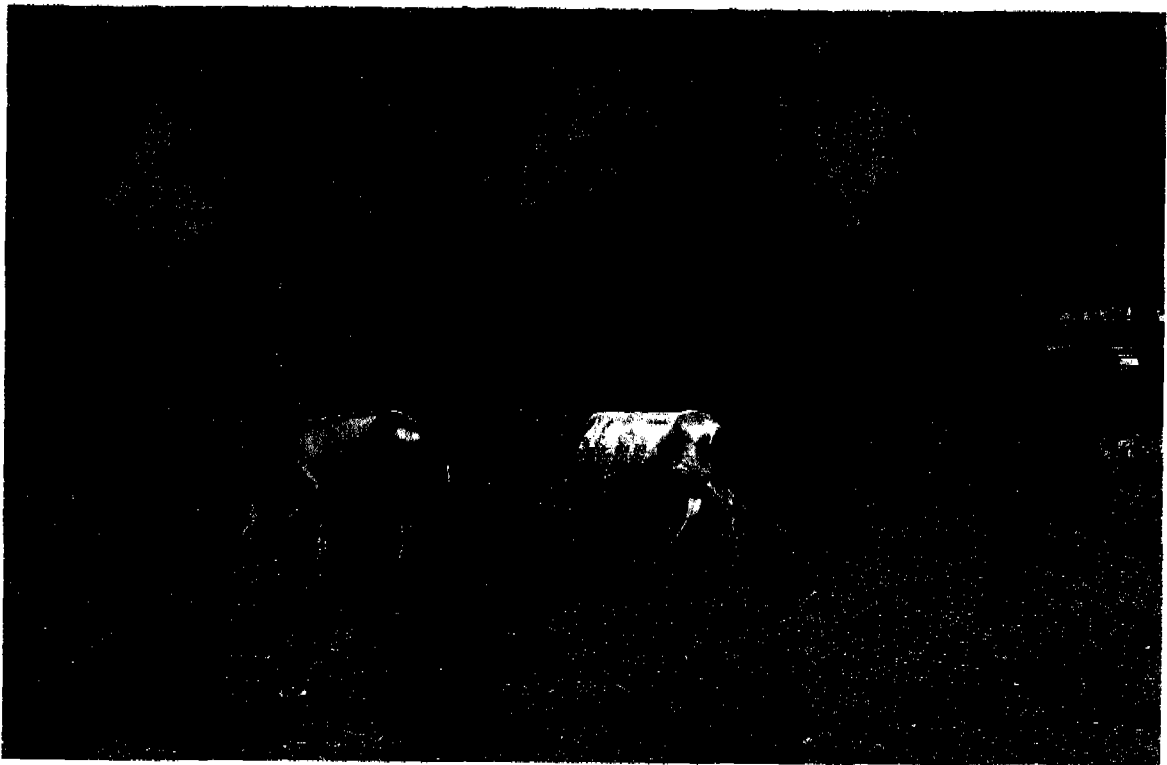
Nature of forest utilisation in Doon has changed from largescale production of timber by the forest department to large scale collection of fuelwood by the poor for the urban market.



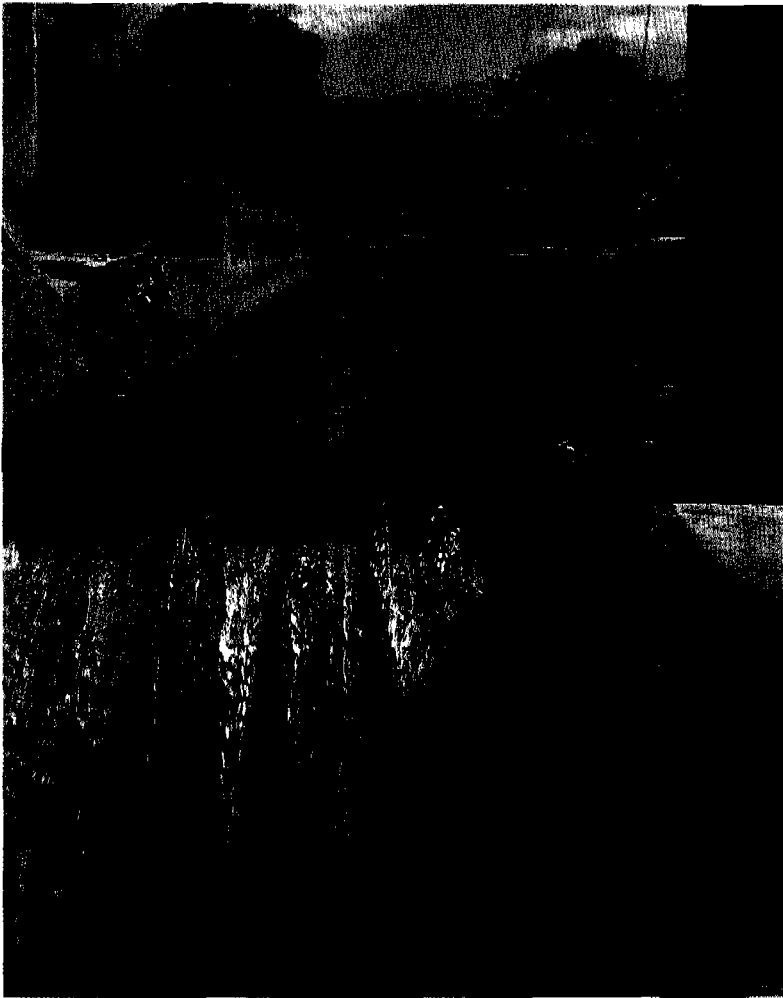
Degraded landscape on the southern slope of the Mussoorie hill damaged by overlopping and overgrazing. The first hydel station in the valley, built by the British at Bhatta, is seen in the foreground.



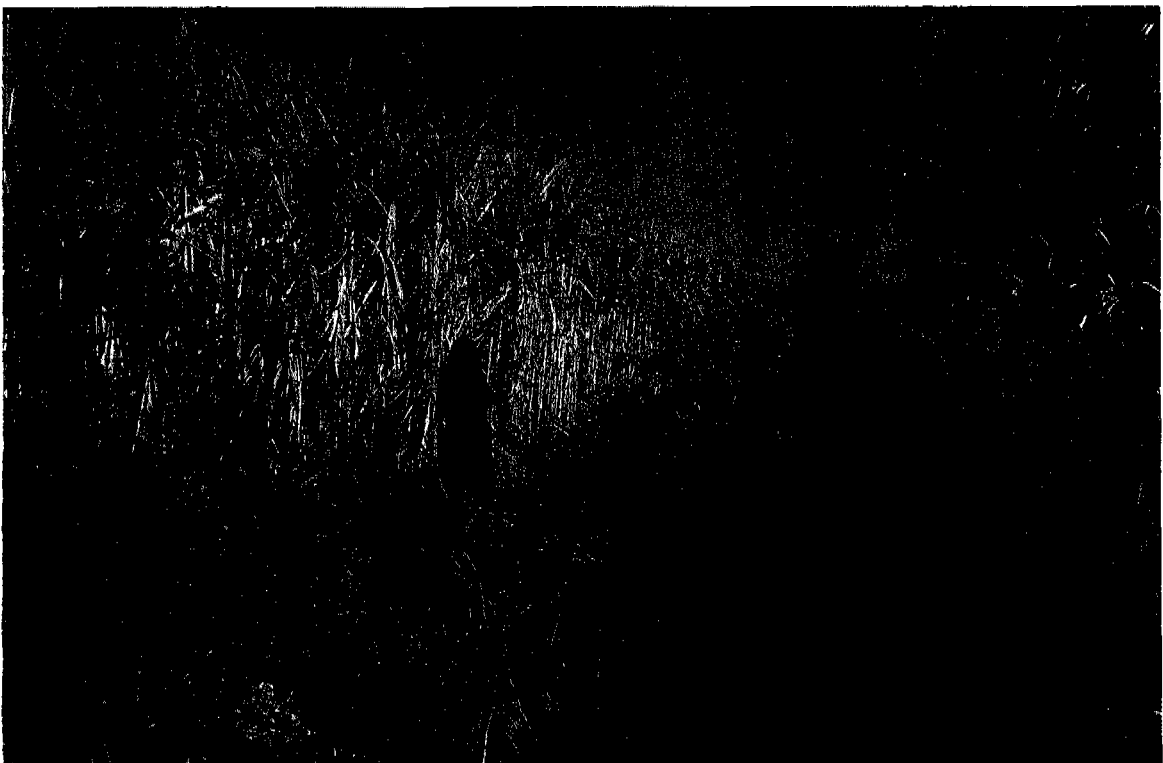
Among the first large scale transformations in landuse introduced by the British in the valley was the growth of tea gardens.



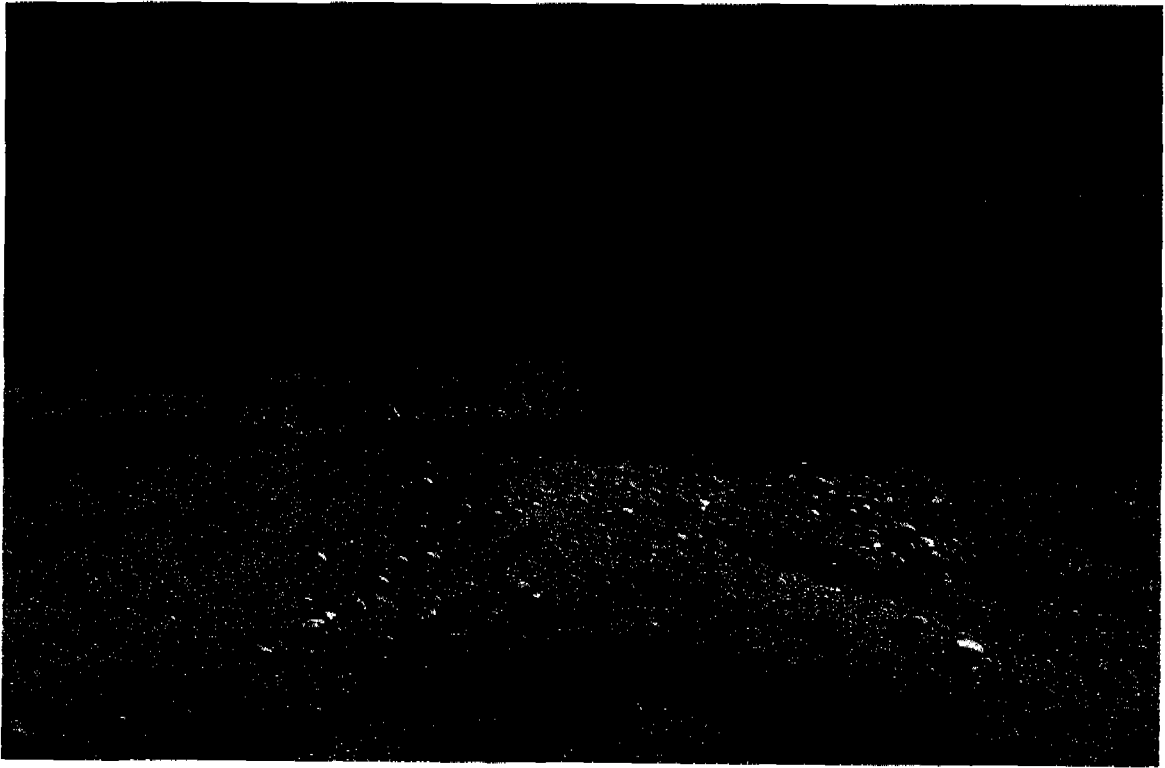
Tea bushes for the cattle! Environmental degradation and urban demand for land are probably the most important reasons behind the decay of the one time flourishing tea-economy in the Doon Valley.



Tapping the mountain streams at the foot of the Mussoorie hill and transporting the water long distances by stone-lined masonry canals was the making of the Doon economy.



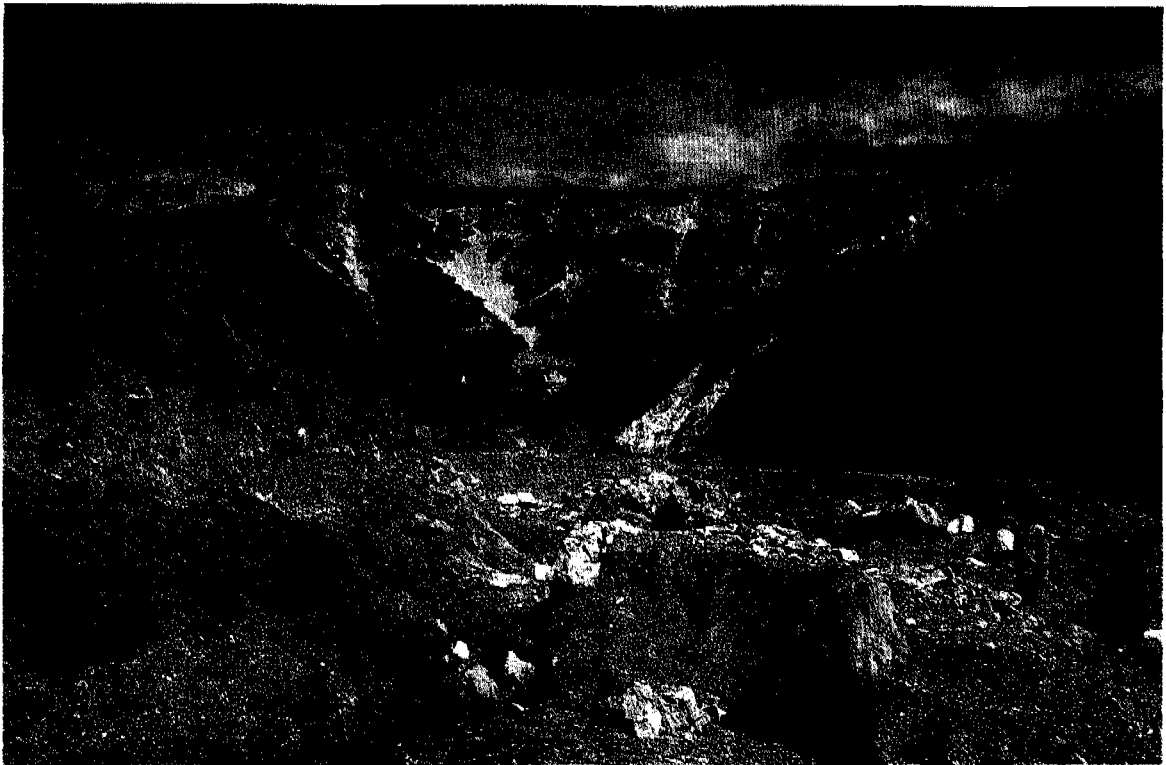
The availability of canal irrigation encouraged cash crops such as sugarcane in the lower parts of the valley.



The mountain hydrogeology of the Doon is such that once the streams emerge from the hills they flow below the gravelly riverbeds making surface water scarce for most parts of the year.



The groundwater then re-emerges from underground, forming large pools at the lowest parts of the valley, creating main drainage flows like Asan, Song etc.



The accumulative impact of limestone quarries on the private agricultural land, village pastures, and water channels was the most significant reason behind rural protests against limestone quarrying in Doon Valley. The photograph shows debris accumulation on the bed of Jud Khala, a small stream emerging from the Mussoorie hill.



The urban water supply of Dehradun during the monsoon months is maintained at heavy cost because of the constant need to divert the debris away from the main intake point. Any delay in doing so will "choke" the whole water supply system causing heavy losses.



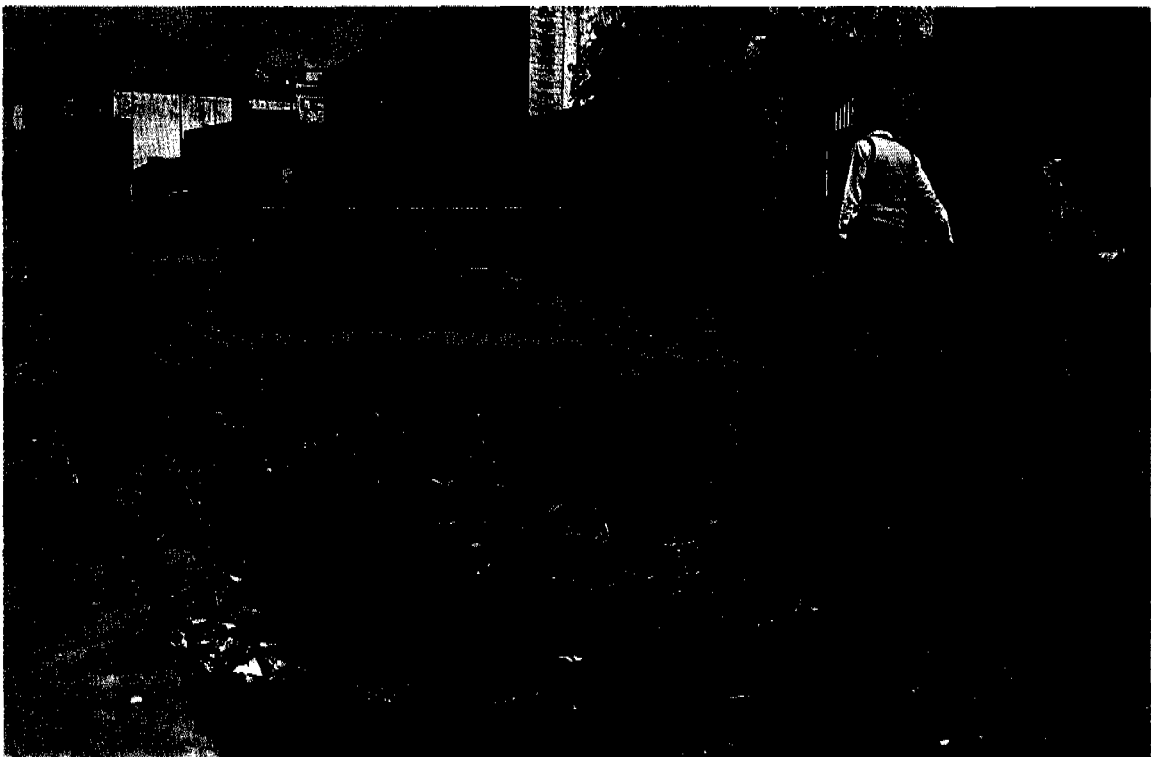
The members of the Ecological Taskforce of the Government of India have taken up the challenge of greening the areas of the Mussoorie hills damaged by quarrying, with a fair degree of success, providing new ideas in afforestation.



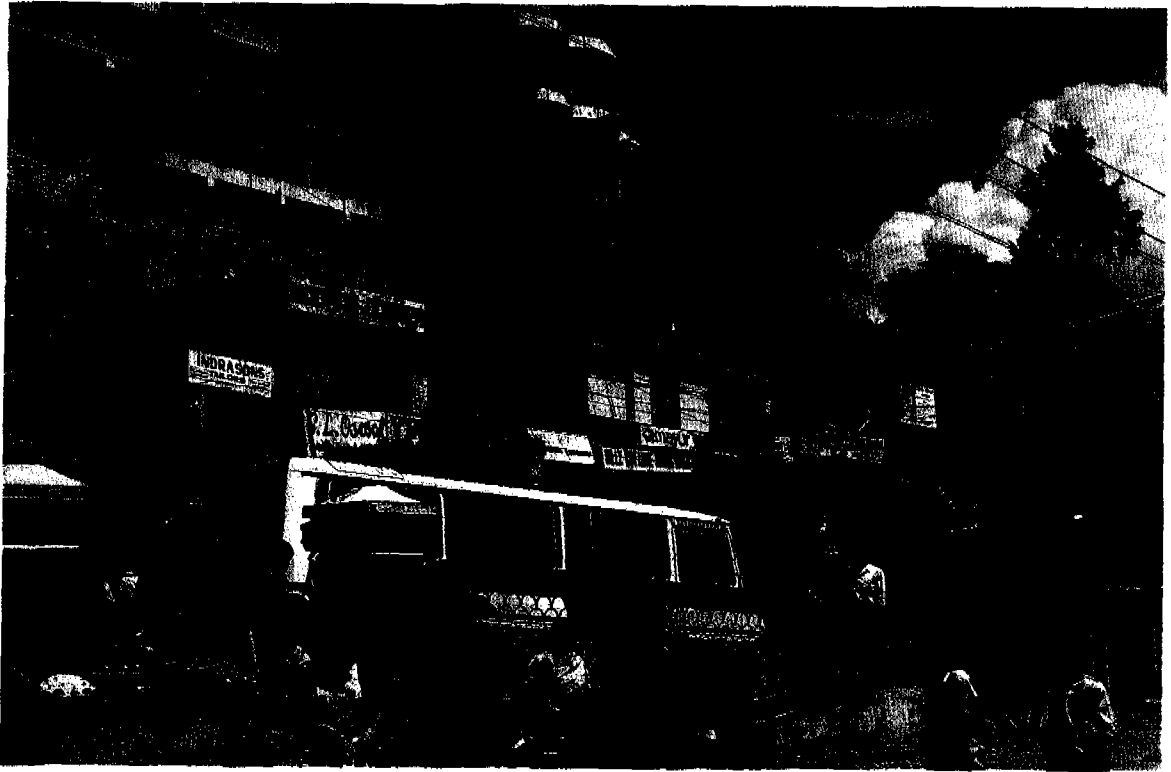
Industrial growth based on local mineral resources created a serious air-pollution problem threatening the flourishing agro-horticulture of Doon Valley and drawing heavy public protests.



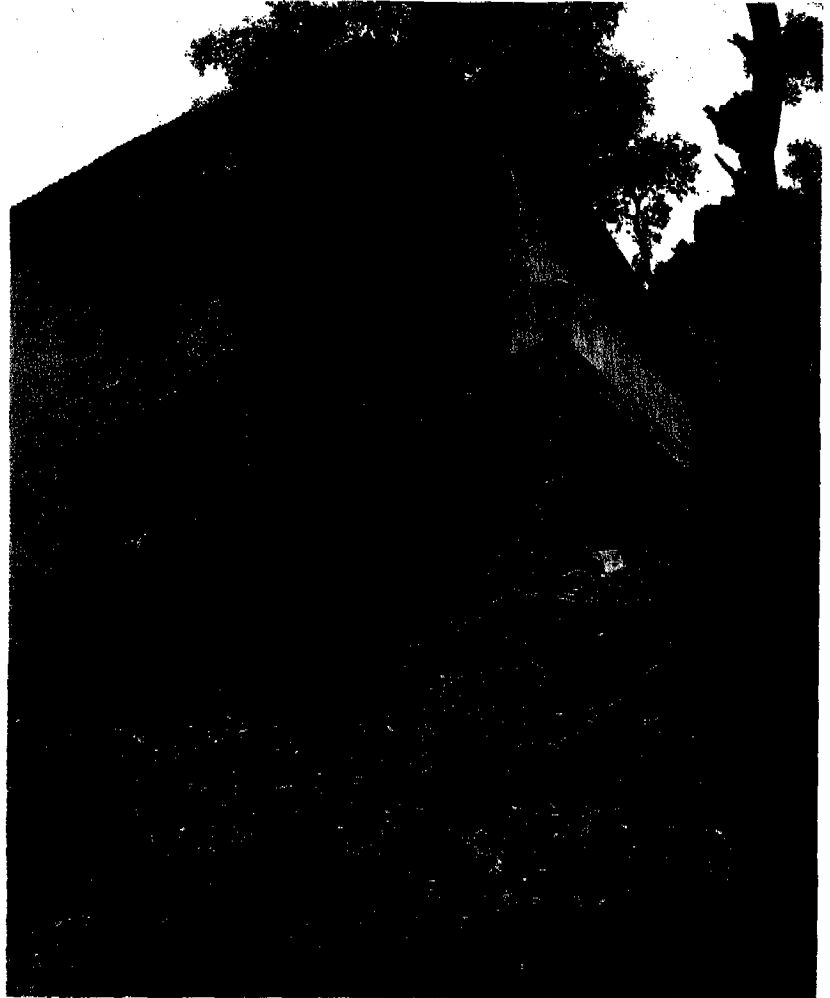
The growth of industries also caused serious pollution of water resources. The photograph shows a notice from the forest department cautioning anyone against bathing in the small rivulet which is highly polluted.



The internal environment of the one-time picturesque town of Dehradun rapidly degenerated because of industrial growth, leading to insanitary living conditions and urban decay.



Environmental degradation in Mussoorie was generated mainly by the huge rush of tourists and their need for accommodation.



House collapses, like this one, may soon become very common in Mussoorie as a result of landslip

The Author

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Founding of ICIMOD

ICIMOD is the first International Centre in the field of mountain area development. It was founded out of widespread recognition of the alarming environmental degradation of mountain habitats and consequent increasing impoverishment of mountain communities. A co-ordinated and systematic effort on an international scale was deemed essential to design and implement more effective development responses based on an integrated approach to mountain development and mountain environmental management.

The establishment of the Centre is based upon an agreement between His Majesty's Government of Nepal and the United Nations Educational Scientific and Cultural Organisation (UNESCO) signed in 1981. The Centre was inaugurated by the Prime Minister of Nepal in December 1983, and began its professional activities in September 1984, with the support of its foundation sponsors:

**HMG Nepal, the Government of Switzerland,
the Federal Republic of Germany and UNESCO**

The Centre, located in Kathmandu, the capital of the Kingdom of Nepal, enjoys the status of an autonomous international organisation.

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- Nepal
- India
- Bhutan
- Bangladesh
- China
- Pakistan
- Burma
- Afghanistan

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