

Environmental Study in Himalayan Region



D.S. JALAL ♦ B.R. PANT
R.C. JOSHI

ENVIRONMENTAL STUDY IN HIMALAYAN REGION



By

D. S. Jalal • B. R. Pant
R. C. Joshi

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

Contents

<i>Preface</i>	<i>vii</i>
<i>List of Tables</i>	<i>x</i>
<i>List of Figures</i>	<i>xiii</i>
1. Introduction	1
2. Preliminary Report on Geology	17
3. Morphometry	25
4. Climate and Natural Vegetation	42
5. Soil Genesis and Erosion	51
6. Specific Study of Landslides	66
7. Population, Settlement and Infrastructure	77
8. Landuse and Cropping Pattern	98
9. Agro-climatic Zones and Sampling Framework	116
10. Land Evaluation on the Basis of Land Capability Classification	147
11. Agricultural Efficiency	169
12. Food, Nutrition and Their Impact	177
13. Physical Factors and Landuse	197

14. Action Programme for Environmental Restoration	206
15. Findings and Recommendation	217
<i>Bibliography</i>	225
<i>Index</i>	237

Preface

Complex and intricate problems arising from land degradation in Himalaya have made environmentalists conscious of the immediate need of conservation and optimal use of the land resources. On account of the formidable problems issuing from the stagnant and deteriorating agricultural conditions, the ever increasing pressure of population on limited land resources, the poor condition of livestock wealth, the serious consequences of thoughtless deforestation, indiscriminate grazing and consequent soil leaching, erosion, landslides, rock-falls, floods and siltation, have made the need of landuse planning more than ever necessary.

Himalaya is a geographical-cultural continuum having innumerable regional variations. Each region boasts of its own individuality, asserts its uncommon characteristics, socio-economic and environmental problems, hence requiring a special treatment in its own way. A comprehensive survey of these problems should ultimately be conducted individually besides taking the country as a whole. Plans for improvements should therefore be based on carefully prepared local surveys. Present work is an attempt at filling a part of this need.

An attempt is made here at presenting a vivid account of the general and agricultural landuse of Kotadun which is characterized by highly undulating topography to the north and represents the landuse characteristics of Outer Kumaun Himalaya. Landuse survey even in the verification of records,

needs detailed field investigation for which the researchers visited to the study area. For further details three sample villages are selected at random, from three well identified physical strata of dunfloor or valleys, midslopes and uplands. The conclusion about agricultural efficiency, land evaluation, nutrition and deficiency diseases are based on the findings pertaining to those villages.

Authors' obligations are numerous. First of all we express our deep sense of gratitude to Dr. D.D. Pant, Professor Emeritus, Physics Department, Kumaun University, Nainital, Dr. K. S. Valdiya, former Professor and Head, Geology Department, Kumaun University, Nainital and Dr. J. S. Singh, Professor of Botany, Benaras Hindu University, Varanasi for their keen interest, inspiration and guidance at every step of the project work. We are also thankful to late Dr. S. L. Shah then Project Coordinator, Kosi Valley Action Research Project, Central Himalayan Environment Association, Nainital for extending his valuable suggestions. We record our indebtedness to the Vice-Chancellor, Kumaun University, Nainital and Campus Director for providing space and other basic facilities to establish the Optimal Landuse Research Laboratory in D. S. B. Campus of the University. Thanks are also due to Dr. L. S. Khanka, Dr. (Smt) Sudha Samant, Dr. N. S. Bora, Dr. A. Pande, Kunwar Singh and Vijay Singh for their kind help during the present work.

Grateful acknowledgement is conveyed to the Ministry of Environment, Forest and Wildlife, Department of Environment, New Delhi for generous sanction and funding of the project. Present book is an outcome of the Annual Progress Reports submitted to this funding department.

The area of the study is away from the University Headquarters and the maps and records maintained in various offices are confidential in nature and are far from availability. In this regard the investigators are thankful to the District Magistrate, Nainital, S.D.M., Kashipur and Peskars Ramnagar, Kaladhungi and Nainital for making them all the required information available. We are particularly

thankful to the authorities concerned for allowing us 10 ha of public waste land in Patkot in order to execution of action oriented programme. We are also thankful to the owner cultivators of Patkot and Saunjala for allowing these programme in 3.6 ha and 1.2 ha of their respective private lands. At the last but not the least we records our sincere thanks to residents, social workers and officials of Kotadun who co-operated the investigators in all respect of research as well as action programme operations.

D. S. Jalal,
B. R. Pant
R. C. Joshi

List of Tables

1.1	Kotadun: Identified Study Unit	15
3.1	Kotadun: Absolute Relief	27
3.2	Kotadun: Relative Relief	28
3.3	Kotadun: Average Slope	35
3.4	Kotadun: Statistical measures of Slope	36
3.5	Slope Vs Absolute Relief	36
3.6	Kotadun: Slope Vs Relative Relief	37
4.1	Kotadun: Temperature (°c)	44
4.2	Kotadun: Rainfall (mm)	45
5.1	Kotadun: Physical Characteristics of Soil	54
5.2	Kotadun: Physical Properties of Soil	57
5.3	Patkot: Chemical Analysis of Soil	61
5.4	Kotadun: Erosion Intensity	64
6.1	Kotadun: Primary Landslides Along M. B. F.	70
6.2	Kotadun: Secondary Landslides Along M. B. F.	71
7.1	Population Growth (1971-1981)	78
7.2	Population Densities	80
7.3	Sex Ratio	82
7.4	Age Groups	82
7.5	Literacy	83
7.6	Kotadun: Size Distribution of Settlement	87
7.7	Livestock 1986	90

7.8	Irrigated Area (1985-86)	91
7.9	Distribution of Canal	92
7.10	Electrified Villages (1986-87)	94
7.11	Kotadun: Institutional Infrastructural Facilities	96
8.1	Classification of Area (1985-86)	99
8.2	Landuse (1985-86)	101
8.3	Unit wise Distribution of Landuse (1985-86)	108
8.4	Cropped Area (1985-86)	112
8.5	Cropping Pattern (1985-86)	113
8.6	Unit wise Distribution of Various Crops (1985-86)	114
9.1	Altitudinal Agro-Climatic Zones	121
9.2	Land Capability Classification Model for Himalayan Region	124
9.3	Area Under Different Categories of Land in the Sample Villages (1986-87)	126
9.4	Changing Landuse in the Sample Villages (1954-55 to 1986-87)	128
9.5	Area Under Different Landuse Classes in the Sample Villages(1986-87)	129
9.6	Existing Cropping Pattern in the Sample Villages (1986-87)	131
9.7	Land-Man Ratio in the Sample Villages (1986-87)	132
9.8	Population Profile (1986-87)	134
10.1	Patkot: Major Landuse in Different Land Categories (1986-87)	153
10.2	Amgarhi: Major Landuse in Different Land Categories (1986-87)	154
10.3	Sigarhi: Major Landuse in Different Land Categories (1986-87)	155
10.4	Patkot: Kharif Cropping Pattern in Different Land Categories (1986-87)	156

10.5	Amgarhi: Kharif Cropping Pattern in Different Land Categories (1986-87)	157
10.6	Sigarhi: Kharif Cropping Pattern in Different Land Categories (1986-87)	158
10.7	Patkot: Rabi Cropping Pattern in Different Land Categories (1986-87)	159
10.8	Amgarhi: Rabi Cropping Pattern in Different Land Categories (1986-87)	160
10.9	Sigarhi: Rabi Cropping Pattern in Different Land Categories (1986-87)	161
11.1	Degree of Agricultural Efficiency	172
11.2	Unit-wise Productivity Index (1985-86)	175
12.1	Actual Per Head Per Day Food Intake (1986-87)	183
12.2	Average Per Head Per Day Food Supply (1986-89)	184
12.3	Nutritional Deficiency Diseases in the Sample Villages (1986-87)	188-189
12.4	Mortality and Morbidity (1986-87)	190
12.5	Average Composition of An Improved Diet Per Head Per Day	194
12.6	A Compendium on Nutrition and its Related Aspects	195-96
13.1	Kotadun: Production	200
13.2	Kotadun: Correlation of Physical Properties and Landuse	202
14.1	Area Under Demonstration Programme at Site - 1	209
14.2	Plantation Work at Site—1	214
14.3	Construction work (1985-88)	215
14.4	Plantation Work at Site—2 and 3	216
15.1	Landuse Evaluation in Kotadun	221

List of Figures

1.1	Kotadun : Location Map	9
1.2	Kotadun : Planning Units	15
2.1	Kotadun : Lithological Distribution	18
3.1	Kotadun : Absolute Relief	26
3.2	Kotadun : Relative Relief	29
3.3	Kotadun : Average Slope	32
3.4	Kotadun : Drainage Network	34
4.1	Kotadun : Temperature and Rainfall	43
4.2	Kotadun : Forest Types	48
5.1	Kotadun : Soils	52
5.2	Kotadun : Erosion Intensity	63
6.1	Kotadun : Environmental Hazards	67
7.1	Kotadun : Population Distribution and Growth	79
7.2	Kotadun : Agriculture Density	81
7.3	Kotadun : Distribution and size of Settlements	86
7.4	Kotadun : Institutional Infrastructure (1987-88)	95
8.1	Kotadun : Major Landuse (1985-86)	100
8.2	Kotadun : Kharif Landuse (1985)	110
8.3	Kotadun : Rabi Landuse (1985-86)	111
9.1	Patkot : Major Landuse (1954-55)	135

9.2	Patkot	: Major Landuse (1986-87)	136
9.3	Patkot	: Kharif Landuse (1986)	137
9.4	Patkot	: Rabi Landuse (1986-87)	138
9.5	Patkot	: Double Cropped Area (1986-87)	139
9.6	Patkot	: Land Classification and Proposed Landuse	140
9.7	Amgarhi	: Major Landuse (1955-56)	141
9.8	Amgarhi	: Major Landuse (1986-87)	141
9.9	Amgarhi	: Kharif Landuse (1986)	142
9.10	Amgarhi	: Rabi Landuse (1986-87)	142
9.11	Amgarhi	: Double Cropped Area	143
9.12	Amgarhi	: Land Classification and proposed Landuse (1986-87)	143
9.13	Sigarhi	: A—Major Landuse (1955-56) B—Major Landuse (1986-87)	144
9.14	Sigarhi	: A—Kharif Landuse (1987) B—Rabi Landuse (1986-87)	145
9.15	Sigarhi	: A—Double Cropped Area (1986-87) B—Land Classification and Proposed Landuse (1986-87)	146
11.1	Kotadun	: Agricultural Efficiency (1985-86)	173
11.2	Kotadun	: Agricultural Productivity (1985-86)	176
12.1	Kotadun	: Agro climatic Zone, Mortality and Morbidity	180
12.2	Nutritional Status And Deficiency Diseases (1986-87)		186
13.1	(a)	Crop Production Graph	
	(b)	Terrain: Landuse and Population	201
14.1	(a)	Crop Production Graph	
	(b)	Terran: Landuse and Population	210
14.2	Working Sites		213
15.1	Land Evaluation Model		222

Chapter 1

Introduction

1.1. THE PROBLEM

The ever increasing pressure of population, deteriorating environmental conditions and increasing value of land signify to study every use, misuse, overuse and underuse of land. Much can be said about the basic importance of optimal use of our limited land resources. According to Stamp (1964) food, shelter, work, recreation, movement and security are the six basic needs of man which involve the use of land for their fulfilment. There are always reasons whether of natural or cultural factors that have determined the use of land in a particular area. The present day landuse of any area is certainly an outcome of hundreds of years of ecological process and human endeavour.

The use of a particular piece of land varies according to the needs of society in changing space of time. Man with his knowledge and skill has converted the land into large agricultural farms, big cities, industrial complex etc. Of course, the nature of land has to play very important role before man's occupancy. There are areas where agriculture is not at all possible or is uneconomic in certain areas, some land is not fit for the development of large cities, industrial complexes or even for the purpose of activities like grazing, forestry, quarrying and constructions. So the landuse of any area is a complex phenomenon and is the outcome of the complete system of a region.

2 *Environmental Study in Himalayan Region*

Undoubtedly, prosperity of any region, growth of its economy and improvement in the living condition of its people much depends upon the proper utilization of the land available. Since, the land is scarce and limited, its misuse can yield very drastic horrified results to the physical as well as the cultural environment, while a just, wise, scientific and proper use of every piece of land can facilitate to grow a region faster and ably manage its future plans. The limited area of land can in no way be expanded while the population depending on that particular land grows faster which spares no alternative to accommodate this extra burden but to utilize the land properly and optimally with scientific endeavours. The definition of proper or optimal use, however, varies from one piece of land to another.

Thus, it is of utmost importance to determine the present uses of land in a region and to ascertain, if possible how it has come into being. The future development and prosperity according to Stamp (1960), must start from the present existing pattern. The landuse planning, thus, seeks for the factors which are operative, to think in terms of potential use and what land ought to be used for.

The basic need today is to think about the reorganization of existing land resources and then to execute plans for its improvement, optimization and re-orientation. The optimum situation can only be achieved through scientific landuse planning. The landuse maps play an important role in this regard in order to ascertain what part is presently put under what uses and that are the prospects of its better use for the prosperity and well being of the population depending on it. The strategy should be that there remains no possibility for the misuse of the land resources. Stamp (1962) determines that land planning is an essence of the determination of the optimum use of every piece of land which must be elastic and can change from time to time to adopt the changing conditions.

The problem of landuse becomes more complex and intricate in mountainous environment where overwhelming proportion of the land is either not directly utilized or left

unused due to adverse environmental conditions. The basic and most important use to fulfil the requirements is for agricultural activities for which hardly one third of the total land is presently available. Further, the productivity of land is restricted in many ways and is so poor that cannot be compared in any way with that of the conducive agricultural environment of plains. Moreover, the problem of soil erosion, land degradation, deteriorating ecological conditions etc. are the other important factors which focus the need for an instant conservation and reorganization of land in these areas.

Land degradation in Himalaya owes its origin, directly or indirectly, to the faulty landuse. Kumaun Himalaya is by not means an exception to this land degradation problem. There almost every patch of accessible land has been exploited. The problem of soil erosion is very alarming on account of very limited soil depth and steep slopes. The chances of recovery of soil according to experts are nil. The soil has reached the point of exhaustion and the economy has begun to collapse. These areas were a green and pleasant lands thirty years ago and today it is blasted health. Unscientific and indiscriminate deforestation and faulty land management have led to the miserable depletion of land resources. The uncontrolled flow of water from streams not only deteriorates the soil conditions but also creates havoc in plains through flooding and siltation. The agriculture is not in a state to fulfil the requirements of the region for more than five-six months in a year. The condition is turning from bad to worse day by day inspite of measures being taken by various agencies to improve the condition. This all emphasises the need for immediate land planning for its optimal use and management of these areas through detailed landuse survey of different parts. Since each region boasts of its own individuality, asserts its uncommon characteristics and agrarian and socio-economic problems, it requires a special treatment in its own way.

International Geographical Union has recommended that the landuse survey in India should be based on the British

model advised by Stamp (1962). But this seems not practical in case of our country owing to certain limitations. The alternative suiting the landuse planning in India may be the modified form of Chinese method wherein the basis is the survey conducted by Buck (1937). It is confined to sample surveying of certain selected areas and the construction of a generalized picture of landuse.

Individual studies of different parts can contribute significantly in solving the local landuse problems. Shafi (1960) has emphasized the need for such local surveys to be conducted throughout the country for improving agricultural and social environment.

1.2. AN OVERVIEW OF LITERATURE

The idea of landuse studies is basically concerned with the ideas of British Geographers where in 1930 the landuse survey of every acre of land was recorded on maps. It was organized by Prof. Stamp (1948) in October 1930. The idea was to find out exactly what use was then made of every acre of land of Great Britain. The bulk of the country was actually surveyed and the land was recorded for the years 1931, 1932 and 1933. There remained small parts which had to be completed later but the whole was virtually finished before the out-break of war in 1939 and the plough-up campaign which made such an enormous difference of landuse in country (Stamp 1964).

Besides Britain, several other countries viz. U. S. A., Japan, China, U. S. S. R., Canada, Pakistan, Nepal, Cyprus etc. conducted landuse surveys. In U. S. A. the beginning of landuse survey can be traced from the work of Baker. He emphasized the need of land classification and surveys. U.S. Department of Agriculture also launched a programme of landuse survey in 1935 and 1938. The concept of American landuse planning as per view of Hill Man (1957), is as broad as country life itself and organisation therefore, presumably begun with the most general functional organization that can be discovered in an area.

In Japan the landuse surveys have been given the highest priority to support its huge population on the small area of cultivated land (Stamp 1964). In China sample landuse surveys were conducted by John Lessing Buck (Buck, 1937) and others highlighting the landuse problem in China. Landuse survey in many other countries are also in progress and being conducted by individuals as well as government and semi-government organization. In Nepal P. P. Karan (1960) had made a study of landuse map using air photographs.

Indian Geographers have long been attracted to study the problems of landuse in the country. In 1940, S. P. Chatterjee pointed out the necessity of undertaking landuse survey in India on the lines of that of Great Britain undertaken by Lord Dudly Stamp. Many Geographers and economists started landuse studies taking small and large units for study. S.P. Chatterjee (1945) proposed an atlas of land utilization in the District of Twenty Four Parganas of West Bengal. A detailed survey was also conducted in Hawrah and 1200 landuse maps were prepared. P. Dayal (1947) prepared a thesis on Agricultural Geography of Bihar. V. L. S. P. Rao (1947) made landuse study of Godavari Region and referred to the aims, objectives and classification of categories of landuse of the World Landuse Commission set up by the International Geographical Union. Mohd. Shafi (1960) emphasized the need of sample landuse survey and carried out landuse survey of Eastern Uttar Pradesh. Other eminent workers in the line who have carried out landuse surveys in different parts of the country and highlighted the various aspects of landuse planning, are U. Sen and M. Guha (1960), R. Lahiri (1950), S. B. Goswami (1960), A. Sharma (1962), R. N. P. Sinha (1960), K. N. Das (1956), R. L. Singh (1968), O. P. Bhardwaj (1961 & 1964), B. N. Ganguli (1955), U. Singh (1955), V. R. Singh (1950), B. K. Roy (1969), C. B. Joshi (1961), A. T. A. Learmonth (1962), K. Z. Amani (1965), B. N. Sinha (1948), D. S. Jalal (1970, 71, 76) Jasbir Singh (1971), V. M. Deshmukh (1975), M. Prasad (1978), B. N. Jha (1979) etc.

Besides, various other institutions and department like National Bureau of Soil Surveys and Landuse Planning ICAR, Agricultural Universities, Department of Science & Technology, Department of Environment, National Landuse and Wasteland Development Board, etc. are also engaged in carrying out sample surveys of various parts of the country.

The Himalayan areas have not received very much attention as far as the detailed landuse planning of the area is concerned. Studies carried out by S. L. Kayastha (1964), S. C. Shah (1973), Tewari (1966), Jalal (1970 and 71), Samant (1986), a few sample surveys carried out by Pantnagar Agricultural University and some studies by NIRD of Hyderabad are worth mentioning. The most important legendary work carried out in Kumaun Himalaya is by Jalal (1976) who has studied the landuse of a most remote part of the country i. e. the border district of Pithoragarh.

No landuse survey is however available for the Kotadun of Kumaun Himalaya which is the study area of present analysis. This part of the Kumaun Himalaya is an entirely different physico-cultural entity obviously distinguishable from the rest parts of Kumaun. The problems of landuse, the agricultural practices and other socio-economic and ecological problems are different owing to peculiar physical and socio-economic environment and area is most backward in reference to the Kumaun Himalaya as a whole. It calls for a specific landuse study and landuse planning. The agriculture is still of subsistence type. Activities outside agricultural sector are also not affluent to make the region self-sufficient. Ecological conditions are getting worse day by day with the indiscriminate cutting of trees and over exploitation of forest resources, soil depth and fertility is diminishing owing to the problem of soil erosion. Likely unwise and unscientific use of agricultural land as well as of the land under others uses creates innumerable problems. This all leads to a further deterioration in agriculture which is already in a very bad state. Keeping all these factors in view a landuse survey of this area is found to be immense

and useful for the overall socio-economic and ecological development of the region. Moreover, such a case study can serve as a model for other hill areas or recommendation and findings of this study may be applicable to many of the environmental conditions similar to those of the area under survey.

1.3. CONCEPT

Land utilization is a comprehensive expression connoting the use of land resource in such a manner that provides for a maximum exploitation of land area available. Planning and management of land refers to the conscious determination of use of land for the attainment of rationally desirable goals. Land has a geographical location and includes many components such as physical, biological, economic and institutional factors of the surface. It possesses variable capacity for different uses. The various uses of land can be studied in terms of land capability, land productivity, land efficiency, potential productivity, standard nutrition, land classification, land evaluation etc. It also involves the socio-economic conditions of inhabitants of an area since the use of any piece of land is very much determined by willingness as well as awareness of an individual or a community to put a land in its specific use. Moreover, in broadest sense, it includes all those man-made improvements which are attached to the surface of the earth and which cannot be separated from it.

In landuse planning there ought first to be the stage of survey—the recording of the present position; secondly, the stage of analysis—the seeking to understand the reasons for that position and of seeking what are the existing trends in development, and then, thirdly, the actual planning for future which must take the past and present trends into full consideration. The planner's task is not only to determine the optimal use of the piece of land but its multiple use whenever possible. The land planning must satisfy the basic needs of the inhabitants. There is a great need for integration between essential uses of land. Rival climents are each very

apt to regard their particular requirement of land as being the most important. In doing so there are three golden rules to be observed. The first may be called the rule of optimal use, the second as the multiple use and the third that there ought not to be any waste land.

Landuse planning also aims at a much better adjustment of each category uses to the physical environment for the optimum utilization of land and conservation of natural resources. It also involves to propose a tentative scheme for the agricultural improvement based on the geographical potentialities under the limitations imposed by controlling factors. Landuse planning suggests the manner in which land resources are used and maintained for which group action is needed from time to time to discourage unwise wasteful practices, which may prove injurious to himself, to the neighbours and community and to society at large. Thus, the landuse study of a region in a synthetic form must bring out the personality to land-man activity, optimal and best use of each piece of land and the associate problems. The findings with their correct perspective should be a base for the formulation of an optimal landuse plan of the area.

1.4. The Study Area

Kotadun is the study area of present investigation. Extending in a general east-west direction, it is one of the five duns (Dehra, Kothari, Chaukhamba, Patli and Kota) in the Uttarakhand Himalaya. Along with its well demarcated boundaries of watersheds of Kunjkhara-Binayak range of Lesser Himalaya to the north and Babilia-Kailkhura range of Siwaliks to the south, Kotadun like other duns, is an elongated valley between river Kosi in the west and river Baur in the east. West of Nainital area, it extends between $29^{\circ} 17'39''$ and $29^{\circ} 30'40''$ N. lat., and $79^{\circ} 9'13''$ and $79^{\circ} 26'24''$ E long. (Figure 1.1) and encompasses an area of 360.78 km^2 and a population of 20657 persons in 1981. Including three forest localities, there are 96 inhabited and one un-inhabited villages.

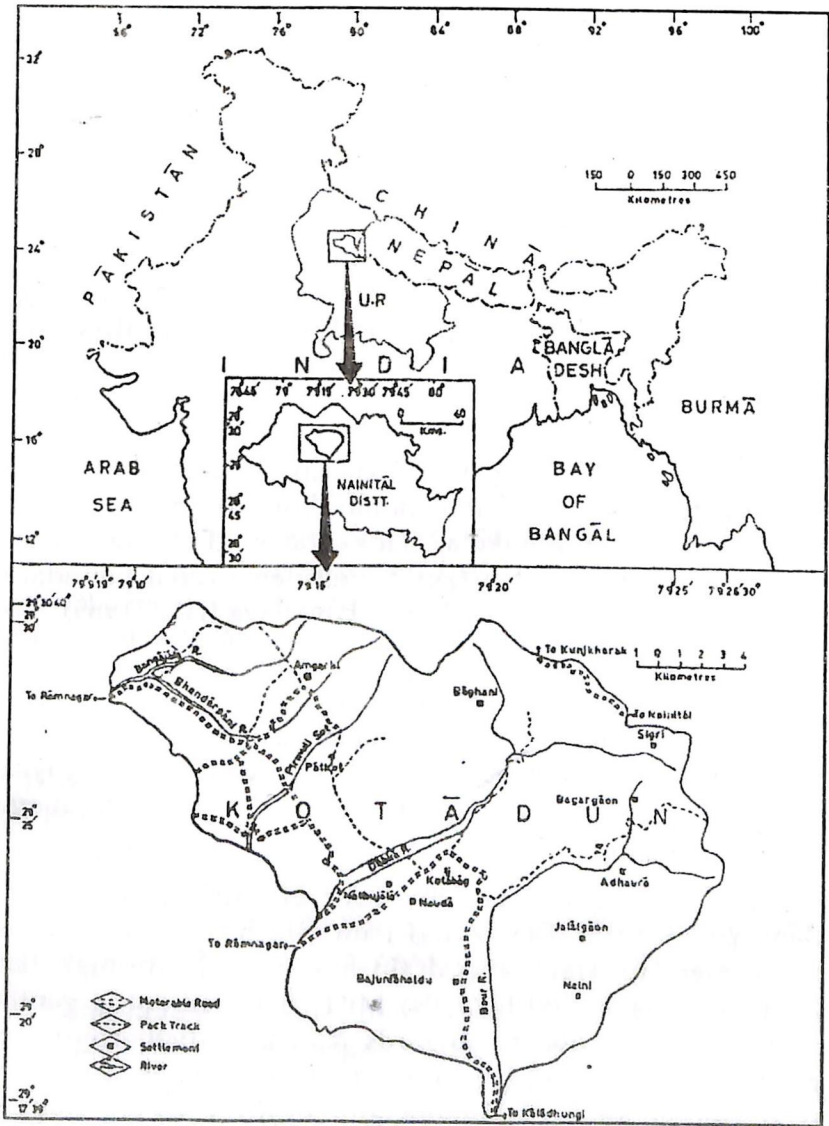


Fig. 1.1 Kotadun: Location Map

Kotadun is the combination of two words viz. Kota+Dun. 'Kota' refers to 'KOTHA' i.e. palace of Chand rulers the ruins of which lie near Ranikota. It was perhaps the winter resort of the Chand rulers. 'Dun' refers to longitudinal structural valley lying between the Siwalik and the Lesser Himalayan ranges. In its geological epoch, the Outer Himalaya (Upper Siwalik, Dun floor and Lower Siwalik) is younger in its stratification and upliftment, and is still uplifting at a higher rate than the Lesser Himalaya. The MBT (Main Boundary Thrust) occurring between the Outer and the Lesser Himalaya is an unstable and fragile zone, and if such a sensitive area is subjected to unplanned or indiscriminate biotic pressure, it becomes highly vulnerable to erosion, masswasting and landslides. In Kotadun this thrust zone extends along southern foot-hills of the Kunjkharak-Binayak range and passing through Goriadeo, Boharakot, Amgarhi, Simali, Sisoniya, Sanarha, Ranikota, Dabka valley, Mahrora, Bagar, Adhaura and Bajun, it makes a well demarcated boundary between the Outer and the Lesser Himalaya (Jalal, 1985).

In general, the altitude ranges from 400 m to 2600 m above m. s. l. while some of the peaks of Kunjkharak-Binayak range rise to more than 2500 m and those of Babilia-Kailkhura range to above 750 m. At the point where stream Bangajala terminates in river Kosi, the altitude dips to a little above 400 m.

The area is drained by four stream systems viz. Bangajala, Masani, Dabka and Baur which take their rise in the Lesser Himalaya and drain antecedently through the Outer Himalaya. South of the MBT, the gradient is gentle with a gradual decent towards dunfloor furthermore, a gradual rise towards Lower Siwaliks. The Outer Himalaya is composed of accumulated and uplifted recent debris carried down by the streams from the Lesser Himalaya. Coarse deposition comprising boulders, gravel and sand tends the streams passing through and dun, to drain subterraneanly during the lean season. The Outer Himalayan formation is suitable for extensively dense tropical-subtropical

vegetation. North of the MBT, on the other hand, the gradient increases suddenly because of abrupt rise in the altitude. Steep slopes and crests of the Lesser Himalaya are uninhabitable and are covered with temperate vegetation.

Most of the settlements in the area occur near MBT on foot-hills or alluvial fans, in the vicinity of some perennial water source in the Lesser Himalaya. In the Dun floor, these have grown along the larger streams viz. Kakrar (feeder of Bangajala), Kaligad (feeder of Masani), Dabka and Baur, so that the water tapped at the foot-hills, is enough to meet the requirements.

The diversified topography, tectonic unstability and seismicity and the climatic variations (south facing slopes exposed to summer sun, high monsoon rains and cold winter conditions) combined with human interferences, have made this region fragile and hazards-prone. In the past three decades in the name of regional development for economic growth, more drastic damage has been done creating an ecological imbalance such as accelerated erosion, landsliding, masswasting, flooding, siltation, sedimentation etc., during monsoon rains and draughts in the dry months. Haphazard, indisciplined and short-sighted human activities such as ruthless exploitation of forest resources, overgrazing, unplanned cultivation, uncontrolled quarrying and constructions etc., consequent upon continuously increasing pressure of human as well as animal population, have caused severe land denudation affecting adversely the environmental conditions in the area under study.

The strategy of restoration of the damaged environment involves scientific investigations (land resource survey, land capability analysis and planning for optimal and multiple use of the land without deteriorating the eco-system) and intensive education to the society through demonstration and extension programmes at the sites affected. Present scheme is aimed at achieving these objectives in order to secure the ecological imperatives, utilize prudently the land capability, improve the economic condition of the society and restore a

better equilibrium between the environment and the development of economic activities mainly the agriculture, forestry, grazing, mining and quarrying, settlements, roads and communications, industries etc.

1.5. AIMS AND OBJECTIVES

The project is aimed at:

- (i) accomplishing a comprehensive landuse and land capability survey in Kotadun, Kumaun Himalaya to obtain information on the present landuse, its malpractices and consequent environmental implications,
- (ii) formulating a scheme for optimal landuse taking into account the land capability, ecological imperatives and economic needs; and
- (iii) educating local people in implementation of the optimal landuse scheme through demonstration and action programmes at two sites selected in Patkot and one in Saunjala.

The study thus includes:

1. drawing an overall picture of present landuse in Kotadun,
2. describing of unit wise landuse pattern of the area,
3. identifying of physical units,
4. explaining of physical and cultural environment of the area,
5. analysing of physical as well as cultural determinants of landuse,
6. explaining of landuse changes from 1954-55 to 1986-87 and cropping pattern of 1986-87 occurred in selected sample villages,
7. developing of model for land capability classification,

8. analysing of agricultural efficiency,
9. dividing of area in different altitudinal agro-climatic zones,
10. studying of land degradation with special reference to land slides,
11. suggesting of a suitable and feasible scheme for improving landuse and ecological conditions.

1.6. METHODOLOGY

The methods involved in carrying out the present investigation are as follows:

- (i) Base maps are presented with the help of SOI toposheets specifically for relief, drainage, settlement, vegetation etc.
- (ii) Maps for the sample villages are drawn from the revenue maps obtained from the tahsil headquarters of Nainital, Kaladhungi and Ramnagar.
- (iii) Data pertaining to physical factors of relief, slope, drainage, forest and revenue area are based on the SOI toposheets through measurements by planimeter and rotarometer (map measurer).
- (iv) Sample of soils and other have been collected during the field investigation.
- (v) Climatic data for the sample sites collected with the help of the meteorological instruments set there and their day to day recordings. For other stations, these were collected from Forest Working Plans.
- (vi) Primary data pertaining to landuse, population, livestock, physical as well as institutional infrastructure, cropping pattern, nutritional status and deficiency diseases etc. are collected through village level questionnaires from village Pradhans, elderly persons of the village, Patwaries, V.D.Os etc., while secondary data relating to these factors

have been collected from the Tahsil land record offices, Block and District Headquarters.

- (vii) The area is divided into two main categories firstly, area owned by the State Forest Department and secondary, area owned by State Revenue Departments. Since the area owned by State Forest Department is managed and planned by the department itself, it is not taken into consideration in this investigation except the analysis of relief, soil, vegetation, geology etc. The area owned by State Revenue Department on the other land, is directly or indirectly under the control of the local society and is affected maximally it is therefore, taken into consideration for further details.
- (viii) For detailed investigation three sample villages have been selected from the identified physical strata of dun floor, mid slopes and uplands.
- (ix) The study area is divided into ten homogeneous physical units considered as basic units for the study. In delineating these units, the base maps pertaining to altitude, relative relief, slope, drainage and settlements are drawn separately. The physical location of each of the villages is identified by superimposing the settlement map over the drainage, altitude, relief, and slope maps turn by turn. Basin-wise location of all the villages are first observed and then these are grouped according to their altitudinal arrangements of two zones of below 800 m (dun-floor) and above 800 m (mountainous tract). Influences of other physical factors though very significant, are not taken into consideration in this particular case as a number of villages are likely to be divisible into several sections and it is not very feasible to go into these details. Each of the units thus identified, is named after the upper and lower sections of river basins (Table 1.1).

Table 1.1 Kotadun: Identified Study Units

Name of the basic unit		Symbols used
Bangajala	Upper	U ₁
Bangajala	Lower	U ₂
Mashani	Upper	U ₃
Mashani	Lower	U ₄
Dabka	Upper	U ₅
Dabka	Lower	U ₆
Baur	Upper	U ₇
Baur	Lower	U ₈
Others	Upper	U ₉
Others	Lower	U ₁₀

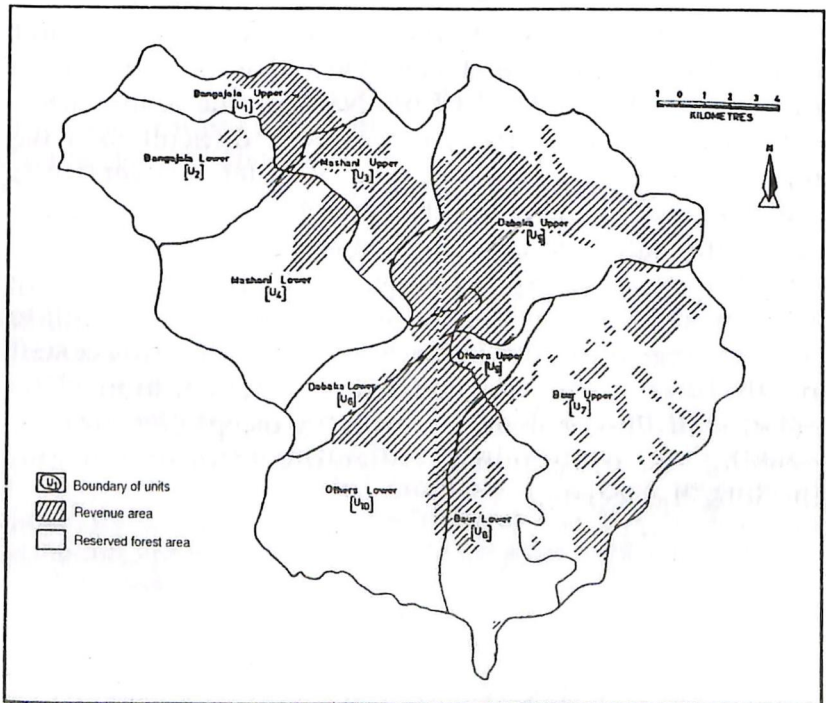


Fig. 1.2 Kotadun: Planning Units

- (x) Three sites for action programme relating to optimal land use, are selected in Kotadun, two in Patkot and one in Saunjala. Site-1 encompassing an area of 3.5 ha is the private land and technical advice is extended to the owner cultivators for implementation of optimal and multiple use of the land particularly for the purpose of agriculture, horticulture and farm forestry. Site-2 encompassing an area of 10 ha, is the public waste land which is selected exclusively for development of tree-culture including social forestry. Site-3 encompassing an area of 0.2 ha, is the private land. It is selected for development of farm forestry.

1.7. LIMITATIONS

Since the study area is one of the most backward and remote area of Kumaun Himalaya and is provided with single private bus transport from Nainital, the headquarters of the Kumaun University, it was very difficult to make frequent visits to the project area. Regular bus service is available upto Kotabagh i.e. the core of the study area while the country side is to be visited on-foot. Moreover, the sites selected for extension programme, are located at a distance of 66 km, 101 km from Nainital it was again very difficult to have exchange ideas and interactions among the project staff and the rural society for extensive demonstrations. The project staff thus, remained mostly in the project area for executing the programme, collecting information and educating the society.