PLANNING FOR SUSTAINABLE DEVELOPMENT IN GARHWAL HILL REGION

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By

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CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled **PLANNING FOR SUSTAINABLE DEVELOPMENT IN GARHWAL HILL REGION** in fulfilment of the requirement for the award of Degree of Doctor of Philosophy submitted in the Department of Architecture and Planning of the University is an authentic record of my own work carried out during the period from Aug, 1996 to August, 1998 under the supervision of Dr. Najamuddin and Dr. R.S. Tiwari.

The matter embodied in this thesis has not been submitted by me for the award of any other degree of this or any other University.

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ABSTRACT

Physical development over space to satisfy human needs has been largely responsible for destruction of nature. Mountains and hills have been conquered and crisis as regards sustainable management of resources seems building up. Scientists, environmentalists and planners are very much concerned over environmental and ecological equilibrium, and see sustainable development (SD) approach as a solution to all present and possible future environmental problems. SD has been defined as the development that meets the needs and requirements of the present generations without affecting the ability of future generations to meet their needs. The challenge faced by planners is not just to accelerate the economic development alone but with it, maintaining the essential integrity of earth's ecological system.

Hills, particularly the Himalayan region constitute about 18 percent of the total area and support six percent of the total population of the country. These areas are a treasure-house of resources such as water, biological diversity, minerals, forest products, agricultural products, tourism, recreation, etc. but have tremendously been affected by both natural and manmade factors. These hill areas have remained socially and economically backward owing to topographical and demographic peculiarities such as fragility, marginality, inaccessibility, increasing population, and lack of infrastructure.

The situation is alarming and hence much emphasis is laid in the national five year plans (FYP) for integrated development of hill districts. The approach enunciated in the Eighth FYP fails to handle area development in a comprehensive and integrated manner. Efforts have been made with little or no attention on intersectoral linkages and environmental conservation.

Considering the significance of hill area development the study has focused on formulating a planning model for SD of Garhwal hill region in the newly formed state of

Uttaranchal. Uttarkashi district in Garhwal region has been taken as case study. Recognising the need of effective instruments for implementation of plans at the micro level a watershed (Khurmola Gad) has been selected for conducting an indepth study of the micro level hill system. The research has been aimed at (i) evolving a theoretical framework for working out plans for hills keeping the socio-economic and ecological parameters in view, and (ii) constructing a planning model for SD in Garhwal hills.

To begin with literature survey has been carried out based on which certain methodological issues in approaching SD in hills have been identified. The ecological crisis is the basis of unsustainability in the hills. Increase in population, uncoordinated development activities, disregard to the objective conditions, institutional failures and political preferences result in unprecedented degradation and depletion of natural resources. A little change in any one of the factors brings about a remarkable change in the hill system eventually affecting its land use pattern. It is understood that the complex interdependencies and interlinkages between various systems pose the basic challenge in planning.

For achieving sustainability, linkages between the different sectors need to be studied systematically and therefore the concept of carrying capacity is identified. The conventional planning models, for plains are based on a steady state and determine demand- supply balance without internalizing the environmental parameters, and therefore it is realized that these models cannot be applied to hills.

The regional and area level plans for hills which are a recent development, identify broad development issues and imperatives in terms of environmental sensitivity without addressing to the effective instruments of plan implementation at micro level. Thus the need of effective instruments for implementation at micro level is emphasized. With due regard to the dynamics of natural processes, elements that should underlie the synthesis of a suitable approach have been identified, and the need for an interactive, multi-dimensional, dynamic and open ended systems approach recommended.

For arriving at an integrated framework for judging the alternative policy options, parameters that help assess carrying capacity (CC) have been defined. These parameters are useful in determining causes of unsustainability. A theoretical framework incorporating the dynamic changes and factors for preparing plans is then introduced. The various steps identified for a coherent assessment and systematic management process at the micro level include assessment of existing functions and their carrying capacity, identification of key factors and decision variables affecting sustainability, functional relationship between variables, and analysis of solutions for arriving at desired goal.

This is followed by an empirical analysis of the problem to define a model planning process for Garhwal hills. Survey research methods have been applied for acquiring a comprehensive information about various physical, socio-economic and other factors concerning development. An extensive household level survey was conducted using survey schedules (questionnaires) so as to identify the various control parameters and their functions with respect to sustainability. The data was then fed into the computer and processed using the SPSS (Statistical Package for Social Scientists) software. The natural resource base information based on Landsat imagery has been analysed by making use of the GIS (Geographical Information Systems).

The study identifies food, fodder, fuel and financial standing (F(s)) of the people as four basic issues causing unsustainability in the area. It is seen that the ecological carrying capacity delimits the availability of these basic resources and the absence of off-farm employment results in poor and inefficient management of natural resources. The apparent conflict in the area is between the three principal components i) ecological issues, ii) fulfilment of basic needs of local people viz, food, fodder and fuel, and iii) economic issues such as lack of off-farm employment and total dependence on primary sector with cash crops grown in forest lands which is an unsustainable practice. The basic needs and the economic support systems of the people are thus

the primary issues. Agriculture, Biomass, Career development sustainability are identified as key factors or the indicators of sustainability addressing the problems of 4F(s). These key factors are conflicting goals as regards land use development which is the basis for ecological balance in any area . In order to control the irrational use of land, need for sustainable solutions for agriculture, biomass and career development (ABCd) has been suggested.

For sustainability these solutions besides meeting the basic requirements also need to be consistent with the resource potential and the ecological framework of the area. A functional relationship between the variables of land transformation process and the physical environment is defined thereby modelling a framework for SD planning in hills(SDPH).

Finally to address the problems of 4Fs and to avoid the negative impact on landuse a model `Luc In ABCds' has been proposed. The model aims at landuse control integrating agriculture, biomass, and career development sustainability. Models integrating the interdependence between systems has been extended to hills. The model so developed aims at gauging the distributive impacts of policy measures and identifying efficient solutions. The model is illustrated using the Microsoft Excel Software. Two scenarios based on (i) Business as usual (BAU) policy, and (ii) joint demand and supply management measures, have been analysed.

A humble effort has been made in the study for developing a framework for micro level planning in hills so that it ernestly reaches grass-roots level and SD is achieved. Various kinds of relationships emanating as development proceeds can be appropriately dealt with using the defined framework. The Garhwal hills are in the process of development which is likely to accelerate as it is part of a recently formed separate hill state Uttaranchal. It is firmly believed that the proposed model for SDPH would bring in SD in the hill region.

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Manika Negi

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CHAPTER I

INTRODUCTION

1.0 PREAMBLE

'Sustainability' for development is a modern day `buzz word'. With the growing environmental concern and the deteriorating ecological equilibrium the world over, the approach of sustainable development is suggested as solution of all present and possible future environmental problems. The limiting factors of the environment have been traditionally well regarded in various scientific fields like plant and animal sciences, demography and cybernetics. In contrast, traditional urban and regional planning approach has been characterized by socio-economic determinism (Joardar, 1996). It was in the seventies that the report by the Club of Rome cautioned that the economic collapse could soon occur as the exhaustible resources' constraint would become binding, population would grow to maximum, food supply and controlling pollution would be very severe and a costly proposition (Meadows et al.,1974). Various Conferences/ Seminars at International and National levels have since expressed their concern about environment.

Sustainable Development (SD) has more than one dimension, interpretation and definition. It visualizes an ideal condition. The challenge of SD as presented by the World Commission on Environment and Development (WCED, 1987) is to continue economic development while maintaining the essential integrity of earth's ecological system. It defines SD as kind of development that meets the needs of the present without affecting the ability of the future generations to meet their needs.

Development on the other hand implies change specifically modifying and adapting the landscape for human purposes, but as on now it has stood more often than not, for destruction of nature for human gain. Degenerative processes have been on increase. The

global statistics on deforestation, desertification, salinization, soil erosion, habitat loss and other landscape pathologies are a testimony (Lyle, 1996). Mountains and hills are no exception and there are indications of crisis building up in these regions as regards sustainable management of resources. The rapidly growing population, the change in its consumption pattern making larger demands on natural resources' base through internal and external pressures, the grossly inadequate knowledge about the natural processes are all contributing to build up this crisis (ICIMOD, 1993). The concept of sustainability is therefore, important and very much suited to the hills as this would ensure that a balance is maintained between people and their activities on the one hand and the capacity of the resource system to support these activities without impairment, degradation and depletion of the resources.

Hill areas in India, have fragile eco-systems and receive special attention since they play a crucial role in sustaining not only the economy of hills, but also in determining the climate, physiography and development in the plains. Hills, particularly the Himalayan region constitute about 18 percent of the total area and support about six percent of the total population of the country (Action Plan for Himalayas (APH), 1992). These areas are also a treasure- house of resources, such as, water, biological diversity, minerals, forest products, agricultural products, tourism, recreation etc. but, unfortunately they have already been exploited for tremendous gains and pressed to social and economic backwardness. As a consequence, social evils, such as, poverty, unemployment, underemployment, poor health and sanitation are prevalent which further pave the way for environmental degradation. This alarming situation draws the attention of administrators, planners etc. towards the hill regions. As a result, emphasis on integrated development of the hill districts has been laid in the national plans and programmes eversince Fifth- Five Year Plan (FYP). However, a scientific approach to achieve the goal of SD is yet to develop.

The approach and strategy enunciated in the Eighth FYP emphasizes various issues in different sectors of development which do not reflect area development in a comprehensive and integrated fashion. Efforts have been made on a narrow sectoral basis and the environmental

considerations have not been adequately incorporated in the planning and policy efforts, nor has environmental conservation fully recognised the livelihood needs of the people. These efforts have focused on investments in environmental projects such as reforestation or sewerage schemes or adding environmental components to projects to mitigate environmental impacts. Also the Environmental Impact Assessment (EIA) approach did not go far because the underlying causes of environmental changes went beyond the corrective measures taken in the immediate project. There is therefore, an urgent need for governance that would protect the common long term interests of sustainability. A systematic integration of the environment and development in the day to day decision making process is required to meet the twin- objective of conservation and development in the hill regions (Meshram et al., 1994; Royal Swedish Society of Sciences, 1996).

On account of the prevailing situation of environment and development it has therefore, become imperative to redefine the path for development of these regions. The major role of planners has been identified as building relevant theoretical foundation and working out plans for alternative patterns of the physical environment, which would conserve the resources in consonance with the broader goals of SD (APH, 1992; GOI/PC Communication, 1996).

1.1 SIGNIFICANCE OF THE STUDY TO PHYSICAL PLANNERS

The long term environmental challenges which are best encapsulated in the term of SD have assumed an increasingly important place and its scope is indeed very vast and complex. The future of man's life and its quality entirely depend on maintaining a balance and adjustment between human functions and the physical environment. The thought required in understanding, planning, designing and managing human ecosystems is necessarily multidisciplinary. The understanding of nature and the relationship between human and nature is a complex phenomenon and involves numerous variables (Lyle, 1996). However, it is also well recognized that health, aesthetic quality and sustainability of the environment are determined largely by the way we use the land. Land is a complex and dynamic living assemblage of what we call environment and is an integral and essential part of our lives. It

is the most valuable environmental resource alongwith which go.water, soil and vegetation and it is only when planning proposals are crystallized into precise land use plans that they are capable of effectively channelizing, monitoring and controlling development effort (Sharma, 1990). To paraphrase Winston Churchill 'we shape the landscape and then it shapes us'. Goudie (1990) on the other hand suggests that certain effects of landuse tend to be cumulative. Considering all this, the physical planners have an obligation to the future generations to minimize the negative effects of landuse and thereby contribute to sustainability of the environment.

Many planners claim that environment has always occupied a high place on their list of priorities, but in actual they have been over concerned with the content of the plan rather than with the nature of the process of planning (Sharma, 1990). The recent awakening of widespread and sustained public concern for quality of life issues encompass aspects of environmental management and these are clearly considered to lie out with the traditional boundaries of planning competence (Robert, 1991). With the planners' inability to translate the need for enhanced environmental quality into clearly defined and realizable programmes, the danger is that the concept of sustainability will become divorced from the main stream of planning thought and be expressed through a separate programme of action. Thus the subject of SD is not only relevant to physical planners but it also calls for planning to redefine its stance on environmental management within its sphere of influence and activity. Peter Robert (1991) suggests that planning should not seek to exercise an exclusive right to manage environmental matters but rather become a focus of action for policy making and implementation.

Considering the limitations and dilemma prevailing and also the importance of landscape in dealing with the environmental issues, a major part of the opportunity for SD is directly within the domain of physical planners. A planner has the potential ability and should seek to control the development right from the conception level over the ultimate use of land which affects the environment, while other disciplines would

design the means to fulfill the need.

1.2 AIMS AND OBJECTIVES

Considering the importance of hill region development in the present context the study aims at formulating a planning model for Garhwal Hill Region in the state of Uttaranchal. The planning model would envisage to channelize and promote development activities simultaneously with protecting and conserving the natural environment. The objectives framed for the present investigation are:

i) To evolve a theoretical framework for working out plans in hills keeping the socio economic and ecological parameters in view.

ii) To construct a planning model for SD for Garhwal hills and apply the same for preparing a scientific development plan.

1.3 SCOPE AND LIMITATIONS

The aim of SD is to bring socio-economic, cultural, physical and environmental management as concurrent tasks from the very initial stages of planning. Therefore the term sustainability has been given a wider connotation. It is not restricted to the natural elements of air, water and soil but encompasses all aspects of the environment-physical, social, cultural and economic which have a bearing on the quality of life and also have an impact on the environment. The study attempts to stress conceptional aspects and the scope of the study has been limited to assessing the potential carrying capacity of the area as regards the environmental resources and to identify how developmental activities can take place without disturbing the ecological balance. The study would thus enable documentation and suggest a model planning process that will allow for a basis for assessing various attributes of SD and also provide for decision making to implement development activities in hill regions.

The study recognises the need for effective instruments of implementation at the micro level in order to translate the decisions of the long term plans at macro level, and therefore

focus is laid on an indepth study of the micro level system. Research efforts because of the limitation of adequate (time series) data are based on primary surveys.

1.4 CHOICE OF THE STUDY AREA

Known for their rare heritage, cultural artifacts and picturesque setting, the hill districts of Garhwal are fast deteriorating and becoming eyesores over the landscape. The frequent landslides, collapse of buildings etc., indicate that the time has come when people have to pay a price for the disturbance that has already been done to the fragile ecosystem of the hills. The settlements are likely to deteriorate to the extent that they will not remain livable unless exclusive focus is laid on the sensitive use of resources for restoration and preservation of environment. The Garhwal region comprises of five districts, viz; Dehradun, Chamoli, Tehri Garhwal, Pauri Garhwal and Uttarkashi. Of these Dehradun falls in the tarai (plain) region, and the rest fall in the hilly terrain which ranges from 850 to 7000 m in altitude. All the hill districts are rural in character. District Uttarkashi is selected for the present study. There is little or no disparity in its six blocks. A watershed `Khurmola Gad' of the `Dunda' block of district Uttarkashi, which has homogeneous character of the hill region is selected as representative from Garhwal hills for conducting the present investigation.

1.5 RESEARCH METHODOLOGY

The research has been carried out in three stages.

Stage I ***Theoretical Background (Based on Literature Review)***

Understanding of SD and its relevance to hilly areas sets the stage for empirical studies and therefore has been attempted first. Various plans, programmes and policies for hill area development have been studied and evaluated in the context of present problems in the hills, in order to identify their effectiveness. Various efforts to integrate environment and development have then been explored in order to identify a suitable approach for hill area development. The literature review leads to outlining of scope and specific objectives of the study

Stage II *Problem Identification and Analysis*

Based on the theoretical background certain methodological issues which enable and constrain development in consonance with the broader goals of SD have been brought out, followed by empirical analysis of the problem. Survey research methods as defined in following section have been employed for the present investigation. The study looks into the micro level system as a whole and undertakes an indepth study for acquiring comprehensive information about various physical, socio-economic and other factors concerning SD. An extensive field level survey has been conducted to collect the relevant data for supplementing the required secondary source data. Suitable techniques also defined in following section have been employed to identify several parameters of hill system which are then incorporated in outlining a planning model for the hills.

Stage III *Possible line of Action*

An overall assessment of changes that have occurred or are likely to occur in the natural environment has been made. Safeguards already taken have been identified and further safeguards recommended with respect to environmental sustainability. The study culminates into evolving a planning model for the Garhwal hills which would enable a close examination of the overall implications of several alternative policy options, characterized by various combinations of the relevant control parameters within the system. The research methodology adopted is schematically shown in Figure 1.5.1.

1.5.1 Data Collection

The study primarily involves review of present system of hill area development to outline ways and means so that the needs and aspirations of the people synchronize with the available resources with them. The data for present investigation at the micro level are collected from both secondary and primary sources.

(i) Secondary Sources of Information

The secondary source information has been collected from published and unpublished

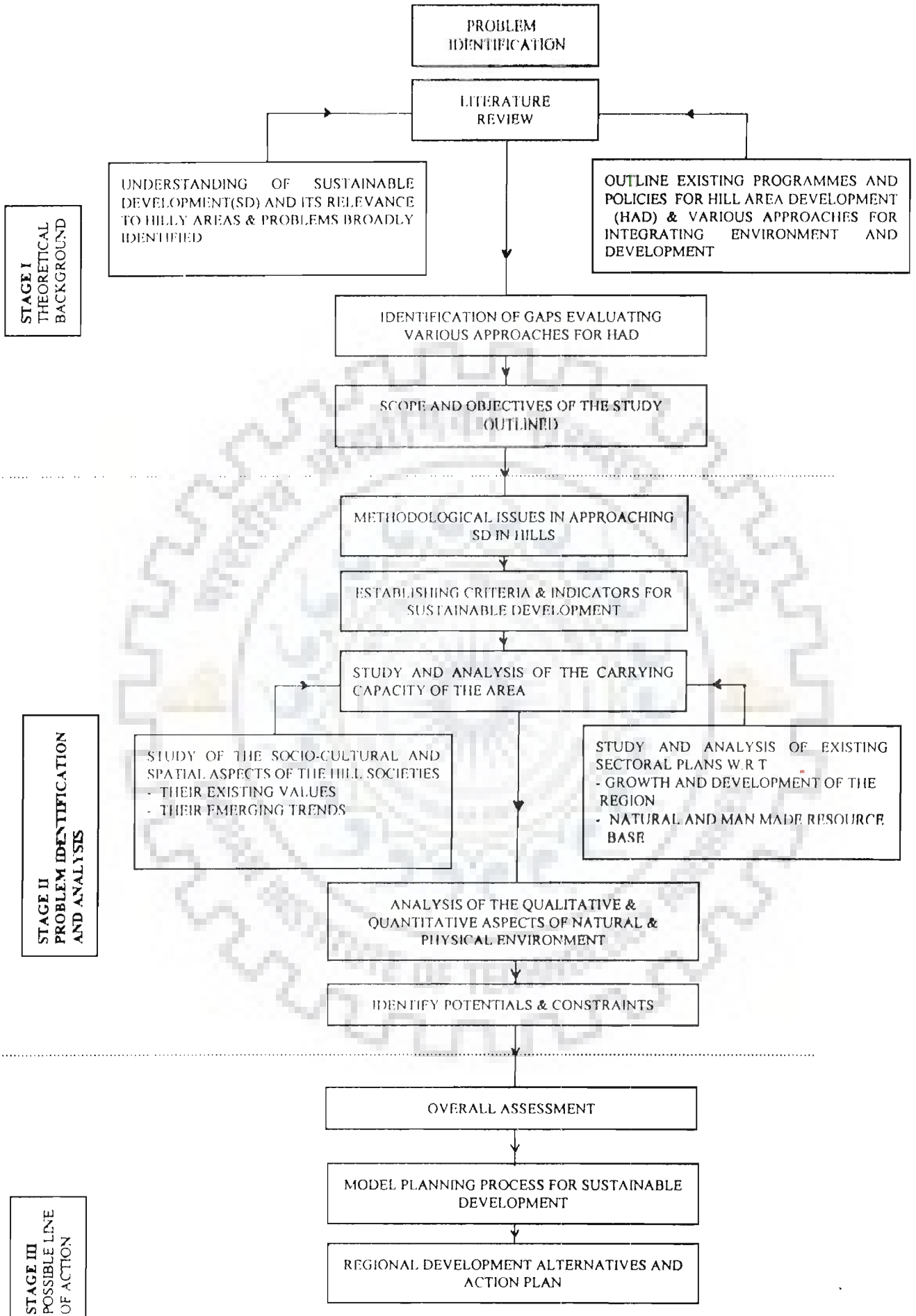


FIGURE 1.5.1 METHODOLOGICAL STRATEGY

documents from government, semi- government and non- government organizations, libraries and educational institutions.

(ii) Primary Source Data

A household survey has been carried out for understanding the factors that influence sustainability At the outset, a complete list of households alongwith the size of their landholdings was prepared from the revenue records. All households were then arranged village wise in an ascending order on the basis of their operational holdings for stratification. Household schedules (Annexure A) were then used for conducting the survey at the household level to identify the control parameters and their functions which determine the dynamic function of the hill rural system with respect to sustainability. During the survey 25 percent households were randomly selected on the basis of their operational holdings.

1.5.2 Survey Tools and Techniques

The survey tools which were employed for the investigation are

(i) House listing schedule

(ii) Household Schedule

- Pilot Survey Schedule
- Actual Survey Schedule

and the techniques used were simple random sampling and stratified sampling.

1.5.3 Analytical Tools

The data related to the present investigation has been processed by using the SPSS (Statistical Package for Social Scientists) software. The natural resource base studies have been analysed by making use of GIS (Geographical Information Systems) software. For illustration purposes the model has been simulated for various scenarios using Microsoft Excel package.

CHAPTER II

LITERATURE REVIEW

2.0 GENERAL

Abundant literature is available for the last few decades on SD and the damages to mankind resulting from man's interference with his environment. Also, changes in the environment of the hill ecosystem have been recognized at the international and national levels. Unfortunately, however, little attention has been given to outline an integrated approach for achieving the goal of SD in the hills (Meshram et al., 1994). The same holds true even now. With the above in view, the literature available has been briefly reviewed under the following heads:

- Hill environment and development.
- Concept of SD.
- Efforts to integrate hill environment and development.

2.1 HILL ENVIRONMENT AND DEVELOPMENT

The hill regions of India in general are ecologically rich but economically less developed. On the other hand the increasing pressure of human activities, in response to the general problem of population explosion and economic change in the country as a whole has transcended the symbiotic relationship between man and nature to a considerable extent. This has resulted in particularly extensive deforestation, intensive farming on steep slopes, heavy human and livestock pressure on the soil, water and biological resources which have in turn damaged the ecology and the environment of the hill areas. Excessive exploitation of natural resources and implementation of ill- conceived development projects have been threatening the ecosystem (Meshram et al.,1994). Also the technology in the hill economies has remained more or less unchanged which has led to more intensive exploitation of the local resources. (GOI/PC, 1985-90). These areas have large economic potential in the form of natural

resources, minerals, rivers, development of pisciculture, tourism etc. which needs to be utilized in a rational and sustainable manner. The constraints experienced are mainly because of the geographical isolation, difficult mountainous terrain, limited potential for agricultural development and lack of geological information (Qaiyum, 1994).

Each hill region because of its peculiar setting and conditions, has a set of its own problems and potentials but some of the common parameters which have a bearing on the planning and development of hill areas have been brought out in the following sections.

2.1.1 Objective Conditions of the Hills

The major objective conditions prevailing in the hills are inaccessibility, fragility, marginality, diversity and the unique environment. These are either a product of hill- specific features like slope, altitude, terrain conditions, seasonal hazards, or a product of combined operations of these features. The carrying capacity of hill areas is dependent on these objective conditions. The conventional development approaches for hills focus mainly on the demand side and address problems on a selective basis, segregating the activities by sector or by administrative units. This erodes the organic integrity of the diversified hill system. The overall pressure on hill/mountain resources is thus increased to an unsustainable level. Upgrading resources to handle the constraints of fragility, marginality and to create infrastructure reducing inaccessibility are important prerequisites for hill area development. However, where there are instances of positive developments such as improved accessibility, harnessing of hills' unique environment and transformation of limited areas within hills, the hills have not benefitted in general because of the lack of sufficient territorial diagnosis before implementing the development processes. Selective over-extraction of hills unique environment on unequal terms of exchange in trading its products to mainstream economy with disregard to local concerns and interests, leads to further complicate the problems (Jodha and Shrestha, 1993).

Natural factors such as intense precipitation and fragile geology of the region, also

cause heavy damage and destroy the productive base and infrastructure, thereby augmenting the pressure on the natural resource base, and adding to the general degradation of the environment. Some form of disaster is an almost regular feature in the hills. With each such disaster and its adverse impact on natural and economic resources of these areas, the vulnerability of human population increases. Adequate knowledge of the functioning of the natural systems of the diverse ecosystem of the region is essential to deal with these (APH, 1992). Many of these disasters cannot be controlled and the solution lies only in adapting to such situations with the help of developmental and technological interventions (Banskota, 1993).

2.1.2 Population Pressure

In recent years, hills have witnessed unchecked population growth and the resultant difficulties of meeting the immediate needs of food, energy, education, health, and shelter (GOI/PC, 1985-90). The unplanned and haphazard physical growth has lead to environmental problems, and loss of character and beauty of hill settlements. Also, with change in the global economy the living standard and aspirations of the hill people have gone up as a result of which there is rapid change in the consumption pattern making larger demand on natural resources, viz. land, water and vegetation (ICIMOD, 1993).

The land-man ratio in the hills is supposed to be very favourable due to large areas of rugged topography and a small population. Contrary to this, density of population in hills is found to be amongst the highest due to prevalent objective conditions and the extent of productive land per capita (Bahuguna, 1990). Encroachment by way of cultivation in the steep unproductive slopes covered by forests is an evidence of this and most poor people sustain themselves through exploitation of these marginal resources.

The recent phenomenon of people from the plains purchasing land in hill areas has lead to large scale speculation in land, resulting in land being converted from forest and agricultural use to non-agricultural uses. Tourism has added a new dimension in the growth and

development of hill settlements leading to enormous pressure with unchecked growth in areas located on pilgrim routes or tourism sites. This tremendous increase in transitory and permanent population has led to increase in developmental activities with mounting toll on ecology and social structure (ITPI, 1994).

2.1.3 Development Activities

Hill development is a matter of great concern. The ecological state of the hills is generally not conducive to meet the basic needs of the people and calls for fast development reconciling the economic needs with those for maintaining biological protection in the natural environment. The main contradictions of hill development according to Bahuguna (1990) are: (i) a lack of coordination between the aspirations of the local people and national interests; and, (ii) the difference in the standard of living of planners and others who implement the plans from those for whom the plans are made. Varied and uncoordinated activities in the form of construction of buildings and roads, changes in use of land, subsequent cutting of trees and massive levelling of hill slopes have resulted in increased hill instability and occurrences of land slides, soil erosion, disturbances of surface and subsurface hydrology, siltation of water bodies and change in macro and micro climates (APH, 1992). The hills are the storehouse of fresh water but for the bulk of its people, water is perennially scarce. Minor irrigation channels are normally planned along soft rocks which often break down resulting in extensive soil erosion. The hydro channels/canals on the other hand involve large scale cutting and blasting thereby creating slope instability. The use of explosives for construction activity cause pollution in the form of gases, dust and noise assimilation in the atmosphere. Also construction of approach roads which is so vital for development and defence affect soil stability and accentuate landslides and soil erosion. Uncontrolled mining has also been a cause of enormous concern, which has caused incalculable damage in some areas, leading to destruction of vital flora and fauna. The progressive clearing of the land for urban uses or developmental activities changes the amount of sediments eroded from the land. Eventually as more land becomes paved or otherwise made impervious as the area continues to develop, the natural drainage patterns get disrupted if the objective conditions of the area are not given

due consideration. Also where forests are cut unscrupulously, muddy torrents gush from steep slopes with the onset of heavy showers and the thick soil cover of bare slopes crumble into the rivers causing siltation, affecting the form, shape and biology of stream channel, besides leading to floods (ITPI, 1994).

Another threat that is looming large on the hill areas is rapid industrialization and in order to promote industries large scale incentive is being given by the governments (Gupta et al., 1994). Besides carrying the risk of impairing the hill environment, the existing industrial developments have not been able to provide employment to local people because of the requirement of specialized knowledge. Introduction of money and open market economy on the other hand has brought an end to the subsistence village economy (Bahuguna, 1990). Although barter economy has been replaced by money economy but the increased output of products is not easily marketable because of the imbalanced geographical dispersal of such facilities. Trade and commerce in the area has also not developed as expected because of the low paying capacity of the local people and eventually it is the villagers who are the losers The historical inertia, population dynamics, settlement patterns, extent of urbanization and industrialization, occupational pattern, availability of infrastructure and social amenities are thus the basic factors affecting the entire hill environment and sociological systems (ICIMOD, 1993).

Caring for environment has also become fashionable and so there is another side to the issue of development activities. While the hills need fast development on which their economic growth largely depends much of the development work is hampered by the so-called environmental concern. Number of non-governmental organisations (NGOs) caring for the country's environment seem to be growing every day. NGOs usually launch a movement in the name of ecology. If this issue is resolved, the cause of people uprooted by the project is taken up leading to a writ petition in Supreme Court. The net result is that the execution of the project is delayed by as much as 10-20 years and then rendered as unjustified based on cost-benefit ratio. For example, according to Bahuguna (Dhawan,1993) construction of dams for

irrigation water and power are for the destruction of the hills as these will flood the fertile lands of the valleys and also create problems of human rehabilitation. However, the Centre for Science and Environment (Dhawan,1993) do not believe in the sponge effect of the forests in eradicating the flood menace and ask for creating manmade storage reservoirs to hold back the flood waters. The dilemma prevails as a result of which the development is hampered. To avoid such eventualities a convincing base to take up any development activity is a must. According to Robert Heilbroner, a US Economist the mechanism of resolving such dilemma "Will have to be political, perhaps military" (Tapan Dasgupta, TOI, 1/11/97).

2.1.4 Institutional and Political Measures

Political and institutional frameworks are necessary to promote long term policy stability. In the hill areas it is generally noticed that institutional interventions have alienated people from resources. Replacement of traditional community sanctions and collective sharing systems in the case of forest lands by poorly enforced formal and legal arrangements has resulted in indiscriminate felling of trees in connivance with the law makers. The institutional intervention by way of creating modern support facilities such as credit, marketing, processing etc. has diverted the attention of farmers to commercially highly valued activities and their survival through subsidies. The interventions are designed to support agricultural intensification which has proved insensitive to diversification and, resource protection and regeneration. (APH, 1992; ICIMOD, 1993). This is mainly so because

i) Political preferences are bent towards overcoming short run problems.

ii) The environmental problems are treated generally as adhoc.

iii) Institutional capacity is underdeveloped and even the limited institutional resources are at times not fully mobilized.

iv) Development programmes are sectoral, lacking civic commitment and knowledge that every citizen should gain from improved practices.

v) Public participation in decision making is lacking , as a result the cultural and attitudinal factors that are important in shaping human settlements are missing.

2.1.5 Environmental Degradation and its Impact

The evil consequences of environmental degradation caused through natural process and man- made erosional agents are identified as

(a) Physical deformities

i) Defacement of landscape and natural scenic beauty through indiscriminate human activities viz, mining, deforestation, urban sprawl, land use change etc.

ii) Indiscriminate landuse transformation and deforestation in hill areas on steeper slopes are responsible for higher run-off amount and speed, and resultant evils viz, land slips, soil creeps, soil erosion, loss of soil fertility, siltation of water bodies etc.

(b) Socio-economic imbalances

These natural constraints have their impact on the socio-economic and cultural life, viz,

i) Low agricultural output and standard of living.

ii) Unemployment and underemployment.

iii) Decline of moral and ethical values.

iv) Biomass production is affected through loss of forests, pasture lands which subsequently has an impact on agriculture.

All these factors put stress on the local population. It is also realized that it is entirely human interference that upsets the ecological balance and it is in the adaptation of human interaction with the environment that we must seek for ways to restore it. Unless human behaviour can be influenced through environmental awareness all hopes of saving the rapidly deteriorating environment will be a disappointment. A clear understanding of the hill system and the human influence is the need of the hour (ICIMOD, 1993; Chadha, 1989).

2.1.6 Indigenous Knowhow

An appraisal of information available for the Himalayan region suggests that

management considerations argued to have emanated from scientific studies are already inherent in the traditional system. People in hills through their own experimentation have developed innovations that can address any situation arising out of any negative development intervention. Traditional farming communities have evolved farming systems, farming situations, cropping systems, crop rotations and crop combinations. Such strong links between biodiversity and sustainability, and knowledge of these facts by farmers for ages need to be respected by experts(APH, 1992).

Further economic growth is essential for the development of the area to enhance the well being of the people. However, the effects of relying on economic growth as the only indicator of development could be catastrophic. The alternative to this way of thinking is to integrate our current knowledge from the different fields of research with traditional indigenous knowledge and to use this knowledge to prevent setbacks in future (Kessier, 1996).

2.2 CONCEPT OF SUSTAINABLE DEVELOPMENT

2.2.1 Origins of the Concern

Sustainability is a concept on which social and natural scientists, and intellectuals of all walks of life have aired their views from time to time. Most discussions focus on the necessary conditions to ensure that future generations have the environmental resources they require.

The origins of a concern for both environment and development go back several decades. It was in the seventies that the report by the Club of Rome cautioned that the economic collapse could soon occur as the exhaustible resources constraint would become binding, population would grow to maximum, food supply and controlling pollution would be very severe and costly proposition. Various conferences, seminars at international and national levels have since expressed their concern about environment. The use of the term SD was made more explicit and promoted, by the report of the Brundtland Commission `Our Common Future' published in 1987. Earlier it was in the UN conference on `Human Environment' in

Stockholm in 1972, that a similar concern was voiced. Later in recognition of the need for continued work in this area, the United Nations Environment Programme (UNEP) was established, but this was of remedial focus (Colby, 1990), as UNEP has no operational power and no responsibility for truly changing the ways in which development activity is organized and measured. This lead to the organizing of the UN Conference on Human Settlements (UNCHS) in 1976. This conference known as the Habitat Conference helped encourage a new emphasis to the central role that basic needs provision, especially water, sanitation, primary health etc. should have in development. Finally as a result of some two decades of searching and debate, the global environmental managers reached a conclusion at the Earth Summit at Rio De Janerio (Brazil) in 1992 and adopted a paradigm 'Sustainable Development'. The strategies of this provide a framework for developing comprehensive environmental policies. Agenda 21 adopted by the United Nations Centre for Environment and Development (UNCED) in June 1992 is a comprehensive programme of action to be implemented from then into the 21st Century by all sector groups in every area where human activity affects the environment. Recently the UNCHS formulated the Habitat Agenda for the 21st Century. In 1992 two threads for achieving more sustainable cities were identified at Rio. These were to (i) plan, build and manage cities differently, and(ii) change the attitude and behaviour of the inhabitants. In UN Habitat II, role of active rural population and indigenous people was considered important in ensuring food security and in sustaining ecological balance ... so that they contribute to the global task of safeguarding fragile environment.

2.2.2 Various Perspectives on Sustainable Development

At the moment the concept of SD is a fashionable one. There are a lot of interpretations of the concept. Not only do the perceptions vary but the concepts also generate contention over the amount and kind of developmental action that is sustainable and for how long and to what effect. Nevertheless, the central theme of the SD is directed towards future plans, projects, objectives and ambitions.

World Commission on Environment and Development defines "SD as the kind of

development that meets the needs of present without compromising the ability of the future generations to meet their own needs". Implicit in its definition are the concerns and need for environmental protection and the economic growth necessary to meet the needs of the present human population, while maintaining the natural resource base for future generations. It also states, "In essence, SD is a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations" (WCED, 1987). Rightly interpreted by Kadekodi (1992), the concept outlined above leaves scope for dynamic adjustments in institutional factors, economic factors, scientific and technological factors and above all, distinguishes between needs and aspirations. The concept embraces well being of all time seen through its plurality of dimensions, but it is neither capable of improving policy nor resulting in a clear scientific declaration (Boesler, 1994).

Robert Allen (1980) views SD as development that is likely to achieve lasting satisfaction of human needs and improvement of the quality of human life.

According to Edward Barbier (1987) the concept of Sustainable Economic Development as applied to the third world ... is therefore directly concerned with increasing the material standard of living of the poor at the grass roots' level, which can be quantitatively measured in terms of increased food, real income, educational services, health care, sanitation and water supply, emergency stocks of food and cash etc., and only indirectly concerned with economic growth at the aggregate, commonly national level. In general terms, the primary objective is reducing the absolute poverty of the world's poor through providing lasting and secure livelihoods that minimize resources' depletion, environmental degradation, cultural disruption and social instability.

While to Allen and Barbier SD implies addressing the needs of the people and their quality of life, Coomer (1979) propounded the thought of sustainable society that lives within

the self-perpetuating limits of its environment. Clark et al. (1986) confirmed the significance of sustainable society and brought out that a major challenge of the coming decades is to learn how long-term large-scale interactions between environment and development can be better managed to increase the prospects for ecologically sustainable improvements in human well-being.

Many others focus on the concept that SD is one that maintains an appropriately defined stock whose composition may change. The concept proposed by Page(1977) suggests".... activities should be considered that would aim at maintaining over time a constant effective natural resources base" and supported by Charles Howe (1979) implies not an unchanging resources base but a set of resources reserves, technologies, and policy controls that maintain or expand the production possibilities of future generations.

Robert Repetto (1986) calls for managing the economic system such that we live off the dividend of our resources, maintaining and improving the asset base. This principle has much in common with the ideal concept of income that accountants seek to determine the greatest amount that can be consumed in the current period without reducing prospects for consumption in the future. According to him, as also by Page (1977) and Charles Howe (1979), this does not mean that SD demands the preservation of the current stock of natural resources or any particular mix of human, physical and natural assets, but that as development proceeds, the composition of the underlying asset base would change. There is a broad agreement that pursuing policies that imperil the welfare of future generations, who are unrepresented in any political or economic forum, is unfair. Repetto also argues that if the work of Brundtland Commission is to be taken seriously the direction of the development process itself must be redirected to give greater emphasis to indigenous knowledge and experience.

Commenting on sustainability - that is optimising within sustainable use rates as a desirable objective. David Pearce (1988) argues for (i) development subject to a set of

constraints which set resource harvest rates at level no higher than managed or natural regeneration rates; and, (ii) use of the environment as a `waste sink' on the basis that waste disposal rates should not exceed rates of ( natural or managed) assimilation by the counterpart ecosystems. He also adds that there are self-evident problems in advocating sustainable rates for exhaustible resources, and that `sustainable' should tend to think in terms of a resource set encompassing substitution between renewables and exhaustibles.

Turner (1988) commenting on the use of non- renewable resources suggests their conservation. According to him, "it makes no sense to talk about the sustainable use of non-renewable resources (even with substantial recycling effort and reuse rates). Any positive rate of exploitation will eventually lead to exhaustion of the finite stock". "....in this [SD] mode .... conservation becomes the sole basis for defining a criterion with which to judge the desirability of alternative allocations of natural resources".

The theoretical work incorporating the concepts of sustainability have been neatly summarized by Colby (1990). Commenting upon the roots, the convergence and interconnectedness of five paradigms labelled frontier economics, deep ecology, environment protection, resources management, and eco-development, he delineates eco-development paradigm.

"Eco-development moves from economising ecology to ecologising the economy or whole social systems. From the conflict between anthropocentric versus biocentric values, it attempts to synthesize ecocentrism refusing to place humanity either above nature (as in frontier economics, environmental protection, and resources management) or below it (deep ecology). The goal is to integrate the ecological relationship among people and the nature in communities, among communities sharing ecoregions, and among ecoregions cooperating to sustain the shared ecosphere of the planet. Recognising the aspirations of all, placing equal value on ecology and creativity is essential".

Similarly according to Upreti (1994) a new development paradigm for environmental conservation and SD must consist of two interactive dimensions, social and biological. The social dimensions should provide knowledge about humankind's relationship with available resources and their usage. The biological dimensions could provide knowledge and understanding about biospheric eco complex functions, linkages between different components within the system and the material basis for existence of all forms of life, including Humankind, on the surface of the planet Earth.

The objectives outlined above, by the various concepts on SD, determine the pathway towards sustainability but each of these require interpretation and definition to operationalize the concept. Mustafa Tolba ((1983) also calls for clarity in the concept as he writes SD has become an article of faith, a shibboleth : often used but little explained. Does it amount to a strategy? Does it apply only to renewable resources? What does the term actually mean? The indeterminacy and the indiscriminate nature of the concepts allow for criticism and this has been vividly brought out by Jencie (1996). According to her the objectives of SD are to:

i) Enhance the well being and safeguard the future, but what exactly connotes well being?

ii) Progress the ideal inter and intragenerational equity; but confusion as to whether this should be determined in terms of outcome or output.

iii) Protect biological diversity but what needs protecting and is there a viable minimum.

iv) Maintain the essential life support systems in ecological processes; however is there consensus as to what is essential and are trade offs appropriate.

2.3 EFFORTS TO INTEGRATE ENVIRONMENT AND DEVELOPMENT

The efforts to integrate environment and development are fairly recent. These efforts have been proceeding along different fronts at both international and national levels. These include the capacity building initiatives, various approaches and opinions to integrate

environment and development including the national level efforts over the various Five Year Plans.

2.3.1 Capacity Building Initiatives

a) At International Level

The earliest global recognition of the serious problems facing mountain area was made by UNESCO in its Man and Biosphere Programmes. International Centre for Integrated Mountain Development (ICIMOD) was established in December 1983, as a result of this recognition. ICIMOD has since then focused on mobilizing efforts towards integrated mountain development in different countries of the Hindu Kush Himalayan (HKH) region. It is so far the only international centre devoted to integrated mountain development. It aims at promoting the development of an economically and environmentally sound mountain ecosystem and at improving the living standards of mountain populations. More recently, an important achievement has been the global acceptance that the problems of mountain areas deserve serious international attention. Chapter 13 of UNCED Agenda 21 recognized mountain areas as fragile ecosystems of the world requiring special efforts from the global community for their protection, management and development (UNCED, 1992). The World Commission on environment previously had not directly dealt with the mountain area problems although many of the issues raised had direct relevance to the problems of mountain development (Banskota, 1994).

Chapter 13 of the Agenda 21 has laid down major issues related to mountain ecosystems. Improving knowledge about ecology and SD of mountain ecosystems, promoting watershed development and alternative employment for people whose livelihoods are linked to practices that degrade mountains is the focus of the proposals made. It calls for creation of global mountain database for launching programmes that would contribute to SD of mountain ecosystems. Promoting integrated watershed development programmes through the participation of local people is defined as a key to preventing further ecological damage. Sustainable tourism, fisheries, environmentally sound mining, bee keeping, the cultivation and

processing of medicinal and aromatic plants and other alternative activities at the village level are suggested to be encouraged to protect the livelihoods of local communities. Planning for mountain disasters and floods including hazard prevention measures, risk zoning, early warning systems, evacuation plans and emergency supplies has also been recommended. In an attempt to address the issues highlighted by Chapter 13 of Agenda 21, ICIMOD has embarked on a Regional Collaborative Programme for the SD of the HKH (ICIMOD, 1996) which identifies three programmes as follows:

i) **Sustainable Livelihoods of Mountain Communities**

- Identify and analyse farming and livelihood systems in the HKH, including factors and processes of transformation, and formulate alternative development strategies.
- Identify, analyse, test, and disseminate appropriate technologies and institutional options, methodologies, tools and approaches that facilitate sustainable livelihoods.
- Formulate investment strategies for income-generation through off-farm opportunities, tourism, energy use, cash crop farming, and agro-enterprises.

ii) **Sustainable Management of Mountain Environment and Natural Resources**

- Identify, analyse, test, and disseminate technological and institutional sustainable land-use options for farmlands and common property land resources.
- Promote sustainable management of bio-resources, including biodiversity, pastures, and forests, by developing information on both natural ecosystems and management alternatives, approaches, and methodologies.
- Identify and promote appropriate management approaches for environmental risks, natural hazards/disasters, and water management.

iii) **Institutional Capacity-Building**

- Institutional capacity-building initiatives focused on Human Resource Development (HRD) through training, exchange visits, workshops, and

fellowships.

- Institutional capacity-building developing and strengthening GIS and other database and through network and regular exchange of information.

b) At National Level

The Government of India has established various institutes and the most recent initiative has been the establishment of the G.B. Pant Institute of Himalayan Environment and Development (1988), to evolve strategies for, and to gain knowledge in SD of the mountain and hill areas, and to improve the living standards of the people in these regions. The Action Plan for The Himalayas (1992) produced by the institute has been an important effort to develop and strengthen the mechanisms for ecologically sound economic development of the Indian Himalayas. It focuses on identifying desirable and feasible actions in different economic and environmental fields.

Apart from this Institute, many state governments and other agencies have actively promoted wider discussion to highlight the environment and development problems of the Indian Himalayas. Conventional agricultural universities in the Himalayan region are also contributing to the improvement of knowledge and skills for SD of the region. The Wadia Institute of Himalayan Geology, Dehradun, set up in 1968, is a premier Institute for studying overall geology with special reference to the role of glaciers and glacierized zones in the Himalayas. Its role further extends to civil engineering and environmental management in the hills.

The National Geophysical Research Institute at Hyderabad has an advanced seismological observatory which maintains a complete record of the earthquakes occurring on any part of the earth. The Wildlife Institute of India, Dehradun, conducts research and organizes training and educational programmes in wildlife management. The Indian Council of Forests Research and Education (ICFRE) at Dehradun conducts, facilitates, and coordinates forestry research, education, training, and extension. As a national body, ICFRE is promoting

and funding research in the field of forestry. The Council for Scientific and Industrial Research (CSIR) has set up a Regional Research Institute at Jorhat (Assam) and at Palampur (Himachal Pradesh) to carry out scientific research on various aspects related to mountain regions.

Apart from building up institutional capacities, several programmes are being carried out for the conservation of natural resources and SD of mountain and hill areas. The Himalayan region, particularly the North-east, is very rich in plant and animal diversity. To protect and conserve it for posterity, four biosphere reserves have been identified, namely, Nanda Devi, Manas, Kaziranga, and Namdapha. (This is in addition to the maintenance of several protected areas such as wild life sanctuaries and national parks).

Major efforts are on for the improvement of the ecology of the Himalayas through afforestation and soil conservation programmes being carried out by the National Wasteland Development Board and the National Afforestation and Eco-development Board. Two eco-task forces of ex-servicemen, in addition to other agencies, are deployed for the eco-regeneration of degraded lands in Uttar Pradesh and Jammu and Kashmir. Field demonstration projects for integrated ecological improvement with the active participation of NGOs, are also being initiated.

Although numerous institutions are working for improvement of the ecology of the Himalayas, required is an apex body for coordinating the efforts of the various institutes as understanding of the linkages between the different components within the system is a prerequisite for sustainable solutions.

2.3.2 Approaches to Operationalize the Concept

Recognition of the broader ramifications of the environmental problems has promoted different approaches for integration of environment and development on a holistic basis. These approaches are however still evolving. Integrated physical, socio-economic and environmental planning has been attempted in a number of countries (Sweden, Poland and

Centrally Planned Economies of Eastern Europe and Japan) as an effective instrument for the purpose. In Sweden ecological approach as the basis for physical planning has meant assisting society to develop within the limits set by the natural resources. Consideration has been given by laying certain guidelines to satisfy the claims on land and water resources. Solutions to conflicts between agricultural interests and urban expansion entails as little development of high quality agricultural land as possible. Evaluation has indicated that although knowledge of land and water resources is substantial, steps from planning to plan implementation have been missing. To develop Sweden's physical planning further stress has been laid on making its ecological approach more concrete and applicable to physical planning at local level with attention given to problems arising from the multiple use of land or water (Wramner, 1982).

The Polish planning system represents an integration of long term physical, socio-economic and environmental planning at national and regional levels. While these plans are genuinely integrated plans with a concrete socio-economic content, the shortcoming has been the insufficient link between national spatial plans and their provincial counterparts. At the same time difficulties connected with the preparation of elaborate plans at the local level have been recognized (Bohdan, 1982).

The problems of conservation and development of mountain region in the European countries have over the years been tackled by adopting sound practices of land use planning with the help of land tenure system, development of hydro- electric power as a major alternative source of local energy for development; secondly, preventing destruction of forest cover and thirdly, by adopting development of planned and dispersed tourism. All the three factors have been blended to achieve the objectives of conservation and development. In Japan hill areas have been kept as sparsely populated, where only two percent of the large population of over 100 million is living in the hills which cover 75% of the land area. This has been achieved partly by conserving the hills as resource regions for forestry, hydro- electric power, tourism and partly by having economic development in the plains. Although it has some adverse impact in terms of acute congestion and pollution in the remaining 25% of the

land area containing 98% of the population, nevertheless hill area has been treated on the basis of conservation development factors as in Europe (Meshram et al., 1994). But this approach as outlined by Colby (1990) can be said to be an example of placing nature above humanity rather than that of integrated development.

Ahmad (1982) is of the view that although it is easy to recognize the need for integrated planning, it is more difficult to devise policies, institutions and systems to ensure that it is carried out on a continuing basis, and calls upon academicians, researchers to identify new ways of thinking about systematic relationships and determine means to effectively manage the process of social growth and change through fluid and adaptive mechanism. Banskota (1994) too is of the view that difficulties involved in operationalizing SD cannot be underestimated. He brings out that although there is difficulty in resolving environmental priorities and type of problems to focus on, the overall limitations of environmental information make it even more difficult to target policies towards specific environmental problems. Successful design and implementation of SD strategies according to him mean substantial investments in the development of skills, information, institutional capacities, and programmes that are environmentally and economically sound.

Leonhardt (1982), from a survey of activities on integrated physical, socio-economic and environmental planning concludes that environmental problems are of a comprehensive nature and are to be included in the planning and decision making process. He thus suggests that sectoral planning should be developed into integrated planning.

Muller (1982), analysed a broad range of issues concerning environmental management based on integrated planning approach and suggested that the environmental decision maker should recognize key factors which constrain his activities, namely the social, technical, political, institutional, ecological and economic factors. He focused on the integration of environmental impact statements (EIS) with cost benefit analysis. He is of the view that the separation of EIS from economic evaluation prevents environmental impacts from being

considered at an early stage in the planning of the project. The practice of environmental impact accounting, with little or no requirement to consider environmental economic trade offs, can lead to inconsistent treatment of environmental impacts across different projects and therefore a wasteful allocation of resources. Michael Redcliff (1987) held a similar view that lessons of ecology should be applied to economic processes thereby providing an environmental rationale to development.

The importance of institutional structure in integrated planning methods is evaluated by Zimmermann (1982) who believes "These (institutional) structures cannot be underestimated in their resistance to integrative planning methods. This is especially true when a high demand for allocative optimality is connected to the necessity for a new institutional delineation of regions or a new definition of actors." He concludes that the institutional question of the assignment of responsibilities and powers represents a genuine political problem and can not be solved with the help of scientific methods alone. Other reasons for actual failure of integrative planning methods according to him are:

i) the huge data requirements
ii) complexity of the problem and the method itself
iii) the danger of lack of discretion in political decisions and
iv) the distance from participatory involvement

Jencie(1996) perceives a number of constraints to affecting Ecologically Sustainable Development (ESD), and says it is difficult to reconcile with the notion of an environmentally sound economy. She brings out that while well being and economic growth are inextricably linked and established as a principle in the achievement of SD, any proposal which in the short to medium term is perceived to `lower living standards', or require radical changes to the technologies of production and exchange, is unlikely to be accepted as feasible. The principle of ESD is recognized to be in competition with many other principles as for example competitiveness, deregulation, privatization of the government assets and utilities,etc.

Khoshoo (1992) highlights the infirmities in the present day economic development which has led to pollution and eco-degradation and like Jencie (1996) believes that advocating a back-to-nature life style which might lower the living standards is not a solution to relate development to sustainability. He stresses that the fruits of modernity must also reach the poorer sections of the society and that it is for science and technology to evolve a system of development which does not cause pollution and eco-degradation in the first instance while rectification of damage becomes a part of the development. The strategies for resource management according to him include population stabilization, energy conservation and efficiency, resource conservation and efficiency including recycling and reuse, technological advances for prevention of pollution requiring little or no clean up, restoration of ecosystem, social health, economic evaluation of natural resources all backed by legal framework.

Population stabilization is also called for, by Myer (1992) who believes that much of the economic growth of the past is not sustainable primarily because of environmental degradation and natural- resource depletion, a resultant of population growth. The growth in human number imposes unsustainable burdens on the environmental-resource base. He adds, while much can be done to relieve the situation through amended policies in the economic and technological spheres, there is a premium on slowing population growth.

For operationalizing SD, Daly (1990) builds an argument for shifting the focus and active margin of investment in natural capital. He emphasizes on the need to maintain the total capital stock: the sum of manmade and natural capital. Although the concept of sustainability has been recognized and incorporated into the very definition of income as "the maximum amount that a community can consume over some time period and still be as well off at the end of the period as at beginning", the condition of maintaining capital intact has applied only to man made capital since in the past natural capital was abstracted from as it was not scarce. Now, the remaining natural capital is the limiting factor and proper management of income requires natural capital maintenance to take priority and policies adopted that maximize its present productivity and increase its future supply. Since natural capital is of two kinds,

renewable and non-renewable, for renewable resource management investment Daly suggests constraining the annual off-take. Keeping the annual off-take equal to the annual growth increment (sustainable yield) is equivalent to maintenance investment i.e. to the avoidance of running down the productive stock. For budgeting non-renewable natural capital he suggests allocating all or part of the net receipts of non-renewable resource exploitation for financing waiting investments in renewable natural capital. The general rule suggested is to deplete non-renewable at the rate equal to the rate of development of renewable substitutes. This approach supports that non-renewable should not forever remain in the ground but rather benefit all. The solution therefore lies in pricing the non-renewable at the cost of its long run renewable substitute. According to him an important use of capital is for supplying technology that will increase the productivity of all inputs in the production process and for substituting more abundant natural resources for those that are scarce. Improved technology can reduce natural resource inputs required for a given level of economic output, and can reduce waste or render waste less harmful to the environment. Nevertheless, according to Mikesell (1992) there are severe limits on the degree to which compensation in the form of financial capital can substitute for the loss of certain kinds of natural capital.

Some economists defining new measures of growth, suggest ways to measure national wealth that would concentrate the attention of policy matters on what effect economic activity has on the environment. Devising national income accounts that value natural resources is one way to discover whether or not the policies are truly sustainable. One approach pioneered in Norway and built on in France and Canada tries to measure the stock of a country's natural resources, mainly in physical units such as hectares, kilograms and litres, and to estimate changes in that stock over time. France tries to measure not only stocks and flows of physical resources but the way they are distributed by region and the way they are used by companies, individuals and governments. Such accounts are believed to have certain shortcomings and are controversial (Cairncross, 1992).

For reconciling development goals with ecological capabilities, Khanna et al., (1992)

argue for a dynamic framework. The strategies outlined by them include i)carrying capacity based planning process, ii)innovative technologies for enhanced material and energy affectivity of production and consumption, iii) structural economic change towards less resource intensive sectors, and iv) preventive environmental management through increasingly interventionist. policies.

Joardar (1996) while referring to the absence of comprehensive operational procedures for SD of cities, suggests carrying capacity based urban or regional planning as a concept and also a tool to establish a paradigm for SD of human settlements. He states that 'Carrying Capacity planning approach' relies on the emerging view that both economic growth and environmental conservation are necessary for the advancement of the quality of life and these should be made complimentary rather than conflicting goals of planning.

Commenting upon the nature of integrated planning (IP) Ahmad et al., (1982) suggest to consider IP as multi-objective oriented activity, based on an understanding of the interrelationships between various subsystems so as to cope with changing social values and increasing scale of economic and technical development. Understanding of relationships is necessary as it has been realized that policies designed to solve one issue affect not only the context within which it is being considered but also the range of actions on other issues. They also go on to define IP as a set of procedures required to achieve the objectives determined by a particular society. In this context IP has been distinguished firstly as a framework to thought because it requires an overall assessment of the various independent issues and problems involved, and secondly as a technique for policy making by means of which complex and synergetic problems can be solved. A fundamental methodological requirement identified is making on explicit statement of trade-offs i.e. criteria for evaluation, between socio-economic and environmental objectives, in the absence of which serious problems exist in interdisciplinary integration.

Mikesell (1992) also believes that sustainability criteria at the project and programme

levels should to be introduced, without which SD may be a little more than a policy goal without procedures for implementation. Identifying and estimating all the social cost of the environmental and natural resource depletion and degradation in the environmental assessment of a project would according to him have important advantages of promoting SD: i) by including these costs in the social costs of projects, projects that are less compatible with sustainability will tend to have a lower priority; ii) Environmental costs can be compared with remedial actions that will avoid or mitigate the adverse impacts or with the net social costs of the alternative projects that will serve a similar purpose; and, iii) the investigation would indicate the amount of compensation required to off-set the loss of natural resource capital resulting from the project.

Nijkamp and Spronk (1982) suggest that in order to accommodate a wide variety of social interests, decision groups and policy structures, policy analysis should be multidimensional in nature. They suggest that in the practice of decision making, aiming at optimal state of the system is often an unrealistic concept and interactive policy models can be regarded as an important decision aid to serve as essential learning tools. They also criticize programming models for the restrictive assumptions underlying such advanced mathematical tools. Interactive approach as suggested by them is composed of a series of steps based on a systematic exchange of information between decision makers and analysts. The two common steps are (i) the analysts propose meaningful and feasible trial solutions on the basis of a well defined compromise procedures; (ii) the decision makers respond to each trial solution by indicating in which respect (i.e. in regard to which effect) the proposed compromise is still unsatisfactory. These steps can be successfully repeated until after a series of steps a final satisfactory compromise solution has been identified.

Besides Nijkamp and Spronk, the interdependence between systems have been discussed by Brix (1980) and Patkar (1992). Brix studied the interdependence between two systems to arrive at the projected future states while Patkar (1992) recognizing the systems interdependence as a determinant of sustainable urban development, extended the model to

consider more than two systems simultaneously. He proposed a conceptual model in which systems dynamics is sustained over the time period through cyclical influences through loops.

Interactive models have already demonstrated their usefulness on several occasions having significant advantages compared to traditional optimization methods (Nijkamp et al.,1982).

All these approaches make an interesting reading but the works remain in a conceptual stage and are yet to be developed into usable tools.

2.3.3 National Level Efforts

To accelerate the pace of development in hills the Government Of India (GOI) has taken up several measures and the most basic of them is treating hill areas as a separate entity for providing special financial assistance. Accordingly hill areas in India have been classified into the following categories:

a) Hill areas which are co-terminus with boundaries of States are not covered under Hill Area Development Programme (HADP), but get preferential treatment in division of Central Plan assistance and are classified as Special Category States; and

b) Hill areas which form parts of states, but are not co-terminus with States' boundaries are termed `Designated Hill areas' and get special central assistance under HADP.

The designated areas are

i) Two hill districts of Assam, viz. North Cachar and Karbi Anglong.

ii) Eight districts of Uttar Pradesh, namely Dehradun, Pauri Garhwal, Tehri Garhwal, Chamoli, Uttarkashi, Nainital, Almora and Pithoragarh.

iii) Major Part of Darjeeling District of West Bengal.

iv) Nilgris District of Tamil Nadu.

v) 159 talukas of Western Ghats area comprising parts of Maharashtra(62

talukas), Karnataka (40 talukas), Tamil Nadu (25 talukas), Kerala (29 talukas) and Goa (3 talukas).

It has also been realized that planning in hill areas involves reaching a harmony between imperatives of ecological and human considerations. The existing soil, water and biotic resources have to be put to uses which are environment-friendly. Besides eco-development, programmes for development of hill areas have to aim at improving the quality of life of the hill people and to focus on fulfilment of their needs, namely, food, fuel, fodder, energy, health education, drinking water, etc. The responsibility for balanced socio-economic development of hill areas primarily rests with the concerned States (Dev et al., 1991).

2.3.4 Review of Programmes and Policies over the Various Five Year Plans

The hill areas of the country have been receiving attention right from the inception of the plan era after independence. In the first three Five Year Plans (FYP) much attention was paid only at providing higher rates of central assistance for some identified sectors. It was a piece meal approach and could not produce any noticeable improvement in the living conditions of hill people. The Fourth FYP stated a multidirectional area development approach. The hill areas were grouped in two categories.

i) Area with unfavourable physiographic conditions, terrain, and climate; and
ii) Economically backward areas marked by adverse land-man ratio, lack of infrastructure and inadequate development of resources potential.

In 1971 the National Development Commission gave special attention to four states namely U.P., Assam, West Bengal and Tamil Nadu. Later Western Ghats covering Maharastra, Karnataka, Tamil Nadu, Kerala and Goa were also added. In 1972-73 two projects with 100% central assistance were introduced in Pauri Garhwal in U.P. and Nungba Division in Manipur State. These were economic development programmes along with

provision of strengthening infrastructure like roads, markets and godowns. By mid 70's the realization for integrated development of the hill areas led to concept of the HADP being introduced in the Fifth FYP i.e., 1974-79. In the Fifth FYP there was an increasing realization that unless adequate programmes are evolved for conservation and proper utilization of the resources of the hill area, not only will the problem of these areas continue to remain unsolved, but the economy of the plains may also come to grief. There was therefore a paramount need for conceiving an integrated strategy for development of the hill area based on sound principal of ecology and economics. A separate chapter on `Backward and Special Area including Hill and Tribal area' was added to the Fifth FYP document. It noted that the realization of the growth potentials of the backward areas should be taken up on a priority basis in order to give practical shape to the ideals of egalitarianism and special justice. At the end of the plan it was felt that SD would be possible only by formulating ecologically harmonious development programme. Hence, the need for eco-development was put forth as a major policy thrust in the Sixth Five Year Plan.

During the Sixth FYP the Government of India set up a high level committee, the Tiwari committee. The specific areas of concern were identified as, i)preservation of threatened species of flora and fauna and also fragile ecosystem; ii)protection of land and water from pollution; and, iii) improvement of condition of human settlement, with the allocation being increased to 5.6 billion as against 1.7 billion in Fifth FYP.The various programmes and schemes were aimed at better land use, control of soil erosion, watershed management, afforestation, pasture development, appropriate agricultural crop planting and forestry in steep slopes.

Two advisory committees, one for the Himalayan Region and the other for the Western Ghats were set up for going into the development of these regions on systematic and scientific lines. Evaluation study of the Western Ghats Development Programme (WGDP) was taken up in 1980-81, and recommended i) improvement in programme methodology, formulation and implementation, ii) setting up of an efficient planning methodology, and iii)development of

comprehensive regional plan for the area

Later the WGDP attempted to identify environmentally sensitive areas which provided an ecological framework to take up various types of development activities in different sensitive zones. Five indicators namely altitude, slope, existing vegetation, soil types and average rainfall were taken up to determine the environmental character of hill areas. Based on these factors considering the physical features and characteristics of various environmental sensitive areas, strategy and proposals for eco-development and other measures for development were suggested. The project highlighted several important issues and problems for consideration at the macro level, but did not go upto the desirable depth of analysis and proposals. The specific data in terms of households, individual farms, detailed topography etc.; needed to work out the detailed, very grass root type, action planning was missing (Saini et al., 1985).Thus the Sixth FYP for the HADP also confirmed that the approach in this direction was sectoral, adhoc and with little reference to micro level area plans.

The Seventh FYP emphasised a harmonized approach to the HADP and aimed at:

i) Socio-economic growth and promotion of a secure basic life support system and judicious utilization of land, mineral, water and biotic resources in a total perspective.

ii) For this purpose, water being the principal catalyst, the watershed management approach was suggested.

iii) Promotion of ecology.

iv) Development of infrastructure for maintenance of human communities.

v) Evolution of appropriate technology, R & D and scientific inputs necessary for harnessing of natural resources and land use.

The Eighth FYP (1992-97) declared the hill states as special category states for giving central assistance for HADP. This was in addition to the normal state funding, During the Eighth FYP, the approach has been substantially the same as that of the Seventh FYP with

special focus on involvement of the people and meeting of the basic needs of the people through improved management of their land and water resources. The measures outlined towards this end included (PC/GOI Communication, 1996) the following.

i) An energy policy which would reduce pressure on forest and provide alternate sources of energy,

ii) Afforestation of denuded forest land with species which can provide both fuel and fodder,

iii) Provision of adequate and safe drinking water by development of gravitational sources of water,

iv) Emphasis on improvement of health facilities including infrastructural facilities in primary health institutions,

v) Development of skilled manpower,

vi) Evolving a proper land use pattern keeping the socio-economic and ecological parameters in view,

vii) Development of horticulture and plantation crops,

viii) Improvement of livestock and cattle,

ix) Development of industries such as electronics which do not pollute the atmosphere and lead to high value addition,

x) Development of network of transport and communication facilities with emphasis on feeder paths and roads,and

xi) Evolution of appropriate technology and scientific inputs which would suit local conditions and harness local resources.

Besides these measures, the Hill area development approach includes adoption of sustainable and more productive farming with emphasis on improved soil and water management practices, generation of off-farm employment opportunities, afforestation through government and non-government agencies, reduction of the use of wood for packing horticultural produce, development of area-specific marketing structures, promotion of

eco-tourism, adequate environmental assessment of major engineering projects, innovative approaches for family planning and welfare to contain population growth at sustainable levels, promotion of the role and status of women in the hills to make development holistic, and so on.

The strategy adopted in the Seventh FYP and also the Eighth FYP took up hill area development on compact watershed basis keeping in view the overriding priorities of eco-development and eco-restoration as well as the basic needs of the people like food, fodder, fuel and safe drinking water but the evaluation programme during the Eighth FYP brings out that overall impact of WGDP in Tamil Nadu was less than expected because of inadequate resources allocation, lack of coordination among implementing agencies of the various sectoral schemes and lack of community participation or awareness about the programme among the local people. (GOI/PC Communication, 1996).The HADP for the Nilgiri hills also aimed at integrated development but the overall objectives have served as basis for evolving specific sectoral objectives (Nilgiri Development Programme, 1996).

The review of HADP reveals that planning in hills has been both centralized and sectoral. Plans are prepared by the Planning Commission at the centre with focus on sectoral plans for either Agriculture, Industry, Transport and Communication, Health, Education, Welfare programmes etc. Sectoral planning has dominated all these years with no systematic attempt at area level planning. In the Fourth FYP although importance was given to the district level planning but no systematic attempt has been made to prepare and implement plans at the grass root level. Recently the 74th Constitutional Amendment has recognized district planning as the basis for comprehensive rural development in the country. Although the intention has been clearly to promote decentralized planning but the new machinery has still based itself on sectoral aspects and thus remained peripheral.

In the recent past the Government of Uttar Pradesh State set up a Doon Valley Special Area Development Authority for the preparation of a Master Plan for 2001 (TCPO, 1990).

The plan considers the existing natural and manmade environment. The physiography of the area has been analysed and remedial measures given top priority. The proposal is a major step towards the long term sustainable planning of hill areas although quantification of various aspects of the carrying capacity are lacking. The Doon Valley MP-2001 represents an integration of long term physical, socio-economic and environmental planning at regional level, but it leaves as separate issues, physical plans at local level, and, medium and short term socio-economic plans at all levels. The macro level plan deal with major issues simultaneously from all relevant points of view but leaves room for specific problems and approaches represented by each planning activity, in areas where this specificity is particularly strong, i.e. at the local level in medium and short term horizons.

CHAPTER - III

METHODOLOGICAL ISSUES

3.0 GENERAL

The knowledge gained from literature review suggests that the theories and strategies needed to progress towards SD in hills have to be different from those that currently make up the bulk of environmental issues. An attempt has been made in the chapter to develop a theoretical framework (Ahmad etal., 1982; GOI/PC Communication,1996) for a model planning process which is supportive and promotive of the SD concept. The framework is presented in two stages. Firstly the methodological issues are discussed extensively, thereby identifying the elements that should underlie synthesis of a suitable approach. Based on the elements identified for the model a framework incorporating the dynamical changes and factors has been introduced, which would govern the way development evolves with time.

3.1 METHODOLOGICAL ISSUES

The survey of literature brings forth certain methodological issues which enable and constrain development in the hills with respect to the sustainability concept. These issues are:

i) Varying perceptions of sustainability and the need to define SD in the context of hills.

ii) On going efforts to integrate environment and development and the necessary changes required.

iii) Recognising the dynamics of development process and the requisite treatment of multiple goals.

3.1.1 Sustainable Development in the Hills

The concept of sustainability is dynamic and multifaceted. Also perceptions of what sustainable society is differ from individuals and groups. Different interpretations as to the

meaning of the term have different implications for planned use of the natural resources. Various commentators have identified the problems associated with the indiscriminate nature of the concept. Therefore, while planning for any area we need to be sure of the overall objectives of the concept. Interpretation and definition of SD in the context of hills would help formulate a shared framework that disparate groups and individuals in the hills can use to guide perception and action.

The central concern of SD is the all time well being of the people (APH, 1992) which is dependent upon their needs and aspirations, (Allen, 1980; Barbier, 1987; and Tolba ,1983) and the carrying capacity of the area (Pearce, 1988 and Coomer, 1979). It is in effect a complex question of value judgement as to what the present society and the societies to come would like to have and a question of analysis of how much a given land can hold in terms of population and activities.

Human needs according to sociologists are arranged in hierarchy such that when the lower level needs are satisfied the higher level needs emerge and come into play. Sustainability implies satisfying each level of human needs. The fundamental needs as defined by Max-Neef (1991) are subsistence, protection, identity, idleness, understanding, affection, participation, recreation and freedom. Maslow (1954) defines a five- level hierarchy of human needs viz., physiological needs (food, shelter and clothing), security needs (protection of life, assurance of continuing income), social needs (acceptance by other people), self esteem needs (achievement of independence), and self fulfilment needs (job satisfaction). The fulfilment of these needs requires both natural and man made resources. The man- made resources imply i) the resources involving conversion of natural resources such as land, water and vegetation; ii) socio-economic and socio-cultural resource such as, household, agriculture, livestock and industries; and, iii) the infrastructural resources comprising of social, physical and economic infrastructure. In effect it is the natural components of the earth which directly or indirectly meet the material needs of the human beings and are inextricably linked. All these together serve as supportive parameters affecting the economic base, quality of life (QOL) and

eventually the sustainability as many of these manmade systems and human activities, such as, agriculture, transport, industry, etc. tend to alter and sometime even damage the balancing process of nature. Such disturbances in the environmental system have the potentiality of damaging the entire process of societal development and civilization. For sustainability there is thus a need to identify factors which cause the damage to the system and analyse the degree of interdependency between variables of resource development, population and environment (Upreti, 1994).

The basic sustenance requirements - the subsistence needs as defined by Max Neef, or the physiological and security needs as defined by Maslow, are directly dependent on the supportive parameters. The other needs, dealing with the qualitative aspects are then dependent on the fulfilment of the basic sustenance needs. This implies that the fulfilment of the basic sustenance requirements with due consideration to the natural resources (carrying capacity of the environment) shall subsequently lead to fulfilment of the higher level needs and consequently lead to SD in the area.

In the case of hills, as is evident from literature survey, the increase in population, and attempts at meeting the needs of the people result in uncoordinated development activities. The disregard for the objective conditions of the hills, the institutional failures and the political preferences thereby cause unprecedented degradation and depletion of natural resources. A little change in either the man made or natural sub system brings about a remarkable change in the hill system. The land use pattern/physical pattern of the area is ultimately affected which leads to environmental concerns. The complex interdependencies and the interlinkages between the various subsystem and the environmental implications, pose the basic challenge before planning in the hills. For sustainability therefore linkages between different sectors need to be studied systematically and the objective should be to improve the current condition and productivity of the hill subsystems while avoiding irreversible negative effects on significant resources and protecting the long term interests of sustainability while supporting the individual in the legitimate pursuit for a better life.

Parameters which give a holistic view of the existence of several subsystems their interdependencies and interactions; and also suggest guidelines for suitable development pattern are best defined by the carrying capacity (CC) of the area (Bishop et al., 1974; APH, 1992; Khanna et al., 1992; Sharma, 1995 and Joardar, 1996). CC is the concept which defines the level of tolerance and compatibility between population activities and demand; and ecological, social, cultural and economic support system of the area to meet these demands. It refers to the intrinsic limitations of the natural environment to act both as a `reservoir' of the resources to provide for human consumption and as `sink' to absorb the residuals or wastes generated from their use. It seeks to establish ecological and behavioural thresholds beyond which biophysical, socio-economic and environmental milieu and the QOL deteriorates. Sustainable solutions can then be arrived at by an assessment of the CC variables and a series of adjustments to reconcile competing needs and aspiration in the development process (Figure 3.1.1).

3.1.2 Changes Needed

Appraisal of the HADP reveals that though policies and programmes have been formulated and implemented for integrated development of the hill areas, no scientific methodology has been evolved over the years which may scientifically define the pattern of development. What is missing is not the capacity to undertake complex analysis but a shared framework that can be used to guide perception and action. Emphasis on various issues in different sectors of development has been activity specific, particular action oriented relating to specific groups and have generally been lacking in physical and spatial dimensions. (Meshram et al., 1994). Commitments made by government for advancement of SD have from the outset with their recommendations on priority issues in each sector, lacked a holistic approach. This has exhibited a continuing mismatch between the attributes of development interventions and the imperatives of specific mountain conditions. The fact that policy recommendations have been formulated on a sectoral basis, the ability to produce integrated outputs is limited and thereby the resultant problem of lack of co-ordination. The focus is required to be on relationship, linkages and the connectedness of individual parts of the system

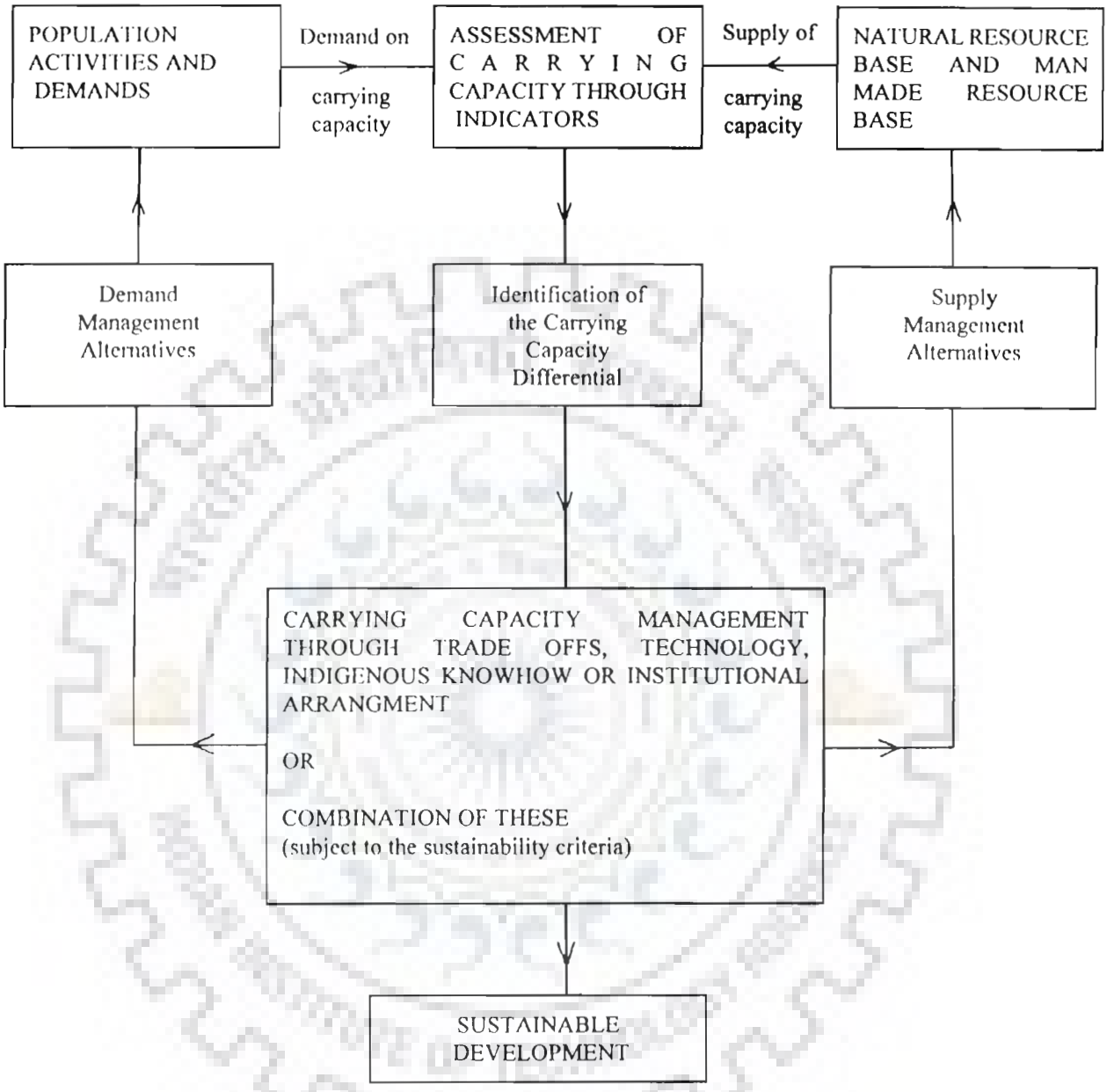


FIGURE 3.1.1 CARRYING CAPACITY BASED SUSTAINABLE DEVELOPMENT

instead of incrementalism and the key factors which constrain the activities leading to SD need to be identified (Muller, 1983). Besides this basic drawback of the ongoing approach to integrate environment and development, the programmes and schemes already in operation under the HADP can continue. There are few example of potentially useful options and the challenge lies in developing these potentials systematically in well conceived integrated area development plans (APH, 1992 and Meshram et al., 1994).

In order to solve the problems relating to human settlements through planned interventions no concerted efforts have been made for the hill areas so far. For the plains certain models have been advocated and one such model adopted is the British model of development which advocates that control over the disposition of land use would result in a decent pattern of living. Symbiotic relationship between environment and human settlements have always depended upon the natural resources for survival but this relationship has been lost with the impact of the global economy. The experience over the last 40 years shows that this model has not produced desirable results (Maitra, 1997). Development plans are prepared for fixed horizons of the time and based on the projections of land demand under various activities, the use of land is designated to result in harmonious development. This also assumes that a state of equilibrium will be reached at the end of the plan horizon. Projections and plans are prepared on the principle of steady state and at the end of the plan period one realises that the predicted projection has been wrong and then the planning for the next plan period starts.

Recently attempts in the direction of long-term plan for hill areas have been made in the `Doon Valley Special Area Development Master Plan - 2001' and in the Western Ghats region of Maharashtra state. The attempt is a step towards integrated planning where the hill specific conditions are considered. These plans are centred around eco-development wherein problems have been identified and addressed with regard to the carrying capacity of the area. Goals and objectives at the broader level have been identified and development forecasted over a period of 10 years. The question of how to translate the decisions in the long term plans into effective instruments of implementation remains unanswered. In order to operationalize the

concept of SD the methodology adopted for these plans needs to be extended in a scientific manner to the micro area level. Besides articulation of broad goals and objectives more important is the task to implement the programme and to steer it to the desired trajectory of development (Bohdan, 1982). The only implementational instrument of long term planning worth speaking has been the system of locational decisions based on regional spatial plans. The instruments through which the long term spatial plans can more directly influence implementation decisions with spatially differentiated impact have not been sufficiently developed. All this requires redefining the development planning levels and elaborate plans at the local level.

The conventional planning models for reasons of their current inadequacies cannot be therefore advocated for the hills. The unique environment and specific conditions (viz., inaccessibility, marginality, fragility, seasonal hazards) prevailing in the hills require a situation specific distinct approach at the micro-level.

3.1.3 Treatment of Multiple Goals

A complete analysis of sustainable management system requires thorough examination of interdependencies and interactions of all elements of each subsystem, the sensitivity of change to the elements and the process needed to respond to larger environments. The concept of carrying capacity of the area has been recognized as basic which gives a holistic view of the existence of several subsystems, their interdependencies and interactions. However, subsequently it is also evident that the fields of governments, economics, social responsibility and ecology are so complex that it is extremely difficult to develop a framework that gives full consideration to all aspects (Muller, 1982). Chaos theory on the other hand has shown that small perturbations can multiply in time to throw the entire system out of equilibrium. Multiple causes can bring on single effect or vice-versa. Causes and effects are often not sequential but interwind and dynamic in ways which makes it difficult to define precise limits to the natural processes and therefore precise quantification and predictions (Lyle, 1996). There also do not exist any clearly identifiable and unambiguous parameters to define the

capacity of the nature. It is for these reasons that rigid programming models which are otherwise useful in making reasonably accurate estimates and predictions are not considered reliable and have been criticised for their restrictive assumptions (Nijkamp et al., 1983; Faludi, 1987 and Lyle, 1996).

Despite these constraints in analysing environmental system, however, the inclusion of environmental effects and management can lead to a search for alternatives likely to be less costly in social terms and imply a more explicit assurance of ecological SD (Mikesell, 1992). Without scientific analyses the present ecological system would otherwise be an eventual hapless victim of self inflicted extinction, predestined to doom by nothing else but an innate inability to adapt in the face of inevitable chaos. There is no easy or quick answer to this ultimate planning and control problem of environmental quality. For sustainability as suggested by Nijkamp et al. (1982) aiming at optimal state of the system is an unrealistic concept and policy analysis is more suited than optimality analysis to the policy makers. Impact analyses, effectiveness analyses and strategic analyses lay much more emphasis on effects of policy measures, on shifts in social objectives, and, on conflict management and compromise principles and such broader view on policy analysis requires an integrative framework for judging alternative policy options(Nijkamp et al., 1982).

In the case of hills too, where several subsystems, those identified as- household, agriculture, livestock, infrastructure and industry, function within a given physical environment and are inextricably linked, aiming at optimal state would be unrealistic. Sustainability is a `process' which cannot be achieved once and for all and also aiming at optimal state would imply drastic changes which may or may not be in the common interest of the general public. The ultimate planning and control problem of environmental quality can then only be sorted by exhorting to increasing realism through an integrated planning approach for judging alternative policy options (APH,1992 and Nijkamp et al.,1982). The planning mechanism needs to be such as may be able to weigh benefits from investments in different sectors against each other. It should undertake sensitivity studies of effects of

marginal reduction in one sector and corresponding marginal increase in another and offer pragmatic solutions for SD. In this context `Systems approach' is the most viable option and issues of concern need to be that the goal of planning process, its control and intervention should not be detrimental to the society and result in broadly beneficial effects. This would involve mobilizing sectoral knowledge to form integrated multisectoral approaches for sustainable practices (Royal Swedish Academy of Sciences, 1996 and Meshram, 1994).

For arriving at the integrative framework for judging alternative policy options so as to most effectively achieve over time the societies' social, economic and environmental goals, two requirements, one for the sustainability indicators so as to identify key factors affecting sustainability (Muller, 1982) and other outlining the criteria for evaluation (Mikesell, 1992) become readily apparent. Indicators that have meaning to the parameters involved in the analysis need to be defined first, followed by defining criteria to assesses a range of alternatives, trade off and procedures.

As natural processes evolve the understanding of nature and the concepts of relationship between human and nature also change. The intellectual change gives impetus to rapid shifts in the internalized models and paradigms of nature's fundamental working (Colby, 1990). Therefore, the model integrating environment and development needs to be open ended as to accommodate the likely evolution of renewed understanding.

In the case of hills, therefore, considering the dynamics of natural processes, the involvement of multiple variables, their interconnectedness and the likely evolution of renewed understanding with time, focusing on optimal state of the system once and for all is an unrealistic concept. Integrating environment and development requires an interactive, multidimensional and dynamic approach. Model for SD planning in hills (SDPH) should therefore focus on decision making processes which would enable the various disciplines dealing with SDPH to understand the dynamics of development and so contribute more effectively to it

3.2 ELEMENTS TO OPERATIONALIZE SUSTAINABILITY

Based on the elements identified for operationalizing SDPH, the on going section outlines a) the indicators and criteria for SD, and b) steps for a coherent assessment and systematic management process to achieve the objective of SD.

3.2.1 Indicators and Criteria for SD

To enable a usable objective to be derived, the goals require to be quantified in commensurate units. For this purpose specific indicators and criteria need to be defined that are measurable and reflect the goals being sought.

i) Indicators of sustainability

Sustainability in a system can be restored by identifying the underlying factors and processes which have been a cause for unsustainability. Assessment of carrying capacity variables would help identify the unsustainability indicators for the area, and options for their reversal would give the indicators of sustainability (Jodha, 1993 and Maclaren, 1996).

The carrying capacity indicators which would help identify the indicators of sustainability can be broadly classified as under :

i) The indicators of the environmental status (natural system),

ii) The indicators of the level of development of various man made systems,

iii) The expected growth indicators, and

iv) The development potential indicators.

Table 3.2.1 brings out an array of indicators to assess the carrying capacity. The list is certainly not exhaustive, nevertheless the indicators selected exhibit the sectoral aspects of development process. The assessment of these would help identify the indicators of unsustainability in an area. Options for reversal would then give the indicators of sustainability.

TABLE 3.2.1 INDICATORS FOR CARRYING CAPACITY ASSESSMENT

BROAD INDICATORS (Goal for Sustenance)	INDICATORS AT MACRO LEVEL	INDICATOR AT MICRO LEVEL
I. ENVIRONMENTAL STATUS (Assessment to help zonation and prioritization of areas in term of environmental sensitivity - areas of intense and induced degradation)	i. Physiographic-altitude, slope, erosion intensity. ii. Geomorphic-seismicity (hazard areas), land slide hazard zones. iii. Unique natural areas, prime wildlife habitats. iv. Land utilization pattern - land under agriculture reserved forest, other than reserved forest, blank areas, land under river bed, snow, rocky areas.	i. Land * Physiographic and Geomorphic Altitude, slope, erosion intensity, soil quality, moisture, salinity, texture sedimentation. * Aspect Climate-sky condition, solar radiation, air pressure and wind, temperature, precipitation relative humidity, storms/ hurricanes. * Land use, land ownership, revenue area, natural area ii. Water * Stocks and flow of water, ground & surface water quality, impurities in river water iii. Vegetation * Natural/vegetation, degraded grazing, semi disturbed, cultivated and artificial.
II. LEVEL OF DEVELOPMENT i. Household * Human resource (appraisal aimed to identify human potential in terms of adequate quantity and quality for sustained economic development)	* Human resources : Demographic profile : Population size, growth rate, fertility-mortality rate, age-sex composition, age-sex-literacy ratio, occupation structure, occupation-education relationship, migration pattern. Level of technological knowledge, employment status.	* Human Resources a. Demographic profile : (Population size, growth rate, fertility-mortality rate, age-sex composition, age-sex literacy ratio, occupation structure, occupation-education relationship, migration pattern. Level of technological knowledge, employment status, b. socio-cultural profile : Population structure, ethnic composition, local taboos, crime, theft, social unrest, migration pattern, daily activity pattern, participation ratio. c. Socio-economic profile : Production system, source of cash income, economic infrastructure facilities.
*) Settlement design (quality and quantity to support needs and demands of the population group)	*) Design : Spatial organization, connectivity, planning criteria, geographical dispersal, housing stock.	*) Design : Organisation of space at community and dwelling unit level, housing stock, structural condition, construction techniques, improvement schemes.
ii. Agriculture (Integration of agricultural system with spatial planning so that settlement can produce enough food to sustain themselves)	ii. Agriculture : Percentage of net irrigated area to net sown, percentage of net sown to total cultivable, per capita agricultural productivity. Cattle population, yield and breed, fodder requirement, necessary support available.	ii. Agriculture : Percentage of net irrigated area to net sown, percentage of net sown to total cultivable. Type of crops and their calender, fruit trees production and potential, use of fertilizers/ pesticides etc. agriculture production, food habits, quantity of supply and consumption of major food per month. Cattle population, yield and breed, fodder requirement, necessary support available.

TABLE 3.2.1 INDICATORS FOR CARRYING CAPACITY ASSESSMENT (Contd..)

BROAD INDICATORS (Goal for Sustenance)	INDICATORS AT MACRO LEVEL	INDICATOR AT MICRO LEVEL
iii) **Infrastructure** (Adequate quality and quantity in terms of acceptable norms)	iii. **Infrastructure** : Availability of social/physical infrastructure-roads, public transportation, banks, hospitals, schools, Conventional and non-conventional energy supply system Type of market (regulated, controlled, administered, monopolistic) Service Amenities (media awareness information avenues) Legal Frame work (Municipalities, development agencies, current plans, policies and regulation-assessment of adequacy, degree of enforcement) social security system, care for the elderly	iii Basic utilities . Per capita access to basic facilities, connectivity with the settlement, extent of success in government programmes.
iv. **Industry** (In order to have adequate employment, income and GNP generation)	iv. **Industry** (level of development and investment in primary, secondary, tertiary sector).	iv. Industry (level of development and investment in primary, secondary tertiary sector) * **Primary sector** : agriculture, horticulture, animal husbandry, sericulture, bee keeping, fisheries, hunting, mining. * **Secondary sector** micro hydel, biogas, construction activity, manufacturing/handicrafts. *Tertiary sector : personal/domestic service, lodging facilities, recreation, eco-tourism, transportation (mule transport), private educational institution, public services (medical, law and administration etc.)
III. EXPECTED GROWTH	i. Estimated population growth. ii. Trends and factors in economy.	(a)**Socio-Cultural Indicators** : density, infant mortality, life expectancy, expenditure on health, dependency on land, per capita access to basic facilities, migration rate, degree of urbanization. (b) **Socio-Economic Indicators** : Income or consumption inequality, Agricultural productivity, degree of industrialization, employment.
IV. DEVELOPMENT POTENTIAL Classification of potential w.r.t. -Utilizing capacity -Potentiality based on interlinks -Sustainability criteria.	***Endogenous*** -Forest to land ratio -Conservation areas -Geographical dispersal of suitable land -Spatial plans ***External Influencing factors*** -Population -Natural resource base -Level of development -Prices -State policies/regional plans & policies -Economic linkages/market forces -Nodality/regional movement/linkages -Land utilization upstream -Water availability	**Natural Resources Potential** -Forest to land ratio. -Areas well suited for Agriculture and other land use. -Conservation areas -Geographical dispersal of suitable land **Man Made Resources Potential** *Agricultural potential. *Household potential *Infrastructure potential *Career development potential (Economic/industrial potential).

The environmental status parameters would look at the natural system and help in prioritisation of the areas from the point of view of environmental sensitivity. Fragile resource areas, areas with severe resource use conflicts, and areas prone to particular type of environmental problems would be singled out for priority attention. The inventory of level of development of the various manmade subsystems of the hill system would bring out their existing functions and also help in identification and appreciation of (i) the most critical subsystems in terms of their impact on environment (or vice versa), and (ii) a set of control parameters which prevail within each subsystem. The expected population growth and demands for future needs based on existing values and emerging trends of the hill societies would indicate the likely pressures on the area and alternative growth scenarios. The development potential, of the hill system can then be assessed based on the general classification of the resource attributes and vulnerability for the subsystems to different levels of use. Based on the set of parameters identified under four broad heads, resource allocation and trade off analysis can be taken up for reversal of unsustainability indicators. This would imply balancing of probable gains against losses, assessing costs and benefits of alternatives, setting priorities and standards, and curbing environmental damage. In order to assess a range of alternative and trade offs the criteria needs to defined (Mikesell, 1982 and Jencie, 1992).

b) Criteria for evaluating trade offs

Most development activities have an impact upon the environment and adversely affect the ecological balance. Required are reasonable and realistic alternatives which would produce minimum adverse impact and also achieves the goal of SD. Since all alternatives are not directly measurable, criteria has to be selected that is measurable and reflect the goal being sought.

The central concern of SD in the hills which are ecologically fragile is resource consumption and the associated environmental impacts including air and water pollution, amenity deterioration etc. The unlimited consumption of resources is antithetical to the goal and principle of SD, thus (i) the reduction in renewable resource consumption while

endeavouring to meet the needs of the people and ensuring that the resource harvest rates are no higher than the managed or natural regeneration rates would fulfill the requirement to be used as performance measure (Pearce, 1988; Turner, 1988; Daly, 1992), and (ii) in case of non-renewable resources and to overcome difficulties inherent in assessing the assimilative capacity, care needs to be taken to control and treat the environmental degradation. Evaluation considering the impact of human activity based on quantification of resources consumed in measurement, control and treatment of the environmental degradation or their resultant social, physical and environmental stress would form another basis for performance measure at the various development levels. In short sustainability can be assessed in terms of the ratio of the total benefit gained to the investment made in overcoming environmental stress which should always be higher for the chosen alternative (Mikesell, 1992; Khoshoo, 1992). Table 3.2.2 brings out the underlying issues to evaluate the developmental impacts.

TABLE 3.2.2 DEVELOPMENT IMPACT AND SUSTAINABILITY ISSUES

Developmental Impact	Sustainability Issues
Environmental	Maintenance and enhancement of ecological balance, biological diversity and biological resources.
Socio-cultural	Benefits must be equitably shared and be compatible with the culture and values of the people.
Economic	Development should be economically efficient and relieve pressure on fragile resources.
Technology	Choice of technology and its application should be appropriate in the context of the regions resources, strengths and problems. Consider economic and environmental trade-offs. Indigenous and traditional techniques should be incorporated.
Institutional	Setups compatible with the local human resource availability, their level of skills and economic needs.

3.2.2 Management Process

In order to operationalize the concept of SD the planning process besides identifying broad goals and objectives at the macro level, needs to take up a detailed analysis at the micro level where sustainability would actually be built through identifying the key factors, their interdependencies and interlinkages. District planning has been recognized as the basis for

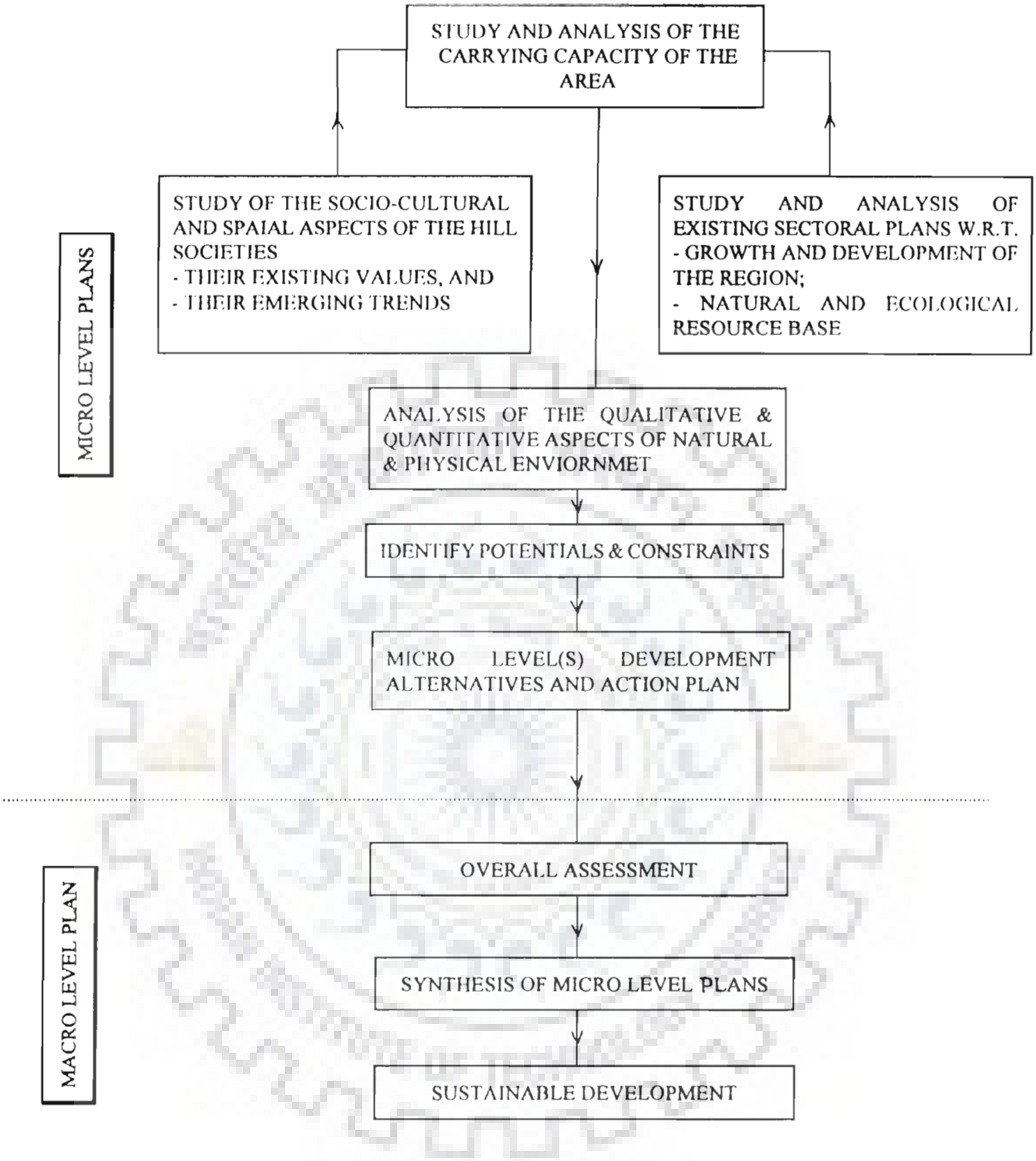


FIGURE 3.2.1 CARRYING CAPACITY APPROACH FOR SYNTHESIS OF MICRO/MACRO LEVEL ANALYSIS

comprehensive rural development in the country as a whole, and can therefore be considered for the macro level analysis. Watershed which has been identified as a planning unit for the hills can be taken up for detailed micro level analysis. All the micro level plans would then build up the district plan (Figure 3.2.1). Various steps necessary for a coherent assessment and systematic management process at the micro level are:

i) Assess the existing functions of the hill system in the watersheds of the area i.e. the carrying capacity at the micro level and maintain the comprehensive data bases that carry definition of status, trend and interaction.

ii) Identify the key factors affecting the sustainability of the area.

iii) Identify the dominant decision variables and the constraints affecting the sustainability dimensions of each key factor.

iv) Carryout the functional relationship between the dependent and selected explanatory variables.

v) Analyse the solutions for finding the required goal values by testing all the decision variables against the constraints and selecting the preferred values which results in broadly beneficial effects.

CHAPTER IV

STATE OF ENVIRONMENT AND DEVELOPMENT IN GARHWAL HILLS

4.0 GENERAL

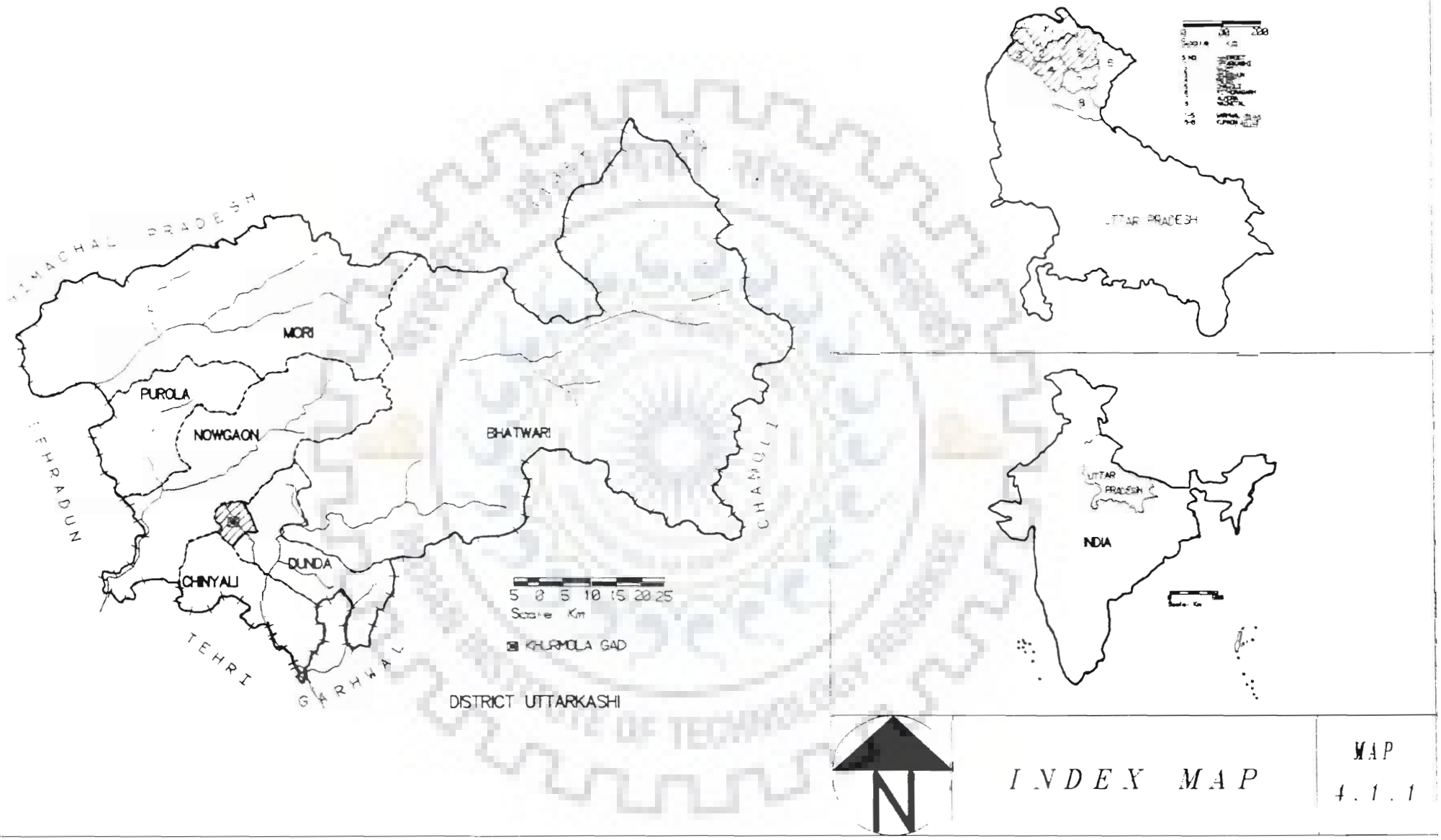
The sustainability of the region under study (Garhwal) can be best achieved by making each district self-reliant. The analysis at the macro level helps in identifying broad development issues and imperatives, and sets out well defined goals and objectives in terms of environmental sensitivity and activity based zonation of the areas within the district, eventually influencing its sustainability. The micro level (watershed) analysis is necessary to help build and operate SD. Plans at micro level would later build up the macro level plan. Planning at macro level is well defined. The need is to focus attention on micro level to implement policy decisions. Planning exercises at different levels cannot be independent of each other and integration is needed at each level. The chapter, with this in view, provides an introduction to the state of environment and development in Garhwal hills. It further deals with the macro level study of the Uttarkashi District which is built upon the comparative study of its six blocks.

4.1 INTRODUCTION

The Himalayas in the state of Uttaranchal lie between 28°-58'-23" N to 31°-37'-16" N latitudes and 77°-36'-37" E to 81°-0'-15" E longitudes . This region was a part of larger state Uttar Pradesh and was popularly known as Uttarakhand. It has recently, on November 8th 2000, been declared as a separate hill state.It occupies an area of 5,125 square kilometres and contains twelve districts. With the formation of new state four more districts have been carved out taking the original total of eight districts to twelve districts in the region. The region is broadly divided into two parts, viz, Kumaon and Garhwal. Kumaon and Garhwal divisions now have six districts each. (The detailed information is not yet available). Almora, Nainital and Pithoragarh fall in Kumaon division whereas Chamoli, Dehradun, Pauri Garhwal, Tehri Garhwal and Uttarkashi fall in the Garhwal division . The

region is flanked by Tibet in the North, Himachal Pradesh in the North and North-West, Gangetic plains of Uttar Pradesh in the South and South-West and Nepal in the East (Map 4.1.1). Garhwal hills lie in the extreme North-West of Uttar Pradesh. These Himalayas are the youngest, tectonically active and structurally very complicated mountain range, wherefrom originate a number of perennial rivers and provide sustenance to the vast masses of people in the valleys and the rich plains of the country. The region has for long remained backward both socially and economically owing largely because of the various topographical and demographic peculiarities, and the general absence of social, physical and economic infrastructure. Emphasis on integrated development of the hill districts has been laid in the national plans as a result of which development programmes have been underway. These development programmes have had their spread effects and since the region is ecologically sensitive development activities can have profound negative impact on the micro and macro level environment unless conceived in an environmentally compatible manner.

The HADP was introduced in this district from the Fifth FYP. At its inception the programme adhered to socio-economic development only which has been gradually shifted to integration of environment and development approach. Notwithstanding all the efforts made so far, the dominant scenario which has slowly emerged is the widening gap between development efforts and the corresponding achievements in terms of measurable economic gains, as well as qualitative changes, such as, the health and production potential of the natural resources base and environmental consequences etc. (Uttarakhand sub-Plan 1994-95). A comparison between the hill regions and the tarais (Plain) is sharply contrasted. Geographically the tarai portion has remained free from the topographical bottlenecks. These regions have relatively progressive agricultural practices and the benefit of irrigation facilities. The difference in literacy rates also show a significant contrast. Studies reveal that data for hills produce highly aggregative results if the plain `tarai' portion of the Himalayan region is included, where phenomenal agricultural and industrial development has been achieved. The hill districts need distinct approach for development and for this reason, only the hill districts (excluding Dehradoon) of Garhwal region have been taken for the study. Table



KHURMOLA GAD MICRO WATERSHED, DUNDA BLOCK, UTTARKASHI

79.9 percent of the total population is spread over 8118 villages and the population density is 82 persons per square kilometre against the state average of 377 persons per square kilometre. The economy of the region is mainly based on agriculture as about 70 percent of the total workers are engaged in primary sector. The work force participation rate for the area as a whole is 48.4 percent which is very high compared to the state average of 29.2 percent. The region has got very low agricultural productivity owing mainly due to the lack of assured irrigation, undulating topography, inadequacy of basic infrastructure facilities, and, scattered and marginal land holdings. Industrial development in the region is negligible. Owing to the strategic importance of the Northern portion of the region, the region has reasonably good transportation and communication facilities. An outstanding characteristic of the region is its imbalanced sex ratio, which is more marked in the rural areas than in the urban areas. The sex ratio for the region is as high as 1053 females per 1000 males. This shows a tendency of male out migration from the region, Uttarkashi is the only district having a low sex ratio of 881 females per 1000 males.

4.2 MEASURES TAKEN BY THE GOVERNMENT

To accelerate the pace of economic development in Uttarakhand (now Uttaranchal) and to strike a balance between development and environment, the Government of Uttar Pradesh had taken several measures by way of a) Strengthening development organisation, and, b) Making efforts to protect and improve the environment. These efforts have been sectoral in their approach and have lacked a holistic view.

4.2.1 Measures to Strengthen Development Organisation

Various measures taken for the purpose were as follows:

i) The hill region of the state had been treated as a separate entity with a sub plan drawn for the same.

ii) Decentralized process initiated since 1982-83 had been intensified by identifying district sector schemes for each district. Department of Uttarakhand had been created to act as Planning Department. Two regional centres one each in Garhwal

TABLE 4.1.1 OVERVIEW OF THE DISTRICTS IN THE GARHWAL REGION

S No	Characteristics	Name of the hill districts in the Garhwal region			
		Uttarkashi	Chamoli	Pauri-Garhwal	Tehri-Garhwal
1	Area (km^2)	8016	9125	5440	4421
2	Altitude (m.)	850 m 7000 m	600 m-7917 m	600 m - 2424 m	335 m - 4000 m
3	Drainage (Main River)	Bhagirathi, Yamuna and Tons	Alakananda, Mandakini & Pinder	Alakananda, Nayar (East and West) Ramganga	Bhagirathi, Bhilangana, Mandakini & Alakananda
4	Temperature Variation (1986)	-12.3 to 37.3°C	3.4 to 42.0°c	0.4 to 23.1°c	-0.4 to 30.4°C
5	Rainfall (1986)	1331.5 mm	1435.6 mm	1198.3 mm	1420.8 mm
6	% forest to total area (1995)	88.61%	61.90%	59.31%	69.13%
7	% net area sown to total	3.62	5.52	12.02	12.55
8	% irrigated to net area sown (1995)	15.62	4.76	9.3	15.71
8	% Grazing land (1995)	1.76%	2.58%	5.67%	0.49%
9	% land for groves and Horticulture (1995)	0.96%	4.19%	8.06%	0.50%
10	Fallow current and others (1995)	0.5	0.2	2.36	1.4
11	Land Holding size < 1 ha 1-2 ha 2-3 ha 3-5 ha > 5 ha (1986)	 56.6% 23.57% 13.43% 5.13% 1.27%	 68.4% 21.1% 6.8% 3.0% 0.7%	 56.7% 22.8% 9.5% 7.2% 3.8%	 67.6% 22.4% 6.2% 3.2% 0.6%
12	Population (1981)	1.9 lakhs	3.6 lakhs	6.3 lakhs	4.9 lakhs
13	Density of population (persons/Km2) (1981)	24	40	117	113
14	Literacy (%) 1981 Total Males Females	 28.9 46.3 9.2	 37.5 57.4 18.3	 41.1 56.3 27.1	 27.9 48.0 9.4
15	Sex Ratio (1981) (F-/1000 M)	881	1043	1091	1088
16	Work force participation rate (%) (1981)	55.2	50.1	43.5	50.8
17	Occupational Structure (1981) Primary sector Secondary sector Tertiary sector	 69.3 1.5 29.2	 81.2 2.0 16.8	 72.3 0.9 26.8	 85.4 0.7 13.9
18	Livestock Population (1982)	3,10,155	5,12,557	6,92,901	3,52,415
19	Length of roads (in kms.)	802.0 kms.	1185.0 kms.	2193.0 kms	1328.0 kms.
20	Length of roads/100 km2)	10.0 kms.	12.9 kms.	40.31 kms.	30.0 kms.
21	Length of roads per lakhs of population (in kms.)	420	325.2	343.8	267

Source Districts' Statistical handbook (1987) and Agricultural Statistics for U.P. (1990-91), SHERPA HANDBOOK (1995)

(Srinagar) and other at Kumaon (Almora) were established to assist the districts in plan formulation.

iii) Independent Heads of development had been created for speedy development of important sectors such as horticulture, tourism, and, rural and small scale industry.

iv) Uttarakhand Vikas Vibhag (Development Division) had been empowered with several administrative powers to control and supervise officers working in the hilly areas.

v) Special allowance had been allowed to the employees serving in the border areas and hill areas of the state.

vi) Research and development institutes had been established to harness potential in the area, which exists in abundance here.

vii) A marketing intervention group had been set up to plan and look after marketing needs of horticulture, rural and small scale industries sector and project formulation.

vii) State level coordination committee and divisional coordination committee with directorate general of border roads was set up to facilitate improved road conditions, especially in border areas.

4.2.2 Measures to Protect and Improve the Environment

i) High priority was given to soil and water conservation including watershed management with peoples participation, promotion of Van Panchayats etc .

ii) Re-orientation of construction activities for arresting ecological degradation. Road construction being made to confirm to the recommendations made by the Indian road congress for hill road making and a mix of combination of motor roads, light vehicle roads, bridle roads and foot bridges had been introduced.

iii) Post harvest management and marketing management, introduction of new

technology.

iv) Development of tourism as an industry and privatization of state run cafeterias.

v) Promotion of small scale/village and cottage industry, using local fibres and wool base. Revival of traditional industries like tea etc.

vi) Strengthening and improvement of basic infrastructure of road, irrigation and power specially in the hill region and interior areas.

vii) Improvement of social and community services like health, water supply and education with focus on decentralized management.

viii) Human resource development, employment oriented education, including skill and entrepreneurship development and technical training.

ix) Family oriented welfare, self employment programme for scheduled castes and scheduled tribes, including streamlining of poverty alleviation programmes of IRDP (Integrated rural development programme), JRY(Jawahar rozgar yojna), etc. and promotional measures for cottage industries, tourism etc.

4.3 UTTARKASHI - A PROFILE

The district of Uttarkashi located in the extreme North-West of Garhwal region and at a height of more than 800 m above mean sea level, spreads over an area of 801,600 hectares. It comprises of six blocks. The district has three towns Uttarkashi, Barkot and Bhatwari and 686 villages with a population ranging from

Less than 200 persons in 273 villages

200 - 499 persons in 290 villages

500 - 999 persons in 100 villages

1000 - 1999 persons in 21 villages

and more than 2000 persons in 2 villages

The district is historically and culturally important since Vedic times (times of sacred writings). It is a bordering one and has two out of four `dhams' (shrines) of Uttarakhand, viz, Yammunotri and Gangotri.

4.3.1 Environmental Status of the District

a) Topography and Physiography

The terrain in the district is hilly all over with ranges varying between 850 m to 7000 m above mean sea level. The district is traversed by major rivers Yammuna, Bhagirathi and their tributaries. In addition to these, numerous seasonal and perennial rivulets and streams flow along the valley providing excellent means of drainage and irrigation to cultivated tracts along their courses. All the main ranges are aligned in NW-SE direction, asymmetrical slopes can be noticed which are steeper along southern side and gentler on the North. Added to all this are huge boulders, snow capped mountains and glistening lakes giving it the scenic beauty. Of the total area in the district 22.87 percent is covered under snow and around 16.19 percent is at heights over 4000 m.

The land utilization of the region is primarily dictated by its topography, soil conditions, climate, infrastructure availability, capacity of the people, level of entrepreneurship, needs of the people and historical background. The survey conducted by the Land Survey Directorate, Forest Department, U.P. State, reveals that the actual land use pattern in the Uttarkashi district is as per data given below (Singh, B., 1992).

Area under agriculture	=	62053 ha	(7.74%)
Area under forest	=	291237 ha	(36.33%)
Area under blank	=	228488 ha	(28.50%)
Area under rock, snow lakes etc.	=	219822 ha	(27.42%)
Total area	=	801600 ha	(100%)

These figures are based on visual interpretation of landsat imagery while the Board of Revenue figures are based on village records which reveal the landuse pattern as below

Area under agriculture	=	31634 ha	(3.95%)
Area under forest land	=	710277 ha	(88.69%)

Area under pasture land	=	14334 ha	(1.78%)
Area other than agriculture	=	4046 ha	(0.51%)
Area under culturable waste	=	2877 ha	(0.36%)
Area under non-culturable waste	=	37676 ha	(4.71%)
Total area reported	=	800844 ha	(100%)

The difference in data is attributed to the fact that in case of revenue records the area for forests is defined by the limits specified, whereas, in the landsat imagery areas blank within the forest boundaries have been mentioned as blank although 90 percent of these blank areas fall within the reserved forest category and amount for 25.7 percent of the total forest land. Such a difference in classification accounts for the variation and hence it would be logical to infer that for assessing the environmental status the data pertaining to the landsat imagery is more realistic. For the purpose of assessing the level of development, the data of both the revenue records and also the landsat imagery are considered. A comparison between the two records reveals the extension of agriculture into uncultivable lands, and the denuded state of the forests.

About 93 percent of the blank area is under severe erosion. Table 4.3.1 shows that about 44 percent of the land is in the altitudinal zone of 1000-3000 m. Agriculture is practised mainly at altitudes 1000-2000 m. Forest lands over 55 percent are at 2000-3000 meters above mean sea level. At altitudes 3000-4000 m, about 70 percent of the blank area is reported which falls mainly under the reserved forest category.

TABLE 4. 3.1 ALTITUDINAL ZONE WISE LAND USE

Altitude	Upto 1000 m	1000-2000 m	2000-3000 m	3000 - 4000 m	> 4000 m
% of total land	0.42	19.34	24.51	11.66	16.19
% of land under cultivation	1.58	74.42	23.85	0.14	----
% of land under forest	0.59	28.9	56.18	13.59	0.64
% of land under blank area	0.30	10.73	9.32	23.65	55.96

The district is entirely mountainous with steep slopes and gorges. Only about 3.62 percent of the land has slope less than 33 percent while 3.17 percent land has 100 percent slope. Table 4.3.2 reflects that a majority of the area under forest has 50-100 percent slope. 70 percent of the land under cultivation has 33-50 percent slope while only 13.62 percent of the land under cultivation has slope less than 33 percent. Use of marginal lands at slope 50-100 percent and 100 percent for cultivation reflects the pressure on land.

TABLE 4.3.2 SLOPE WISE LAND USE DATA

Slope	< 33%	33%-50%	50%-100%	>100%
% land under cultivation	13.62	70.52	15.68	0.27
% land under forest	2.75	35.12	58.47	3.66
% land left blank	3.83	30.78	58.94	6.45
% land of total area	3.62	26.99	39.25	3.17

The areas under different land uses in the district have been classified under four erosion intensity classes. Blank areas suffer the most from severe erosion. Table 4.3.3 brings out that about 78 percent of the land under cultivation suffers moderate erosion. This is mainly because they occupy lands having slope over 33 percent. Even land under forests experience moderate to severe erosion as the forests are not in a good condition.

TABLE 4.3.3 EROSION INTENSITY DATA

Erosion intensity	E_1 (Slight)	E_2 (Moderate)	E_3 (Severe)	E_4 (Destroyed)
% of total land	12.65	23.94	35.78	0.27
% of land under cultivation	11.53	77.38	10.87	0.21
% of land under forest	32.50	44.95	22.43	0.11
% of land left bank	0.14	5.84	93.27	0.75

b) Climate

Owing to the complicated relief microclimates are of considerable importance in this region. The climate of the district varies from subtropical in some of the lower valleys to extreme cold in the higher mountain ranges. The temperature and precipitation are affected by mountainous topography resulting in varied climate, thereby influencing the terrain,

vegetation, soil and socio economic set up of the region. 70-80 percent of the total rain occurs between July and September. January is the coldest when snowfall occurs in various parts of the district and the mercury drops below zero. The average day temperature varies from 29°C to 40°C and night temperature varies from 0°C to 4°C. The average rainfall in the district is about 1695.3 mm.

c) Soil and Natural Vegetation

The soils are acidic and highly differential responding to the environmental vegetation. Soils have glacial and fluivo glacial origin while soils in the valley are generally alluvial. There is a high interdependence between natural vegetation and other environmental factors. With 88 percent of the area covered under forests, the region has large number of commercially useful trees which can be classified as

i. Sub tropical vegetation (< 1200 m) with main trees being, sal (Shorea robusta), kaju (cashewnut), bamboo etc.
ii. Temperate forest (1200 -1800 m) with chir(pine) and grass
iii. Sub alpine forest (1800-3400 m) with a mix of deciduous and broad leave trees like oak and blue pine.
iv. Alpine vegetation (> 3400 m) has only small pastures.

d) Geology and natural hazards

Since Uttarkashi lies in U.P. Himalayas so it becomes a part of larger geological unit and shares geological history with it. Its recent origin and unstable geological structure makes the region prone to earthquakes.

Within the area in which Uttarkashi is located there have been some historic earthquakes. The isoseismal intensity (modified mercalli scale) of nine and greater is observed. The seismic code in India divides the country into five seismic zones (I to V) and Uttarkashi

is mainly in zone IV with a probable maximum magnitude of 6.5 - 7 on Richter scale. Critical analysis of the historical as well as instrumentally recorded seismicity of the Himalayas shows that the convergent plate boundary has most recently ruptured in many sections (Kangra, Bihar, Nepal and Assam). According to plate tectonics theory these ruptured sections have relieved the accumulated stresses. A regeneration of the strain due to continued convergence will occur over a period of time (200 - 300 yrs) before the next great earthquake will rupture the same section of the boundary. On the other hand the sections of the plate boundary left unruptured in the sequence mentioned above may now be ripe for episodes of strain release and are identified as places with high potential for seismic hazard. The sections of Himalayas covered by Garhwal- Kumaon and the North Eastern region are situated in such seismic gaps and the region may have significant levels of accumulated strain on account of persistent convergence of Indian and Eurasian plates. As these disasters cannot be controlled solutions lie in adapting to such situations with the help of developmental and technological interventions.

4.3.2 Level of Development

(a) Socio-economic characteristics

i) Distribution and growth of population

The district has a total population of 2.4 lakhs (1991 census) with a density of 30 persons per square kilometre, which is well below the regions average of 82 persons per square kilometre. Rural population accounts for 92.9 percent of the total population. Slope conditions have a direct bearing on the density pattern and maximum concentration of the population is found along the lower parts of the Bhagirthi. The district witnessed the maximum growth of 24.31 percent during 1971-81 and 25.2 percent during 1981-91 (Table 4.3.4). The population growth rate in all the blocks is quite similar. The societies in the district have suffered relative isolation in the past. More than 90 percent know Hindi but generally use regional dialects. Overall there is low linguistic diversity in the area.

TABLE 4.3.4: BLOCKWISE POPULATION DISTRIBUTION, DENSITY AND GROWTH RATE

S No	Block	Area (Sq km)	Population						Total (%age)	Population Density (persons per sq km)	Population Growth % (1981-91)
			Rural			Urban					
			Male %	Female %	Total	Male %	Female %	Total			
1	Mori	203.7	52.11	47.89	26546	-	-	-	26546 [11.07]	130	24.46
2	Purola	111	52.13	47.87	21525	-	-	-	21525 [8.98]	193	31.33
3	Nowg-aon	267	51.87	48.13	48059	57.44	42.56	3214	51273 [21.38]	192	24.93
4	Dunda	183.9	49.77	50.23	44746	-	-	-	44746 [18.67]	243	26.52
5	Chuny ali	138.4	48.95	51.05	36306		-	-	36306 [15.15]	262	28.95
6	Bhatw-ari	188	54.04	45.96	42078	59.86	40.14	14047	56125 [23.41]	298	21.55
7	Forest Area	6924	-	-	3188	-	-	-	3188 [1.33]	264	4.46
8	Total for the District	8016	51.57	48.43	222448 (92.9)			17261 (7.1)	239709 [100%]	30.0	25.20

Figures in parentheses ( ) indicate percentages to row total.
Figures in parentheses [ ] indicate percentages to column total.
Source: Statistical Hand Book 1995, Government of Uttar Pradesh, Department of Economics and Statistics.

Table 4.3.5 CLASSIFICATION OF SEX-RATIO, MARITAL STATUS, EDUCATION LEVEL ACCORDING TO AGE

S No	Age Group	Sex Ratio		Marital Status						Education Level			
				Unmarried		Married		Others		Technical		Graduation	
		Male % (M)	Female % (F)	M(%)	F(%)	M(%)	F(%)	M(%)	F(%)	M(%)	F(%)	M(%)	F(%)
1	0-14	17.82	17.50	17.72	17.18	0.10	0.23	-	0.09	-	-	-	
2	15-29	14.36	12.09	7.05	2.15	7.20	9.86	0.11	0.084	0.012 (22)	0.002 (4)	0.62 (1189)	0.15 (293)
3	30-44	9.97	8.38	0.49	0.02	9.16	7.88	0.32	0.48	0.04 (76)	-	0.49 (938)	0.03 (57)
4	45-59	7.32	5.55	0.22	0.013	6.49	4.25	0.61	1.29	0.013 (25)	-	0.12 (220)	0.01 (18)
5	>60	3.69	3.32	0.06	0.007	2.75	1.08	0.88	2.23	-	-	0.005 (10)	0.003 (5)

Figures in brackets indicate the total numbers.
Source: Statistical Hand Book 1995, Government of Uttar Pradesh, Department of Economics and Statistics.

TABLE 4.3.6 BLOCKWISE LITERACY RATE IN THE DISTRICT

S No	Block (Population)	Literacy Rate		
		Males %	Females %	Total %
1	Mori (26546)	45.02	13.57	30.11
2	Purola (21525)	65.13	21.79	44.35
3	Nowgaon (51273)	59 41	16.97	39.03
4	Dunda (44746)	73 74	20.73	46.97
5	Chinyali (36306)	64.55	14.92	39.06
6	Bhatwari (56125)	83 23	33.74	60.84
7	Forest Area (3188)	67.65	33.57	55.11
8	Urban (17261)	89 60	67 62	80.93
9	Total For District	68.74	23 57	47.22

Source: Statistical Hand Book 1995, Government of Uttar Pradesh, Department of Economics and Statistics.

TABLE 4.3.7 BLOCKWISE OCCUPATION STRUCTURE

S No	Block				Occupation Structure of Main Workers (%)									Others
		% of total Population	Main %	Marginal %	Farmers	Farm Labour	Forestry, AH etc.	Mining	HH Industry	Other Industry	Construction	Trade & Commerce	Transp. & Communication	
1	Mori	58 5	54.5	4.0	84 43	2.59	3.38	0.28	1.21	0.75	1.34	1.22	0.30	4 50
2	Purola	53 02	48 1	4.92	79.86	1 97	2 41	0.14	0.32	0.77	3.69	2.73	0.34	7.77
3	Nowgaon	52.48	50.2	2.28	88.0	1.46	1.23	0.01	0.21	0.36	1.16	1.90	0.38	5.29
4	Dunda	50.10	47 6	2.5	83.21	0.77	0.85	0.04	1.62	0.36	1.87	1.75	0.46	9 07
5	Chinyali	51 28	49.8	1 48	86.30	0 56	1 85	-	0.29	0.44	1.47	1.78	0 50	6 81
6	Bhatwari	47.28	45.3	1.98	67.30	1 29	3.75	0.03	0.19	0.85	4.15	2.30	0 73	19.43
7	Forest	51.19	-	-	25.92	3.36	45.25	-	2.66	0.20	3.17	5.13	0.51	13 8
8	Urban	36.07	-	-	14.17	0.32	3.01	0.03	1.38	5.3	6.89	14.85	3.17	50.88
9	Total For Distt	50 65	47 8	2.68	77.55	1.32	2.75	0.06	0.71	0.79	2.41	2.62	0.60	11 1 8

Source Statistical Hand Book 1995, Government of Uttar Pradesh, Department of Economics and Statistics.

ii) Age -sex ratio

Most of the blocks in the district show a low sex ratio except Chinyali and Dunda where it is respectively 1042 and 1009 females per 1000 males. The age-sex composition (Table 4.3.5) with the marital status and education level reveals that the maximum population is in the age group of 0-14 years and majority of the population gets married between 15-29 years of age. This signifies a quantum jump in the population size in the coming years. Only 7 percent of the total population accounts for over 60 years of age group.

iii) Literacy Level

The male and female literacy rate of 68.74 percent and 23.57 percent respectively is high compared to the literacy rate of the region which is 52.0 percent and 16 percent respectively. Bhatwari block has the highest literacy rate of 60.84 percent while in other blocks it ranges between 39 percent and 46 percent. The education level of females is quite low compared to the male population (Table 4.3.6).

iv) Occupational Structure

The total workforce participation rate of 50.65 percent for the district (Table 4.3.7) is higher than the regions average of 48.4 percent and also the states average of 29.2 percent. The structure of the agricultural and non-agricultural employment shows that agriculture is the main employment sector, accounting for 77.55 percent of the total population. The labour force engaged in agricultural production activities is only 1.32 percent signifying that majority of the labour force for agricultural production comes from within the family. Forestry and animal husbandry account for a very low share of total workforce. The service sector which includes trade, business, transport and a number of activities accounts for only 6.4 percent of the total workforce. Employment in the construction sector is on an intermittent basis. The district has rich mineral resource but mining as such has not been an important avenue for employment. The reason lies in i) lack of appropriate infrastructural network to facilitate mineral exploitation, ii) lack of scientific assessment of mineral deposits, iii) technological

TABLE 4.3.8 LAND UTILIZATION PATTERN FOR DISTRICT UTTARKASHI

S No.	Year/ Block	Geographical Area	Reported Area (For Blocks)	Area under Forests	Alluvial Land (Current and other)	Fallow & Uncultivable Land	Use other than agriculture	Culturable waste	Pasture Land	Land Under Groves Trees & Shrubs	Net Sown Area
1	1989-90	801619 (100)	109253 (13.63)	710278 (88.60)	3730 (0.46)	19189 (2.39)	6571 (0.82)	8664 (1.08)	13265 (1.65)	7271 (0.90)	32648 (4.07)
2	1990-91	801619 (100)	109253 (13.63)	710279 (88.60)	3958 (0.49)	20363 (2.54)	6973 (0.8)	9194 (1.15)	14080 (1.76)	7716 (0.96)	29057 (3.62)
3	1991-92	801619 (100)	109253 (13.63)	710278 (88.60)	3793 (0.47)	19516 (2.43)	6683 (0.83)	8812 (1.09)	13495 (1.68)	7395 (0.92)	31647 (3.95)
4	Mori	169372.5	20372 (100)	3383 (16.60)	1234 (6.06)	5976 (29.33)	482 (2.36)	2254 (11.1)	2214 (10.87)	1803 (8.85)	3045 (14.95)
5	Purola	35270.5	11108 (100)	2983 (25.9)	250 (2.25)	1374 (12.37)	718 (6.46)	43 (0.39)	561 (5.05)	793 (7.14)	4371 (39.35)
6	Nowgaon	99420	26704 (100)	2000 (7.49)	955 (3.58)	6860 (25.69)	2074 (7.77)	2108 (7.89)	2213 (8.29)	1853 (6.93)	8596 (32.19)
7	Dunda	58784.5	18393 (100)	4506 (24.5)	214 (1.16)	1991 (10.82)	1446 (7.86)	690 (3.75)	3212 (17.46)	795 (4.32)	5562 (30.24)
8	Chinyali	29372.5	13852 (100)	3675 (26.56)	221 (1.60)	1965 (14.20)	1114 (8.04)	651 (4.69)	1705 (12.30)	591 (4.30)	3892 (28.10)
9	Bhatwari	409380	18824 (100)	1415 (7.52)	1041 (5.53)	1978 (10.15)	1064 (5.65)	3350 (17.8)	4045 (21.38)	1798 (9.55)	4259 (22.62)
10	Total for Blocks (1992-93)	801619	109253 (100)	17912 (16.39)	3915 (3.58)	20144 (18.43)	6898 (6.3)	9096 (8.33)	13930 (12.75)	7633 (6.98)	29725 (27.20)

(Figures in parentheses (..) indicate percentages to row total.
Source: Statistical Hand Book 1995, Government of Uttar Pradesh, Department of Economics and Statistics.

TABLE 4.3.9 BLOCKWISE CROPPING PATTERN FOR DISTRICT UTTARKASHI (1994)

S. No.	Block	Reported Area	Net Sown Area (NSA)	Area Sown More than Once	Gross Cropped Area	Cropping Intensity	%age of area sown more than once to NSA	Potential arable land	%age of NSA to potential arable land
1	Mori	20372	3045	2375	5420	179.2	43.51%	6533	46.61%
2	Purola	11108	4371	1237	5608	126.79	22.32%	4664	93.72%
3	Nowgaon	26704	8596	4020	12616	146.52	31.92%	11659	73.73%
4	Dunda	18393	5532	3052	8584	155.51	35.48%	6464	86.04%
5	Chinyali	13852	3892	2091	5983	153.98	34.89%	4764	81.69%
6	Bhatwari	18824	4289	2169	6458	151.04	33.48%	8650	49.23%
	Total (District)	801619	29725	14944	44669	150.27	33.45%	42736	57.85%

Source: Statistical Hand Book 1995, Government of Uttar Pradesh, Department of Economics and Statistics.

TABLE 4.3.10 BLOCKWISE LANDHOLDING FOR DISTRICT UTTARKASHI

S No.	Block	Size of Landholdings					
		Marginal (< ha)	Small (1-2 ha)	Medium (2-3 ha)	Large (3-5 ha)	> 5 ha	Total
1	Mori	-	-	-	-	-	-
2	Purola	5199 (62.45) (0.35)*	1538 (18.47) (1.37)*	852 (10.23) (2.3)*	572 (6.87) (3.71)*	164 (1.97) (6.63)*	8325 (100) (1.08)
3	Nowgaon	4381 (56.93) (0.33)*	1696 (22.04) (1.43)*	927 (12.05) (2.46)*	570 (7.41) (3.74)*	121 (1.57) (6.31)*	7695 (100) (1.17)*
4	Dunda	8743 (67.92) (0.29)*	2505 (19.46) (1.39)*	988 (7.67) (2.39)*	533 (4.14) (3.76)*	103 (0.80) (6.47)*	12872 (100) (0.86)*
5	Chinyal	-	-	-	-	-	-
6	Bhatwari	4359 (7.55) (0.32)*	1060 (17.40) (1.45)*	383 (6.29) (2.51)*	238 (3.90) (3.72)*	52 (0.85) (7.0)*	6092 (100) (0.84)*
7	Total (District) 1990-91)	22682 (64.83) (0.32)*	6799 (19.43) (1.40)*	3150 (9.0) (2.4)*	1913 (5.47) (3.74)*	440 (1.26) (6.55)*	34984 (100) (0.98)*
8	Total (District) (1985-86)	16498 (56.6) (0.40)*	6870 (23.57) (1.50)*	3913 (13.43) (2.59)*	1495 (5.13) (4.55)*	370 (1.27) (5.64)*	29146 (100) (1.23)*

(Figures in parentheses (...) indicate percentages to row total.
(Figures in parentheses (...)* indicate the average landholding size.
Source Statistical Hand Book 1995, Government of Uttar Pradesh, Department of Economics and Statistics.

TABLE 4.3.11 PERCENTAGE OF IRRIGATED AREA TO AREA SOWN AND SOURCE OF IRRIGATION (HA)

S.No.	Block	%age of irrigated area to area sown		Source and area irrigated		
		Gross	Net	Canals	Others (Tanks, Gul, Hydrams)	Total
1	Mori	16.94%	23.41%	491 (68.86)	222 (31.14)	713 (100)
2	Purola	31.72%	24.89%	330 (30.33)	758 (69.67)	1088 (100)
3	Nowgaon	15.06%	12.2%	373 (35.56)	676 (64.44)	1049 (100)
4	Dunda	27.16%	21.81%	539 (44.66)	668 (55.34)	1207 (100)
5	Chinyali	27.79%	18.49%	383 (53.19)	337 (46.81)	720 (100)
6	Bhatwari	18.5%	17.78%	423 (55.44)	340 (44.56)	763 (100)
7	Total (District) (1992-93)	21.91%	18.63%	2539 (45.83)	3001 (54.17)	5540 (100)

(Figures in parentheses indicate percentages to row total)
Source: Statistical Hand Book 1995, Government of Uttar Pradesh, Department of Economics and Statistics.

TABLE 4.3.12 BLOCKWISE AGRICULTURAL INPUTS FOR DISTRICT UTTARKASHI

S No	Block	Use of Fertilizers in kg per hectare of Gross Cropped Area			Agricultural Implements (1991)			Seed/ Fertilizer Stores (1991)	Godowns (1991)	Insecticide Depot (1991)
					Traditional Plough		Modern			
		1984-85	1991-92	1992-93	Wooden	Iron				
1	Mori	24.9	14.7	19.4	4311 (97.33)	29 (0.65)	89 (2.01)	2	9	1
2	Purola	13.4	11.4	15.1	4566 (97.02)	68 (1.45)	53 (1.13)	1	3	1
3	Nowgaon	17.1	7.6	10.0	11141 (97.81)	30 (0.26)	219 (1.92)	1	10	1
4	Dunda	8.4	10.8	14.2	7130 (95.45)	318 (4.26)	22 (0.29)	2	9	1
5	Chinyali	8.0	7.3	9.5	5670 (96.41)	195 (3.32)	16 (0.27)	1	4	1
6	Bhatwari	31.9	18.4	24.2	4598 (98.35)	17 (0.36)	60 (1.28)	2	10	1
	Total (Distt.)	16.7	11.1	14.6	37416 (97.10)	657 (1.7)	459 (1.19)	9	45	6

(Figures in parentheses indicate percentages to total agricultural implements).
Source: Statistical Hand Book 1995, Government of Uttar Pradesh, Department of Economics and Statistics.

limitations in fragile environment and iv) overall environmental consequences.

b) Agriculture

The pattern and quality of agriculture development is an important indicator of the well being of human resource. The land utilization pattern for the district over the years shows no significant change (Table 4.3.8). The block wise land utilization pattern and the cropping pattern reveals that the net sown area is only about one fourth on an average. A small percentage as current fallow land is indicative of high cropping intensity. Table 4.3.9 shows the cropping intensity in various blocks. The percentage of net sown to potential arable land is quite high in all the blocks except for Mori and Bhatwari block where the higher reaches are not inhabited. The cultivable waste is very little, and therefore leaves little scope for more area to be brought under cultivation or tree plantation. A small percentage of land is under

TABLE 4.3.13 BLOCKWISE AREA UNDER MAJOR CROPS OF THEIR PRODUCTIVITY FOR DISTRICT UTTARKASHI (mt tons/ha)

S No	Block	Rice	Wheat	Maize	Others	Total cereals	Total Pulses	Oil seeds	Vegetable (Potato)	Crop* Production (kg/capita/annum)	
										1984-85	1990-91
1	Mori	551 (18.09)	1367 (44.89)	99 (3.25)	1329 (43.65)	3346 (109.88)	189 (6.21)	278 (9.13)	142 4.66)	207	179
2	Purola	2444 (55.91)	1437 (32.86)	128 (2.93)	984 (22.51)	4993 (114.23)	171 (3.91)	284 (6.49)	111 (2.54)	417	338
3	Nowgaon	3229 (37.56)	2659 (30.93)	261 (3.04)	2629 (30.58)	8778 (102.12)	272 (3.16)	375 4.36)	609 (7.08)	303	261
4	Dunda	1725 (31.18)	2411 (43.58)	44 (0.79)	2407 (43.51)	6587 (119.07)	178 (3.23)	191 (3.45)	179 (3.24)	247	209
5	Chinyali	1281 (32.91)	2155 (55.37)	53 (1.36)	1265 (32.50)	4754 (122.14)	164 (4.21)	183 (4.70)	146 (3.75)	219	183
6	Bhatwari	1439 (33.55)	2393 (55.79)	49 (1.14)	833 (19.42)	4714 (109.90)	217 (5.06)	199 (4.64)	559 (13.03)	181	160
7	Total (District)	10669 (35.89)	12422 (41.79)	634 (2.13)	9447 (31.78)	33172 (111.59)	1191 (4.01)	1520 (5.11)	1746 (5.87)	253	216
8	Total Production Metric tons	16539	16478	655	12954	46626	743	682	25680		
9	Yield/ (Mt tons/ha) (avg for state)	1.55 (1.82)	1.33 (2.17)	1.03 (-)	1.37 (-)	1.40 (-)	0.62 (0.91)	0.45 (-)	14.70 (-)		

(Figures in parentheses indicate percentages to net sown area)
(* - The National Commission on Agriculture gives 190.9 kg/capita/annum as consumption standard).
Source. Statistical Hand Book 1995, Government of Uttar Pradesh, Department of Economics and Statistics.

use other than agriculture. The size and structure of land holdings is an important factor in determining the cropping pattern and agricultural practices. The district is characterized by predominantly marginal holdings (Table 4.3.10) where people's first priority is production of food grains. Marginal and small land holdings account for over 80 percent of the total land in all the blocks and the average size of these land holding is 0.4 hectare and 1.50 hectares respectively. The number of small and medium land holdings and also the area under them have reduced over the year 1985-86 and 1990-91. The percentage of gross irrigated is 21.91 percent (Table 4.3.11), while the percentage of irrigated to net sown is only 18.63 percent.

The sources of irrigation are mainly canals, tanks, guls and hydram, while the remaining area is rainfed.

The agricultural input by way of fertilizers (Table 4.3.12) in all the blocks is much below the standard requirement. Agricultural implements used are mainly traditional wooden ploughs. Agricultural service centres are few and far in each block. Agricultural productivity is very low in each block compared to the state average (Table 4.3.13) owing mainly due to the hostile terrain structure, steep slopes, fragmented and scattered land holdings. Agricultural productivity has further declined over the years signifying the deplorable state of agriculture in all the blocks. Wheat and rice are the main crops cultivated followed by millets.

c) Livestock

The livestock density is quite high in all the blocks considering their ecological carrying capacity. Table 4.3.14 reveals that the bullocks, cows, sheep and goat account for 86.4 percent of the total. Cows and bullocks alone account for one third of the total livestock.

TABLE 4.3.14 BLOCKWISE LIVESTOCK STATISTICS - 1988 (Nos.)

S. No.	Livestock Type	Block						
		Mori	Purola	Nowgaon	Dunda	Chinyali	Bhatwari	Total
1	Cow/Bullock	18054	14482	26924	15126	10664	16290	102630
2	Sheep	40958	9029	11510	2228	1349	13633	78766
3	Goat	22777	9130	20428	5609	6189	11356	75638
4.	Others	1015	625	1063	140	422	549	4014
5.	Total	84311	37564	67643	31588	26735	47957	297587

The production of milk is very low. Sheep rearing is an important industry with 136 tonnes of wool production per annum (1981). As many as sixteen sheep development centres are functioning in the district.

d) Industrial Economy

The district has weak industrial development. It derives its industrial resources from forest, livestock, agriculture including horticulture. Forestry does play an important role in the economy of the district. Herbs are the minor forest produce and large varieties grow in the wilds. These are collected through cooperative stores and there are twelve such cooperatives. Afforestation programmes cover 450 hectares annually. The cottage and village industries play an important role in the economy of the district. The most important cottage industry is the production of wool and woollen goods. Sheep are reared in large numbers and the industry flourishes at an altitude between 1523 m and 2440 m. Carpets, tweeds, blankets etc. are produced. Other cottage industries like basket making and wood crafts also exist. Cash crops such as pea and potato are the main income generating source. Horticulture has not made a headway due to food grains being their first priority and also because the difficulties in marketing the produce due to remoteness of the areas. According to 1981 census the production of fruits accounted for 21 thousand tonnes worth Rs. 2 crores. Stray surveys reveal that minerals such as iron, graphite limestone, kyanite deposits occur in the district but have not been exploited for reasons of lack of awareness, technical knowhow and ecological reasons. The district has enough man power and potential for hydroelectric power generation. Tourism has been recognized as an industry and has a lot of potential because of the famous shrines, the splendid scenic beauty and wide variety of flora and fauna. Adventure tourism sport is an added potential in the region.

4.3.3 Role of Non -Governmental and other Voluntary Organizatios

There are various development programmes being undertaken by the NGOs in the area. A review of NGOs' initiative shows that they all emphasize on formation of community based organizations and establishment of participatory approach. The stress is on empowering people to take control over various spheres of their lives.Several activities initiated in the area include a)Urban Environmental Management viz,Solid waste management system, Urban

Environmental mapping,and coping with intermittent water supply. Academy of Mountain Environics Dehradoon is the lead organization dealing with this.Shri Bhuvneshvari Mahila Asharam and Masons and Housing interest groups in Gairsain are active in providing housing support services.People's forestry management programmes are taken care of by Van Panchayats and Panchayat Seva Simithi.Anugruha and Janadhara are the lead institution identifying problems of elderly women and providing advocacy support for people in protected areas .There are also disaster intervention groups such as Hesco and Janadhar who have been initiating programmes involving several NGOs in the region to build community shelters for those affected by the natural calamities.There is unfortunately a lack of free flow of information between the various stake holders.

4.4 ANALYSIS OF ENVIRONMENTAL STATUS AND LEVEL OF DEVELOPMENT

The disparities in levels of development of various blocks needs to be assessed to select a future course of action for each block. District Uttarkashi comprises of six blocks, namely; Mori, Purola, Nowgaon, Dunda, Chinyali and Bhatwari. A study conducted by the School of Planning and Architecture `Zonation of environmentally sensitive areas in the Garhwal hills' (1990) reveals that majority of the blocks in Uttarkashi district have low environmental status which is mainly because of the high altitudinal and slope variation. Maximum area is in the slope category of 30 percent and above. Area under horticulture is less, although looking at the land suitability, horticulture is the best suited landuse. Study has been carried on a cross section of data pertaining to the six blocks based on the composite index approach (SPA, 1990). The indices so evolved reflect the sectoral aspects of development at block level. The level of development of the study area has been studied in three components:

i) Level of agricultural development

ii) Level of urban and industrial development

iii) Level of infrastructural development

For level of agricultural development following four indicators have been considered

i) Percentage of net irrigated area to net sown area

ii) Percentage of net sown area to total cultivable area

iii) Per capita agricultural productivity

iv) Average size of rural settlement

The study reveals that five out of six blocks have same level of development. Purola block has slightly higher level of development. The level of urban and industrial development shows that fifty percent of the blocks viz, Chinyali, Nowgaon, Mori have low level of urban and industrial development, while Dunda, Purola have medium level of development, and Bhatwari has the highest level of development. The indicators used for assessment are :

i) Percentage of urban population to total population

ii) Number of urban centres in the block

iii) Average urban settlement size

iv) Density of population

v) Number of small scale industries per 10,000 population

vi) Number of household workers per 10,000 population

vii) Number of other workers per 10,000 population

The study provides a relative statement of the level of development considering the urban settlement in the blocks. These urban centres in actual cannot be considered as indicators of development since they are small and do not qualify as urban in a social and economic sense except for that they have been so designated in the census. The relative variation in development level thus assessed does not exist and all blocks qualify for a similar level of development.

The infrastructure development in the six blocks has been assessed using following

indicators:

i) Percentage of electrified villages to total inhabited villages

ii) Length of metalled road per 10,000 km^2

iii) Number of hospital beds per 10,000 population

iv) Number of banks per 10,000 population

The study reveals that the level of development in five out of six blocks is the same while Mori block has a still lower level of development.

Tables 4.3.4 to 4.3.14 give the development status of each block separately and broadly bring out the fact that not much disparity exists in the level of development in all the six blocks.

4.5 PROBLEMS AND ISSUES

The analysis of the environmental status and the level of development in the district highlights the following problems and potentials with respect to development plans for basic resources.

4.5.1 Land

i) Land utilization in the district is primarily dictated by its topography, infrastructure, availability and the needs of the people.

ii) The district is entirely mountainous with 70 percent of the land under 33-50 percent slope category and 36 percent under severe erosion.

iii) The environmental status on the whole is low because of high altitudinal and slope variation.

iv) Although large portion of the area is not suitable for farming purposes due to the topography and the steep slopes the cultivation has extended beyond revenue limits signifying its deplorable state.

v) Large number of marginal and small land holdings which are both fragmented and scattered, pose a challenge to land management.

vi) The presently available culturable waste can be brought under cultivation.

vii) The Per capita cultivable land to total population as well as to agricultural workers is low, 0.12 hectares and 0.16 hectares respectively, compared to the recommended minimum of 0.2 hectares per capita (Ashish, 1983).There is therefore exists potential to divert the human resource to more productive activities.

viii) Productivity of the land can be increased by improving traditional practices of farming by intensifying the use of modern inputs.

ix) Steep slopes lead to rapid run-off of the rain water, thereby causing problems of erosion and retention of moisture in the soil. In the absence of adequate irrigation facilities the crop produce is adversely affected.

x) At high altitudes the intensity of solar radiation is high which can be harnessed for alternate energy generation.

4.5.2 Water

i) The region/ district has plenty of rainfall during the four months from June to September but the steep slopes result in substantial wastage of run-off.

ii) The various rivers and numerous rivulets which drain the region/district leave scope for exploiting the water potential for irrigation through water harvesting and for energy generation through small hydro projects. Area wise creation of small storages would serve in providing enough moisture while the small hydro projects (SHP) would not only provide alternate energy but also employment opportunities for the less skilled labourers.

4.5.3 Vegetation

i) Major portion of the land in the region is covered under forests and in

Uttarkashi over 88 percent of the total geographical area is under forests. The forests are not in a good condition with large areas denuded and experiencing moderate to severe erosion. This leaves scope for afforestation programmes The major forest produce is timber and fuel wood with minor produce as herbs, edible fruits etc., which offer scope for development of forest based industries.

ii) Forests support the maintenance of domestic animals. Due to the small amount of grazing land and high livestock density, the forests have been over exploited and degraded over the years.

4.5.4 Human Resource

i) The overall population growth rate has recently gone up, despite the high out-migration.

ii) High sex ratio has overall socio-economic implications for development programmes.

iii) The low literacy level in general and specifically of the women folk who are the main work force in the region/district, poses major hurdles in diffusion of information and technology.

iv) The high work force participation ratio offers a good potential to develop the economic base.

4.5.5 Economy

i) The region/district has a weak industrial set up.

ii) Trade and commerce in the region is not developed.

iii) The area has potential for economic activities viz, agriculture and its allied sectors, such as, animal husbandry, forestry, and related industries.

iv) Though no statistics is forth coming regarding horticulture, it however offers lucrative economic prospects to the area and is also environmentally more desirable. However, replacement of cultivation of food crops needs to be

carefully planned considering the time dimension involved in getting returns from horticulture and also that the region should support the minimum sustenance requirements of foodgrains.

v) The Garhwal hills because of their scenic beauty and religious importance have a vast potential for tourism. It is estimated that tourism can play a significant role in the economy. In 1991 total number of tourists visiting Uttarkashi District were 1.7 times the total population of which 1.6 percent were foreign tourists.

4.5.6 Role of NGOs and Voluntary Organizations

Substantial impacts can be attributed to NGO initiative but then examples are few.This suggests that massive research efforts and other support need to be undertaken in order to bring about dynamic development. Institutional arrangements and properly designed and implemented inputs are needed for these groups of professionals in the form of training opportunities,manuals, guidelines and knowhow support.There is also a need to document information in their field of activities with the objective of developing, standardizing information on resources, processes, technologies available and information that is necessary specifically for community development.

4.6 CONLUSION

This region is still a developing one and leaves scope for incorporating new ideas and thoughts for implementation. The development process in the region would accelerate since it has recently been declared as a separate hill state-Uttaranchal.Attempts in the direction of integrated development from the very outset would lead to SD in the region.

CHAPTER V

MICRO LEVEL ANALYSIS - IDENTIFICATION OF RESOURCES AND THEIR CHARACTERISTICS

5.0 GENERAL

This chapter deals with the structure of the sample households and the level of development at the micro level. The sample households (HH) have been categorized into four groups, viz. marginal, small, medium and large, depending upon their land holding size. Such a classification becomes imperative so as to cater to the needs and aspirations of each class of the society inhabiting the watershed. All the carrying capacity parameters as listed in the theoretical approach were reaffirmed after a preliminary study of the secondary data and a reconnaissance survey of the study area. The carrying capacity based on the identified indicators is analysed and synthesized to identify the problems and potentials.

5.1 ENVIRONMENTAL SETTING

a. Location

The micro watershed Khurmolagad is situated between 78^0-30' and 78^0-15' longitude to $30^0$30' to 30'15' latitude, in Dunda block of district Uttarkashi (Map 4.1.1). It comprises of five mini micro watersheds and covers eight villages namely Gewneti, Wan, Majgaon, Nagal, Saundh-gaon, Chhamroli, Sartali and Nowgaon.

b. Linkages

Metalled road linking `Uttarkashi-Barkot' passes through the watershed and leads to the Hindu Shrine Yamnotri. Most of the villages are at 5 km distance from the metalled road and accessible only through bridle paths.

c. Physiography

The project area is at an altitude between 1600 m and 2400 m. The watershed has well defined natural drainage system Gewneti gad, Bahugad, Saundgad, Fullogi Baurgad and Syalanagad, which collect run off water from small gullies and drain it to main stream Khurmola gad, which finally drains the water to the Bhagirathi river.

d. Climate

The climate in the watershed varies from subtropical to temperate at varying altitudes from 1600 to 2400 m. The temperature drops below 0^0C in winters.

5.1.1 Hydrology

The area recieves more than 1900 mm annual precipitation but due to high slope, rapid runoff is the usual phenomenon and the area faces problem of scarcity of water for irrigation. Lands covered with grass and forest allow rain water to percolate downwards thereby recharging the underground aquifers. Many natural water sources and springs are the result of this underground water. There is no uniform underground water table but there are springs which ooze water. These cavities are recharged in rainy season and in the winters when snowfall occurs. Harvesting rainwater in ponds (locally called as diggis), in-situ 'bunding',etc and then utilizing it in lean period (Soil and Conservation Unit Report, 1995) are a few alternatives to increase area under irrigation.

5.1.2 Vegetation

The watershed is covered with dense Oak forest on the upper reaches with an area of 1641.6 hectares and on the lower slopes the main species are Chir (Pine), Bhimal (Grewia optiva) , Kakaid (Pistacia integerrema) and Tun (Cedrela toona) are the species grown on risers of fields by the farmers. The watershed has an area of 3857.6 ha under forest (reserved category) which is the main source of fuel wood and fodder for the villages. The people have certain rights over the forest. A few trees are given as free grant to villagers every year. In addition, petty demands of the villagers are met through sale of trees at concessional rates.

LEGEND

- WATERSHED BOUNDARY
- STREAMS
- ROADS
- CONTOURS
- AGRICULTURE LAND
- FOREST LAND
- WASTE LAND

LANDUSE PATTERN

ENVIRONMENTAL STATUS ANALYSIS

N

1.0 0.5 0 1 2 3 kms

SCALE

MAP

5.1.1

KHURMOLA GAD MICRO WATERSHED, DUNDA BLOCK, UTTARKASHI

5.1.3 Environmental Status

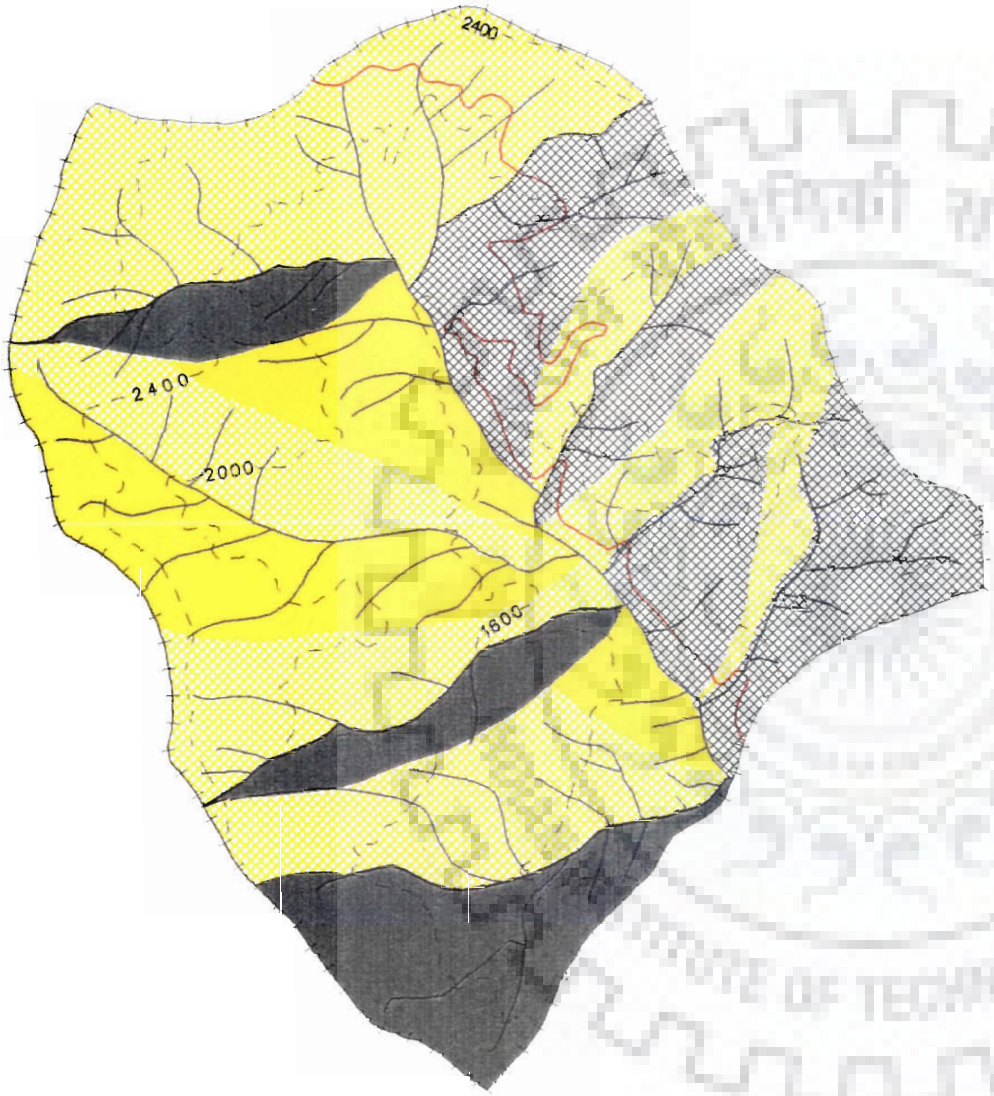
The environmental status of the watershed has been analysed and the land capability classification arrived at through scientific analysis and mapping of environmental resources with the help of GIS (Map 5.1.1 to Map 5.1.6). The various parameters analysed are the slope, erosion intensity, altitude, aspect and land use. The other parameters such as soil type, texture and depth, and, landslide hazard zonation were not included because of the non-availability of data. The classification is based on the land capability criteria as defined by Gupta and Arora, 1985 (Dhar et al.,1995). In the absence of a universally accepted land capability classification ideally suited for various end uses, soil scientist have broadly classified U.P. hill soils into eight group with reference to their designated use, sustainability without loss of production and productivity. These categories are briefly discussed in Table 5.1.1.

TABLE 5.1.1 Characteristics of Classified Land use Class

S.No.	Land use class	Characteristics
1	II	Mild erosion, deep soil, 10-15% slope.
2.	III	Slight to moderate erosion, moderate deep soil, 15-25% slope.
3.	IV	Moderate to serve erosion, frequent gully formation, greater slopes 25-33% and above.
4.	V	Mild erosion, deep soil, 33-50% slope and dense forest.
5.	VI	Slight to moderate erosion, greater slopes 33-50% and above, poor forest cover.
6.	VII	Severe erosion, frequent gully formation, 25-50% land damage, very steep slope, very shallow soil.
7.	VIII	50-100% land damage, severe gully formation, gravelly stony, very shallow soil, very steep slope.

Class I lands are ideally suited for cultivation and have no hazards.
Source: Dhar et.al.,1995

The analysis of the environmental status is given in Table 5.1.2. The analysis reveals that the entire land under agriculture is suitable mainly for horticultural use and, for crop cultivation only in areas that can be irrigated (Map 5.1.5). However, based on land capability criteria and the concept of 'sustainability without loss of production and productivity' as given by Gupta et al.,1985 improving the irrigation and remodelling of terraces can make the land capable for crop cultivation. About 96.4 ha of degraded forests can be brought under orchards



LEGEND

- WATERSHED BOUNDARY
- STREAMS
- ROADS
- CONTOURS
- SOUTHERN ASPECT
- EASTERN ASPECT
- WESTERN ASPECT
- NORTHERN ASPECT

ASPECT

ENVIRONMENTAL STATUS ANALYSIS

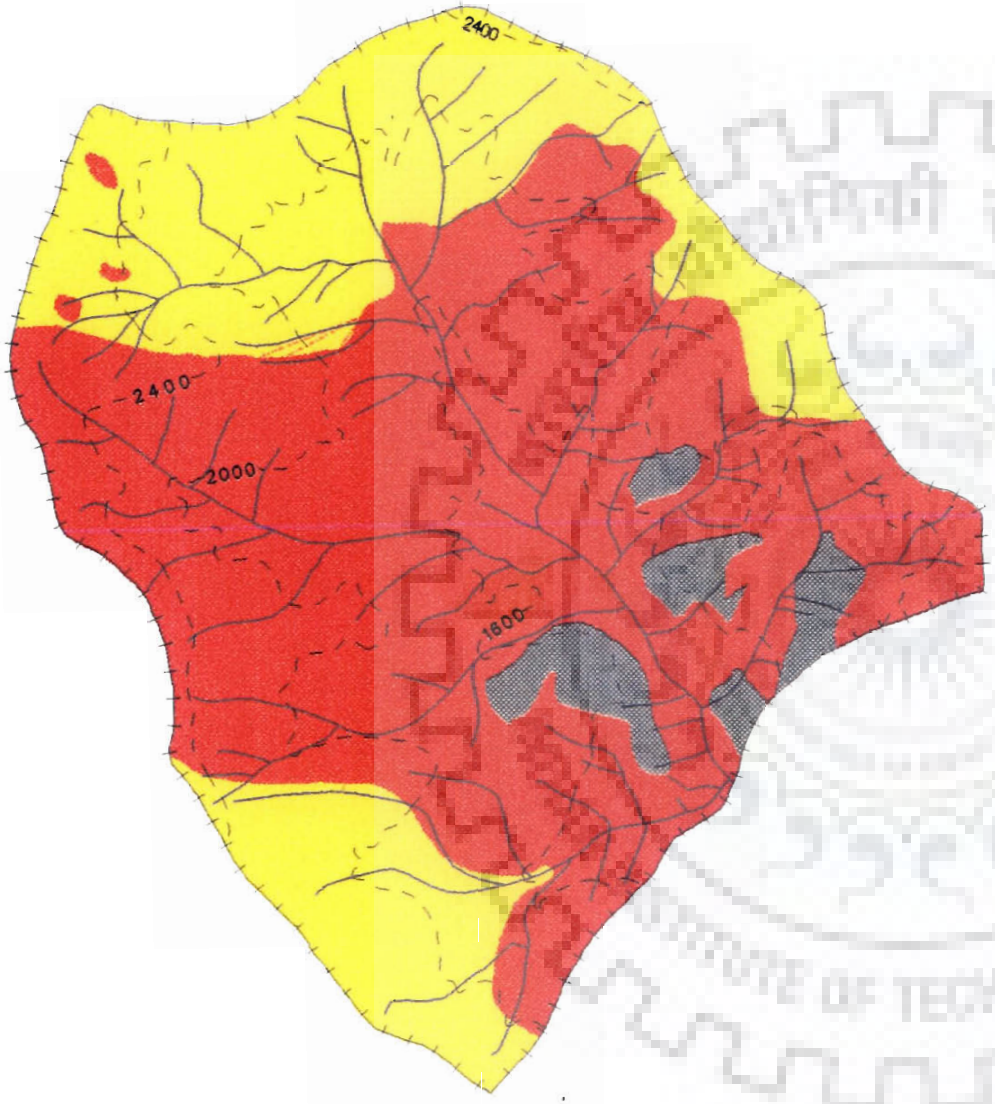
N

SCALE

MAP

5.1.2

KHURMOLA GAD MICRO WATERSHED, DUNDA BLOCK, UTTARKASH



LEGEND

- WATERSHED BOUNDARY
- STREAMS
- CONTOURS
- E1 EROSION INTENSITY
- E2 EROSION INTENSITY
- E3 EROSION INTENSITY

EROSION INTENSITY

ENVIRONMENTAL STATUS ANALYSIS

N

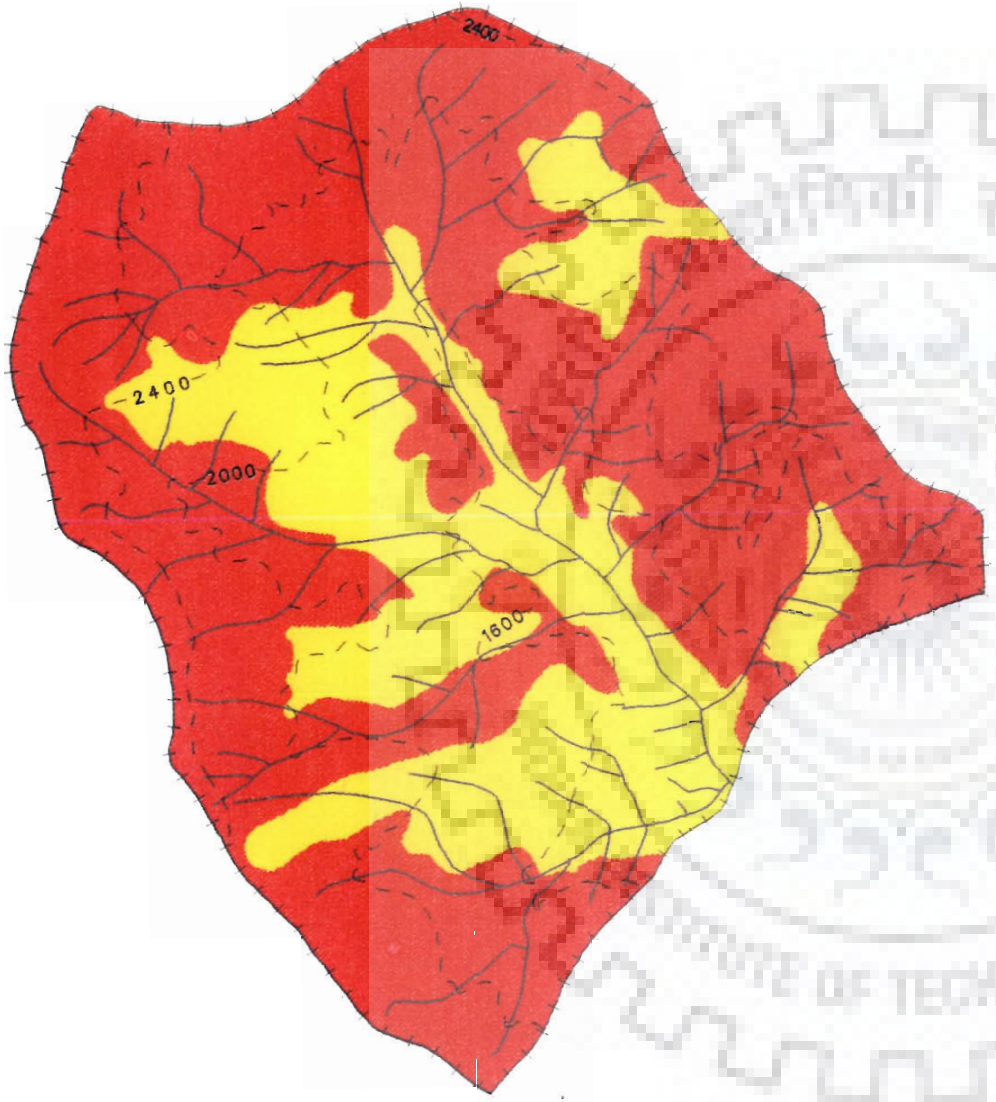
0 0.5 0 1 2 3 Kms

SCALE

MAP

5.1.3

KHURMOLA GAD MICRO WATERSHED, DUNDA BLOCK, UTTARKASHI



LEGEND

- WATERSHED BOUNDARY
- STREAMS
- CONTOURS
- 33-50% SLOPE
- 50-100% SLOPE

SLOPE

ENVIRONMENTAL STATUS ANALYSIS

MAP
5.1.4

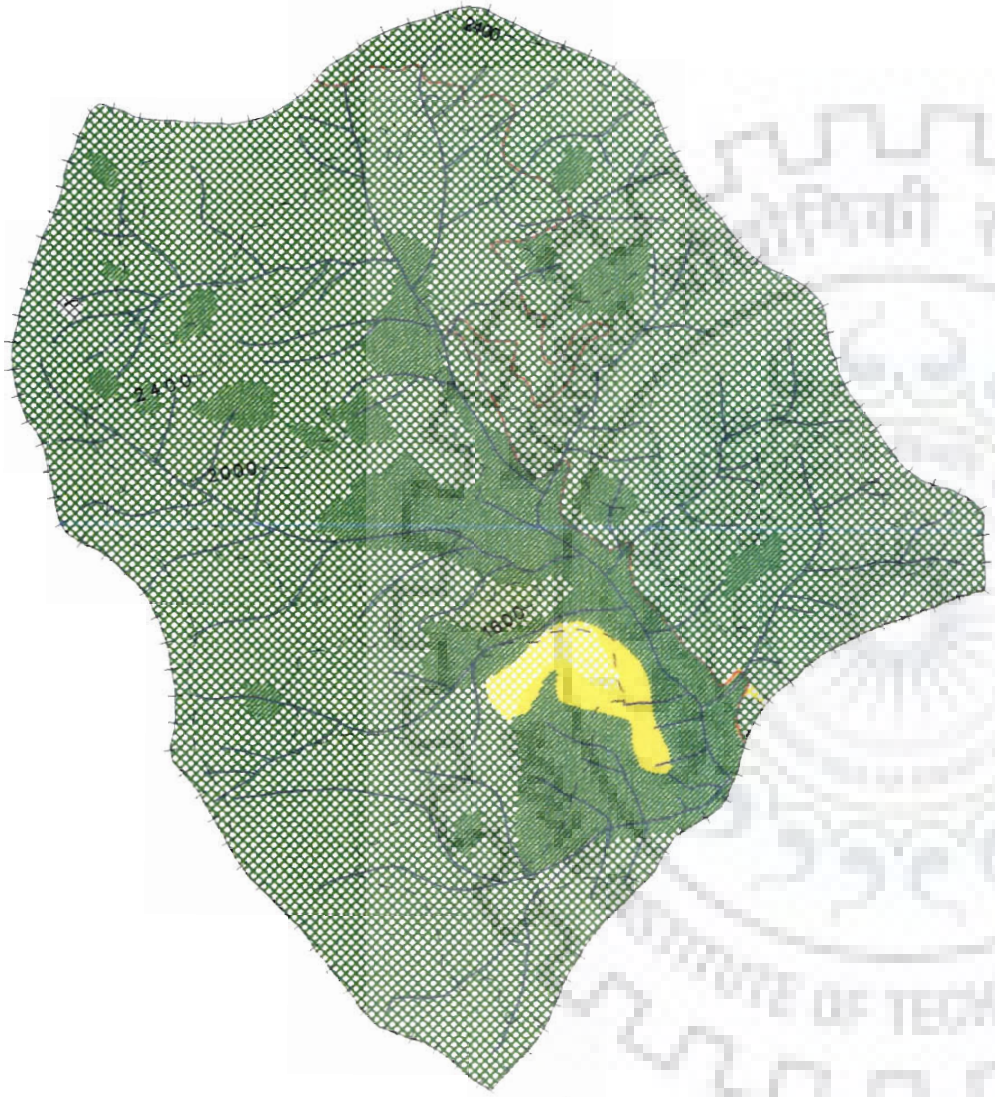
KHURMOLA GAD MICRO WATERSHED, DUNDA BLOCK, UTTARKASHI

and terraces restored through vegetative measures. The forest lands with moderate erosion intensity can incorporate silvi pastoral land management, and soil conservation measures need to be practised. The 119.7 hectares of badly gullied and ravined waste lands can be treated through soil conservation measures by bringing the land under improved vegetation cover. Area with rocks can not be put to any use and remains under present vegetation. The study area has no scope for extending area under crop cultivation, however the present area requires soil conservation measures. Considering the `aspect' factor the suitable area under agriculture is reduced to 507 hectares.

TABLE 5.1.2 ENVIRONMENTAL STATUS ANALYSIS

S No	PRESENT LANDUSE	AREA (ha)	LAND USE SPECIFICATIONS	LAND CAPA-BILITY CLASS	AREA (ha)	PROPOSED LAND USE	SUGGESTED TREATMENT
1	Agriculture (Cultivated land and human settlement)	630	a) Moderate erosion with proper terracing and 33-50% slope	IV	630 (13.24%)	Orchards/crops where irrigation could be provided	Restoration and improvement of 'Gul' water management, changing cropping pattern remodelling terraces.
			b) Severe erosion with defective terracing and slope 33-50% and above.	IV			
2.	Forest land	3857.6	a) badly degraded forests with severe erosion and 33-50% slope.	V	51.42 (1.08%)	Orchard or horticulture pastoral, cash crops	Terrace restoration through grass, plantation of orchard and top trees.
			b) degraded forests with severe erosion and 50-100% slope.	VI	44.98 (0.95%)		
			c) vegetation cover 0.5-0.7 and > 0.7 with slighted moderated erosion	VII	3761.19 (79.15%)	Silvi pastoral land management	Soil conservation measures, grass-legume mixture.
3.	Waste land	264.3	a) badly gullied and ravined with steep slope and severe erosion	VIII	260.3 (5.5%)	Permanent vegetation, cover under fuel and fodder reserves	Protection through soil conservation and improvement of vegetation cover
			b) rocks etc.	VIII	3.99 (0.08%)	Steep rocky and precipitous land	Under present vegetation no treatment.

(Classification based on land capability criteria as defined by Gupta and Arora, 1985).



LEGEND

- WATERSHED BOUNDARY
- STREAMS
- ROADS
- CONTOURS
- CLASS IV
- CLASS V
- CLASS VI
- CLASS VII
- CLASS VIII

LAND CAPABILITY CLASSIFICATION

ENVIRONMENTAL STATUS ANALYSIS

N

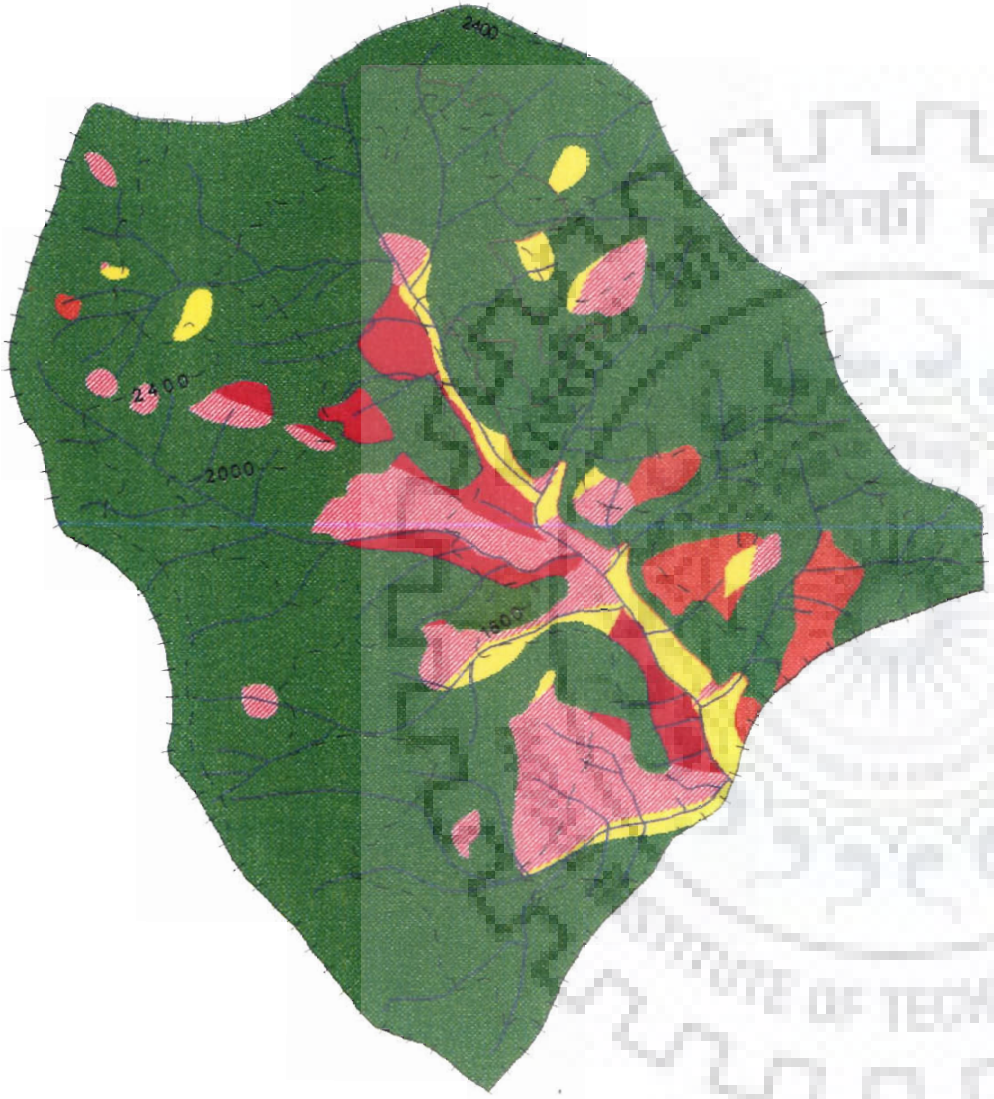
1.0 0.5 0 1 3kms

SCALE

MAP

5.1.5

KHURMOLA GAD MICRO WATERSHED, DUNDA BLOCK, UTTARKASHI



WATERSHED BOUNDARY
STREAMS
ROADS
CONTOURS
AGRICULTURE LAND WITH SOUTHERN ASPECT
AGRICULTURE LAND WITH EASTERN ASPECT
AGRICULTURE LAND
FOREST LAND
WASTE LAND

SUITABLE ASPECT FOR AGRICULTURAL USE

ENVIRONMENTAL STATUS ANALYSIS

N

1.0 0.5 0 1 2 3kms
SCALE

MAP
5.1.6

KHURMOLA GAD MICRO WATERSHED, DUNDA BLOCK, UTTARKASHI

As per the revenue records the land utilization pattern is as follows.

Total area under village in the watershed = 630 ha

Non arable land	= 317.95 ha
Cultivated land	= 312.05 ha
Net sown area	= 302.15 ha
Current fallow	= 9.9 ha
Other fallow	= 6.0 ha
Culturable waste	= 4.9 ha

The extent of land left fallow reveals a high cropping intensity while the GIS analysis reveals the area to be under 33-50 percent slope with moderate to severe erosion and as unsuitable for agricultural use.

5.2 LEVEL OF DEVELOPMENT

In order to understand the linkages and interdependencies of the various subsystems of the hill system, a detailed study of each subsystem is imperative. The several interacting subsystems of the hills' manmade system have been separately discussed here. The linkages between development and environment so revealed would help in differentiation of emphasis according to current level of development and future potential, extent of poverty and environmental risks.

5.2.1 Household

The subsystem household plays an important role in the social, cultural, economic as well as the environmental development of the region. It is an important factor in determining the structure and process of resource development and utilization. It also in turn affects the quality of environment as well as the economic status of the society. A detailed analysis of distribution of land holdings, population distribution, literacy, occupation and sex ratio have been attempted, along with consumption pattern of resources and the income pattern of the households. Such an appraisal is aimed at identifying the human resource and their livelihood

TABLE 5.2.1 DISTRIBUTION OF LAND HOLDINGS

S No	Land Holding Size(ha)	Number of Households	Area in Hectares			
			Total	Average	Minimum	Maximum
1	0 - 1	79 [68 10]	37 747 [34.10]	0 478	0.052	0 938
2	1 - 2	22 [18 97]	32 462 [29 32]	1 476	1 102	1 998
3	2 - 4	14 [12 07]	35.469 [32 04]	2.362	2.083	3.333
4	Above 4	1 [0 86]	5.029 [4.54]	5.029	5.029	5 029
5	Total	116 [100]	110 706 [100]	0.954	0.052	5 029

(Figures in parentheses [ ] indicate percentages to column total)
Source Primary Survey

TABLE 5.2.2 POPULATION DISTRIBUTION

S No	Land Holding Size (ha)	Male	Female	Total Nos.	Average Family Size
1	0 - 1	262 (51 27) [62 98]	249 (48.73) [64 18]	511 (100) [63.56]	6.5
2	1 - 2	76 (50 67) [18.27]	74 (49.33) [19.07]	150 (100) [18.660]	7.0
3	2 - 4	76 (55.47) [18 27]	61 (44.53) 15.72	137 (100) [17.04]	10 0
4	Above 4	2 (33 33) [0 48]	4 (66.67) [1 03]	6 (100) [0 74]	6.0
5	Total	416 (51 74) [100]	388 (48.26) [100]	804 (100) [100]	7 0

(Figures in parentheses ( ) indicate percentages to row total)
(Figures in parentheses [ ] indicate percentages to column total)
Source Primary Survey

needs and aspirations.

a) Distribution of landholding

The Table 5.2.1 reveals that

i) Majority of the households are in the marginal farmers category. The number of households decreases with the increase in landholding category.

ii) The total area under the occupation of each landholding category is nearly equal, which implies that each category requires equal attention.

iii) The average holding size in the marginal farmers category is 0.478 ha and 1.476 ha in case of small category farmers and 2.362 ha in case of medium category farmers, which reflects a large disparity in the landholding categories.

iv) Only one household falls in the `above 4 ha' category. It accounts for 0.6 percent of the total households and so its value is not considered to arrive at any decision in the subsequent analysis. However the household has been studied to see, if any peculiar characteristics are prevalent in the said category which might adversely affect the watershed development as a whole.

b) Population distribution

The Tables 5.2.1 and 5.2.2 reveal that

i) Majority of the population, about 82 percent of the total, belongs to the marginal and small farmers category whereas the medium and the large farmers account for only 17.4 percent and 0.74 percent respectively.

ii) On an average the male population is slightly higher than the female. This is explained by the fact that since there is some tourism potential in the watershed the less educated and unskilled workforce depend on seasonal tourism related employment rather than migrating out to plains. Out migration is high in case of highly educated and skilled workforce who otherwise constitute a small percentage. The ratio of male to female is similar in all the landholding categories.

TABLE 5.2.3 AAGEWISE POPULATION DISTRIBUTION

S No	Land Holding Size (ha)	Age Groups (Years)					Total
		0 - 6	7 - 15	16 - 45	46 - 60	60 +	
1	0 - 1	9 (18.9) [64.67]	65 (12.72) [66.33]	175(34.25) [59.73]	118(23.09) [60.20]	56(10.96) [83.58]	511(100) [63.56]
2	1 - 2	3 (21.33) [21.33]	18(11.9) [18.37]	55(36.66) [18.77]	37(24.66) [18.88]	8(5.33) [11.94]	150(100) [18.66]
3	2 - 4	21 (15.3) [13.99]	12 (8.76) [12.24]	61(44.32) [20.82]	41(29.93) [20.92]	2(1.46) [2.99]	137(100) [17.04]
4.	Above 4	0 (0) [0]	3 (50) [3.06]	2 (33) [0.68]	0(0) [0]	1(17) [1.49]	6(100) [0.74]
5	Total	150(18.6) [100]	98(12.19) [100]	293(36.44) [100]	1960(24.38) [100]	67(8.33) [100]	804(100) [100]

(Figures in parentheses ( ) indicate percentages to row total).
(Figures in parentheses [ ] indicate percentages to column total)
Source Primary Survey

TABLE 5.2.4 LITERACY STATUS

S No	Land Holding Size (ha)	Total Population	Total Literates	Male	Female
1	0 - 1	511 (100)	196 (38.36) [100]	153 [78.06]	43 [21.94]
2	1 -2	150 (100)	61 (40.67) [100]	43 [70.49]	18 [29.51]
3	2 - 4	137 (100)	71 (51.82) [100]	54 [76.06]	17 [23.94]
4	Above 4	6 (100)	2 (33.33) [100]	1 [50.00]	1 [50.00]
5	Total	804 (100)	330 (41.04) [100]	251 [76.06]	79 [23.94]

(Figures in parentheses ( ) indicate percentages to total population
(Figures in parentheses [ ] indicate percentages to total literates.
Source Primary Survey

iii) The average family size of seven persons is observed in the watershed as a whole. The household size increases with the increase in the land holding size. This trend is brought out by the fact that in the absence of mechanized farming, the large family size provides the manpower.

iv) Table 5.2.3 reveals that the population in the 0-6 years category is 18.65 percent compared to 19.7 percent of 1991. This signifies that the birth rate is under control. The trend of increase in marginal holdings with time, as explained by the laws of inheritance of property, and the subsequent low requirement of manpower explains the lowering of birth rate.

v) Table 5.2.3 also reveals that on an average, the population in the age group of 16-45 years covers over 36 percent of the total population, which is also the most productive age group. This is followed by population in the age group of 45-60 years of age which accounts for over 24 percent. Of the remaining 40 percent about 8 percent of the population is confined to the household and agricultural activities. The 7-15 years of age group accounts for 12.19 percent of the total population and is the potential age group which can be groomed for the future economic development.

c) Literacy Level

Tables 5.2.4 and 5.2.5 reveal that

i) Only 41.04 percent of the total population is literate .

ii) Of the total literates females account for only 23.94 percent, while the males account for as much as 76.06 percent.

iii) The proportion of literates to the total population is higher in the larger land holding categories. Also the number of people with higher secondary qualification is higher in the larger landholding categories. On the contrary the proportion of people to the total with higher secondary qualification, going for higher education is more in marginal land holding category. The recent trend of more school going children in the smaller land holding categories reveals the

TABLE 5.2.5 LEVEL OF EDUCATION

S No.	Land Holding Size (ha)	Total Number of Literates	School Going	Higher Secondary	Graduate	Post Graduate	Technical Qualified
1	0 - 1	196 (100) [59.39]	92 (46.94)	52 (26.53)	7 (3.57)	1 (0.51)	0 (0)
2	1 -2	61 (100) [18.48]	31 (50.82)	24 (39.34)	1 (1.64)	0 (0)	0 (0)
3	2 - 4	71 (100) [21.51]	17 (23.94)	25 (35.21)	6 (8.45)	0 (0)	1 (1.41)
4	Above 4	2 (100) [0.61]	1 (50.00)	1 (50)	0 (0)	0 (0)	0 (0)
5	Total	330 (100) [100]	141 (42.73)	102 (30.91)	14 (4.24)	1 (0.30)	1 (0.30)

Figures in parentheses ( ) indicate percentages to row total
Figures in parentheses [ ] indicate percentages to column total
Source Primary Survey

TABLE 5.2.6 OCCUPATION STRUCTURE

S No	Land Holding Size (ha)	Primary Occupation			Secondary Occupation		Total Work Force (Nos.)	Total Population (Nos.)
		Farming	Formal Sector	Informal Sector	Farming	Informal Sector		
1	0 -1	315 [87.98] [1.12*]	26 [7.26] (13.27*)	17 [4.75]	43 [12.01]	50 [13.96]	358 [100] (70.06)	511 (100)
2	1 -2	104 [94.54]	4 [3.63] (6.56*)	2 [1.82]	6 [5.45]	24 [21.82]	110 [100] (73.33)	150 (100)
3	2 - 4	105 [92.10] [5.26*]	8 [7.02] (11.27*)	1 [0.88]	9 [7.89]	10 [8.77]	114 [100] (83.21)	137 (100)
4	Above 4	5 [100]	0 [0] (0*)	0 [0]	0 [0]	0 [0]	5 [100] (83.33)	6 (100)
5	Total	529 [90.12] [1.70*]	38 [6.47] (11.51*)	20 [3.41]	58 [9.88]	84 [14.31]	587 [100] (73.01)	804 (100)

(Figures in parentheses (..) indicate percentages to total population).
(Figures in parentheses [....] indicate percentages to total work force).
(Figures in parentheses (...)* indicate percentage to total literates).
(figures in parentheses [...]* indicate percentage of total workforce engaged in horticulture).
Source: Primary Survey

increased awareness about education to meet the needs not met by small operational holdings.

d) Occupation structure

i) Table 5.2.6 reveals that 73 percent of the total population accounts for the total work force in the watershed. On an average 90 percent of the total workforce has farming as the primary occupation while 6.5 percent are engaged in the formal sector, and another 3.5 percent in the informal. The basic reason for farming being the primary occupation is the lack of other organized sector employment.

ii) People engaged in the formal and informal sectors have farming as their secondary occupation and those with farming as their primary occupation are engaged in informal sector activities like working under the 'Jawahar Rozgar Yojna', `Panchyat' development schemes or other daily wage activities. The main reasons for farming personnel to engage themselves in informal sector activities is mainly to supplement their household incomes.

iii) Population engaged in horticulture and animal husbandry accounts for only 1.7 percent of the total work force. This is a striking feature as against the background of the fact that subsistence agriculture is not capable of absorbing the increasing pressure of the population. The inverse relationship between the occupational structure of the rural poor and the land use pattern reaffirms the need for assessing and analysing the resource base and potential at the micro level.

iv) Total dependence on unproductive agricultural economy is explained by the almost lack of other means of livelihood and employment in the watershed. Although horticulture is the most suitable and also remunerative landuse, switching over to horticulture is not possible as the peoples first priority is foodgrains.

v) Very small percentage of literate population in the formal and non-formal sector

TABLE 5.2.7 INCOME DISTRIBUTION

S No	Land Holding Size (ha)	Number of Household in Various Income Groups				
		0-5000	5000-12000	12000-18000	18000-50000	Above 50000
1	0 - 1	13 (16.46%)	24(30.38%)	7(8.86%)	31(39.24%)	4(5.06%)
2	1 - 2	1 (4.55%)	4 (18.18%)	3(13.64%)	10(45.45%)	4(18.18%)
3.	2 - 4	0(0%)	0(0%)	0(0%)	4(28.57%)	9(64.28%)
4.	Above 4	0(0%)	0(0%)	0(0%)	1(100%)	0(0%)
5.	Total	14(12.07%)	28(24.14%)	10(8.62%)	46(39.66%)	17(14.68%)

(Figures in parentheses indicate percentages to total no. of HH in each category)
Source: Primary Survey

TABLE 5.2.8 SOURCES OF INCOME

S. No	Land Holding Size (ha)	% age Contribution of Various sources of Income		
		Agriculture	Livestock	Service
1.	0-1	6,42,200 (37.87%)	1,65,200 (9.74%)	8,88,300 (52.38%)
2	1-2	5,36,075 (78.79%)	55,300 (8.13%)	89,000 (13.08%)
3.	2-4	4,62,900 (47.68%)	88,000 (9.064%)	4,20,000 (43.26%)
4.	Above 4	44,500 (100%)	0(0%)	0 (0%)
5.	Total	16,85,675 (49.70%)	3,08,500 (9.10%)	13,97,300(41.20%)

Source: Primary Survey

TABLE 5.2.9 CONSUMPTION AND PRODUCTION PATTERN OF FOOD GRAINS

S No	Land Holding Size (ha)	No. of HH Purchasing Foodgrains	No of HH below the Standard* requirement (those purchasing)	Total no. of HH below the Standard* recommended
1	0-1	70 (100)	40 (57.1)	43 [59.5]
2.	1-2	15(100)	5 (33.3)	7 [31.8]
3.	2-4	8 (100)	2 (25.0)	7 [50.0]
4.	Above 4	0(0)	0(0)	0 [0]
5	Total	93 (100)	47 (50.5)	57 [49.1]

*190.9 kg/capita/annum is recommended by the National Commission on Agriculture for the rural areas.
(Figures in parentheses [.....] indicate percentages to total number of households (HH).
Source: Primary Survey

is indicative of poor employment potential.

e) Income Status and Consumption Pattern

Tables 5.2.7 and 5.2.8 reveal that 44.83 percent of the total households fall below the poverty line, expressed as income of Rs. 18000 per annum. Agriculture accounts for 58.7 percent share of the total income generated in the watershed although the environmental analysis reveals that agriculture is not a viable source of income generation and creates undue pressure on land. The income is mainly from cash crops grown in forest lands. This practice violates the land utilization pattern and therefore is unsustainable. Population over the poverty line makes its earning mainly through service in formal sector which accounts for 41.2 percent of the share of total income generated in the watershed. Because of the lack of off-farm employment within the watershed this income is mainly in the form of 'money order' economy.

Table 5.2.9 reveals that the minimum nutritional demand in terms of food grain requirement for the people is not locally met. In most cases total food grains consumed do not meet the minimum requirement even after purchase from the open market. This brings out the fact of poor affordability of the households. A total of 49 percent of the total households consume calories less than the standard specified requirement. The shortfall is largest in the marginal farmers category. This explains that what ever their meagre earning, it is not enough to sustain their basic need of food grains, thereby leaving them to exploit marginal lands and natural resources indiscriminately.

The total food grains intake in the present case has been calculated considering wheat, rice, millets and maize. This has been compared to the consumption standard of 190.9 kg/capita/annum, as recommended by the National Commission on Agriculture for the rural areas. The consumption pattern of food grains brings forth that households in marginal farmers category are the worst affected and because of the non availability of cultivable land there is no possibility of expanding agriculture

TABLE 5.2.10 HOUSEHOLD CONSUMPTION PATTERN OF FUEL WOOD & OTHER SOURCES OF ENERGY

S. No.	Land-hold-ing Size (ha)	Average Fuel wood Consumption (Q/Annum/HH)			Crop Residue available as Fuel Q/Annum/HH	Number of L.P.G. Cylin-ders used per Annum	Kero-sene used (lts)	Solar Energy for lighting
		Cooking	Water Heating	Total				
1.	0-1	68.44 (83.69)	13 34 (16.31)	81.78 (100)	0.88 (1.08)	6	81	4 tubes
	1-2	77.44 (84.12)	14.62 (15.88)	92.06 (100)	2.10 (2.28)	0	70	2 tubes
3.	2-4	69.12 (78.07)	19.42 (21.93)	88.54 (100)	3.68 (4.16)	20	48	4 tubes
4.	Above 4	68 40 (85.18)	11 90 (14.82)	80 3 (100)	6.48 (8.06)	0	5	2 tubes
5	Total	75 14 (83 99)	14.32 (16.01)	89.46 (100) [82 48]	1.50 (1 68) [1.23]	26 [10.50]	204 [4.8]	12 tubes [0.99]

(Figures in parentheses (.) indicate the percentages to row total).
(Fuel wood used for lighting is not quantified)
(Figures in parentheses [ ] indicate percentage to total energy consumption based on heating value (gross energy content)
Source: Primary Survey

TABLE 5.2.11 CLASSIFICATION OF AGRICULTURAL LAND

S No.	Land-holding Size (ha)	Total Area under Cultivation (ha)	Area under Agricul-ture (ha)	Area under Horticulture (ha)	Irrigated Area (ha)		Unirrigated Area (ha)	
					Area (ha)	Land Parcels (Nos.)	Area (ha)	Land Parcels (Nos.)
1	0-1	36.146 (100) [33.57]	36.113 (99.91)	0.032 (0.09)	8.623 (23.86)	823	27.52 (76.14)	14540
2	1-2	31.923 (100) [29.65]	31.923 (100)	0	6.72 (21.05)	703	25.20 (78.95)	1255
3.	2-4	34.863 (100) [32.38]	34.693 (99.51)	0.17 (0.49)	1.89 (5.42)	767	32.973 (94.58)	1487
4.	Above 4	4.749 (100) [4.40]	4.749 (100)	0 (0)	0.346 (7.29)	180	4.403 (92.71)	156
5.	Total	107.681 (100) [100]	107.478 (99.81)	0.202 (0.19)	17.579 (16.33)	2473	90.10 (83.67)	17438

(Figures in parentheses (...) indicate percentages to row total)
(Figures in parentheses [...] indicate percentages to column total)
Source: Primary Survey

horizontally. The option available to meet the food grain requirement is to explore the relative contribution of various inputs to agriculture to increase its productivity and/or to improve the affordability of individual households.

The analysis carried out relating to the energy use pattern in the watershed reveals that

i) wood is the maximum used fuel. Table 5.2.10 brings out that the average use of fuel wood is 3.5 kg per person per day. Alternate sources of energy account for only 17.52 percent of the total consumption.

ii) LPG is used by a few families and not on a routine basis because of the transportation problems involved. The huge size heavy cylinders make it difficult to manoeuvre steep serpentine bridle paths. These account for 10.5 percent of the total energy consumption.

iii) Crop residue accounts for only 1.23 percent of the total energy consumption

iv) For lighting purposes both kerosene lamps and resinous wood splinters are used. Kerosene accounts for 4.8 percent while 16 percent of the houses do not use kerosene lamps and the wood of the Chir (Pine) trees is used for illuminating the house. In such cases Chir trees are damaged at the base to take the resinous wood splinters. The damaged trees normally fall off in the event of high velocity winds thereby leading to deforestation.

v) Most striking aspect of the study area is that as per the census records all villages are electrified and electric poles are a proof to it, but the electricity supply is totally disrupted. In most instances connections to villages have been cut because of the non payment of bills.

vi) One of the villages in the watershed has solar energy lighting provision but again only a few households enjoy the benefit. It is so mainly because of the inability of the people to pay for the instalment charges and subsequent monthly bills. The energy use pattern brings forth the fact that in the event of lack of alternate sources of energy, poor affordability and easy access to the forest

TABLE 5.2.12 (A) CROPPING PATTERN OF RABI CROPS (ha/crop)

S. No	Land Holding Size (hec.)	Wheat	Mustard	Barley	Masoor	Pea	Potato	Total
1	0-1	16.16 (79.88)	1.5 (7.43)	0.24 (1.20)	0.64 (3.15)	0.23 (1.22)	0.03 (0.16)	20.23 (100)
2.	1-2	11.39 (87.26)	0.69 (5.3)	0.14 (1.07)	0.3 (2.33)	0.25 (1.95)	0.09 (0.72)	13.05 (100)
3.	2-4	9.64 (77.40)	0.89 (7.19)	0.41 (3.29)	0.55 (4.39)	0.11 (0.92)	0.08 (0.64)	12.45 (100)
4.	Above 4	1.09 (77.18)	0.07 (4.93)	0.00 (0)	0.15 (10.56)	0.02 (1.69)	0.00 (0)	1.42 (100)
5	Total	38.28 (80.75)	3.16 (6.67)	0.79 (1.67)	1.64 (3.46)	0.62 (1.30)	0.207 (0.44)	47.15 (100)

(Figures in parentheses ( ) indicate percentages to row total).
Source. Primary Survey

TABLE 5.1.12 (B) CROPPING PATTERN OF KHARIF CROPS (ha/crop)

S. No.	Land Holding Size (ha)	Paddy	Madua	Sawan	Gahat	Til	Maize	Total
1	0-1	18.72 (51.84)	10.57 (29.26)	3.24 (8.97)	1.31 (3.63)	0.63 (1.74)	0.36 (0.99)	36.11 (100)
2.	1-2	16.15 (50.66)	9.43 (29.57)	1.93 (6.04)	1.25 (3.92)	0.64 (1.99)	0.4 (1.26)	31.92 (100)
3.	2-4	11.56 (33.32)	10.89 (31.39)	4.58 (13.20)	1.41 (4.06)	1.34 (3.86)	0.41 (1.18)	34.69 (100)
4.	Above 4	1.45 (30.45)	1.5 (31.86)	0.1 (2.10)	0.25 (5.26)	0.2 (4.25)	0.06 (1.26)	4.75 (100)
5.	Total	47.872 (44.56)	32.39 (30.15)	9.86 (9.18)	4.22 (3.93)	2.80 (2.60)	1.24 (1.15)	107.49 (100)

(Figures in parentheses ( ) indicate percentages to row total).
Source: Primary Survey

TABLE 5.2.13 CROPPING PATTERN OF CASH CROPS

S No.	Land Holding Size (ha)	Cultivated Area Under Forest (ha)	Area Cultivated in Hectares Under			Cropping Intensity %	Average Area Owned per Household
			Pea	Potato	Gross*		
1	0-1	5.85	5.85	5.85	11.7	200	0.074
2.	1-2	2.85	2.85	2.85	5.7	200	0.13
3	2-4	2.06	2.06	2.06	4.12	200	0.15
4.	Above 4	0.12	0.12	0.12	0.24	200	0.12
5	Total	10.88	10.88	10.88	21.76	200	0.09

lands, major requirement of the fuel energy is met through fuel wood. This causes indiscriminate cutting and lopping of trees and resultant deforestation and ecological imbalance.

5.2.2 Agriculture

Agriculture is the main source of livelihood in the watershed, despite the limited land suitable for cultivation of crops. The land is unsuitable mainly because of high absolute and relative relief, soils prone to erosion and climatic constraints.

a) Structure of Operational Holdings

i) Table 5.2.11 reveals that over 99 of the total land owned is under cultivation, of which only a small fraction 0.19 percent is under horticulture and 99.8 percent is under agriculture. The land holdings are fragmented and separated by large distances which makes it difficult to introduce mechanized means. Only 16.33 percent of the total land under cultivation is irrigated while the remaining 83.67 percent is rainfed.

b) Cropping Pattern

The cropping pattern of the field crops given in Table 5.2.12 (a) and (b) reveals that

i) the agriculture of the area is diversified with wheat, mustard, barley, pulses, pea and potato being cultivated in the Rabi Season; while Paddy, Madua (millet), Sawan (millet), Til (sesame), Pulses and Maize are cultivated during the Kharif season.

ii) wheat shares over 80 percent of the total cultivated area during the Rabi season, while Paddy, alone accounts for nearly 45 percent of the cultivated area in the Kharif season, followed by Madua and Sawan which share 32 percent and nearly 10 percent respectively, of the total cropped area during the Kharif season.

iii) all the land holding categories whether marginal, small or medium cultivate the

TABLE 5.2.14 CROPPING PATTERN AND PRODUCTIVITY OF HORTICULTURAL PRODUCTS

S. No.	Land Hold-ing Size (ha)	Apples			Apricots			Walnuts		
		Area	Pro-duce (Q)	No. of Trees	Area	Produce (Q)	No. of Trees	Area	Produce (Q)	No. of Trees
1.	0 -1	0	0	0	0	0	0	0.032	18	20
2.	1 - 2	0	0	0	0	0	0	0	0	0
3.	2 - 4	0.114	54	70	0.056	70	35	0	0	0
4	Above 4	0	0	0	0	0	0	0	0	0
5	Total	0 144	54	70	0.056	70	35	0.032	18	20

Source Primary Survey

TABLE 5.2.15 CROPPING INTENSITY

S No.	Land-holding size (ha)	Net sown area (ha)	Area sown more than area (ha)	Gross cropped area (ha)	Cropping intensity %
1	0-1	36.11	20 226	56 336	156%
2	1-2	31.923	13.05	44.926	140.9%
3	2-4	34.693	12.453	47.1461	135.89%
4	Above 4	4.749	1.42	6.169	129.9%
5	Total	107.48	47.15	154.58	143.89

Source: Primary Survey

TABLE 5.2.16 IRRIGATION INTENSITY

S No	Land-holding size (ha)	Net irrigated area	Area irrigated under second crop	Gross irrigated area	Irrigation intensity %
1	0-1	8 623 (23.86)	8 045	16.668	29.58%
2.	1-2	6.721 (21.05)	5.665	12.386	27.56%
3.	2-4	1.890 (5.42)	1.244	3.134	06.64%
4.	Above 4	0.346 (7.29)	0.346	0.692	11.21%
5.	Total	17.588 (16 33)	15.3	32.88	30%

(Figures in parentheses indicate percentage of land irrigated to total land under cultivation).
Source: Primary Survey

diverse variety and in almost similar proportions, where food grains is their first priority.

iv) little of all the crops are grown in the traditional fashion in order to retain the fertility of the soil and to gain multiple crops from limited holdings.

The cropping pattern of the cash crops given in Table 5.2.13 reveals that

i) in the study area pea and potato are the major cash crops. These crops give good economic returns to farmers mainly because they are harvested when storages of the plains are almost exhausted.

ii) survey reveals that these crops are grown in the forest lands. The forest lands which were sometime in the past leased to the villagers continue to be in their possession eventhough the lease has expired. Not only this, those not having lease permits too have acquired forest lands ranging from 0.02 ha to as much as 0.16 ha.

iii) majority of the larger holdings in the forest land belong to the farmers having larger operational holdings in the village land. This reflects further marginalization of the marginal farmers.

The cropping pattern of horticultural produce given in Table 5.2.14 reveals that

i) apples, apricots and walnuts are the main fruits cultivated on a larger scale. Citrus fruit tree are invariably found in the homesteads and field borders which yield just enough for consumption by the household.

ii) apples account for highest percentage of the land under horticulture, followed by apricots and walnuts.

iii) the total land under horticulture amounts to 0.19% of the total land under cultivation which is quite insignificant.

c) *Cropping Intensity*

Table 5.2.15 reveals that

i) the cropping intensity in the watershed ranges between 130-156 percent.

ii) smaller the land holding size, greater is the cropping intensity. This is explained by the fact that since agriculture is in a deplorable condition in the watershed, the population solely dependent on it cultivates maximum land possible during the agricultural year.

iii) farmers with larger holding size normally leave the land fallow to regain its fertility and such lands serve as grazing grounds for their cattle. The less advantaged having fields adjoining such fallow lands are forced to leave their lands vacant to avoid their crops from being damaged by cattle.

d) Irrigation Intensity

Table 5.2.16 reveals that

i) the irrigation intensity is only 30 percent and is explained by the complexities of physiographical conditions which affect the availability of water for irrigation.

ii) on an average only 16.33 percent of the total cultivated land is irrigated.

e) Crop Productivity and Various Inputs

Tables 5.2.17, 5.2.18 and 5.2.19 reveal that

i) the average production of wheat, paddy, millets and pulses, is quiet low compared to the average for the state.

ii) the main agricultural inputs include irrigation, man and animal labour, use of fertilizers mainly organic, and use of small quantities of high yielding variety of seeds.

iii) paddy and wheat share the highest proportions of irrigated area which account for 87.24 percent and 92.16 percent of the total irrigated land during the season.

iv) the man and animal labour days put in per hectare for different land holding categories is the same.

TABLE 5.2.17 PRODUCTIVITY OF MAIN CROPS

S No.	Yield (Q/ha)	Wheat	Paddy	Madua	Sawan	Pulses	Oil seeds	Pea	Potato
1.	Main crop	14.54	13.98	9.28	14.37	4.28	15.8	6.65	87.58
2	By-produce	20.88	20.56	11.08	18.26	6.13	28.06	8.79	No use
3.	State average for main produce (1990-91)	21.71	18 27	12.17	9.20	9.12	-	-	-

Source: Primary Survey

TABLE 5.2.18 AGRICULTURAL INPUTS FOR THE MAIN CROPS

S. N.	Yield (Q/ha)	Wheat	Paddy	Madua	Sawan	Pulses	Oilseeds	Pea	Potato
1	Mandays/ha	135	220	162	164	164	88	198	181
2.	Bullock pair hours/ha	321	338	302	305	320	207	323	159
3.	Inorganic fertilizer kg/ha N	15.80	15.36	2.34	1.26	6.34	2.45	39.19	298.17
	P	14 90	15.64	1.71	1.16	12.67	1.27	85.86	190.5
4	Use of organic fertilizer, Q/ha (N.P K)	24 63	27.48	18.99	19.79	21.69	24.57	35.15	20.28
		(170505)	(170505)	(130737)	(130204)	(150204)	(170505)	(250307)	(140408)
5	Percentage of HYV seeds	2	1 5	0	0	0	0	4	3
6	Percentage of total irrigated	9 16	87 24	0	0	0.19	4.77	1.94	0.27

Source Primary Survey

TABLE 5.2.19 NUMBER OF HOUSEHOLDS USING COMMERCIAL FERTILIZER (CF) AND HYV SEEDS (HYVS)

S No	Land Holding Size (hec.)	Wheat		Paddy		Pulses	Oil seeds	Pea		Potato	
		CF	HYVS	CF	HYVS	CF	CF	CF	HYVS	CF	HYVS
1.	0-1	24 (30.38)	4 (5.06)	22 (27.85)	7 (8.86)	3 (3.79)	0 (0)	24 (30.38)	1 (1.27)	30 (37.91)	1 (1.26)
2.	1-2	12 (54.55)	3 (13.64)	11 (49.99)	3 (13.64)	6 (27.27)	6 (27.27)	18 (81.82)	2 (9.09)	18 (81.82)	2 (9.09)
3.	2-4	13 (92.85)	7 (49.99)	12 (85.71)	5 (33.71)	9 (64.28)	1 (7.14)	14 (100)	4 (28.57)	14 (100)	4 (28.5)
4.	Above 4	1 (100)	0 (0)	1 (100)	0 (0)	1 (100)	0 (0)	1 (100)	0 (0)	1 (100)	0
5.	Total	50 (43.10)	14 (12.07)	46 (39.68)	15 (12.93)	19 (16.38)	7 (6.03)	57 (49.14)	7 (3.45)	63 (54.31)	7 (6.03)

HYV seeds are not used in any of the households for millets, pulses and oil seeds.
Source: Primary Survey

TABLE 5.2.20 LIVESTOCK POPULATION

S. No.	Land Holding Size (ha)	Working	Milch			Others		Average Cattle Head units per HH*
			Buffalo	Cows		Goats		
				Local	Cross Bred*	Adult	Heifer	
1	0-1	118	119	45	0	0	0	15
2	1-2	40	35	16	0	30	10	20
3.	2-4	36	29	11	4	50	15	31
4	Above 4	2	1	0	0	0	0	12
5.	Total	196	184	72	4	80	25	18

* Cross breed found only in cows, Rest are local breeds
** Conversion of livestock population to cattle head units based on criteria as adopted by U P State Forest Department
Source: Primary Survey

TABLE 5.2.21 CONSUMPTION PATTERN OF FODDER

S No	Land hold-ing Size (ha)	Fodder Consumed (Q/day)					Crop Residue Available as Fodder (Q/day)	Deficit (Q/day)
		Buffalo	Cow	Bullock	Goat	Total		
1	0-1	36.96	7.54	28.18	0	72.68 (100)	2.47 (3.4)	70.21 (96 6)
2	1-2	11.04	3 17	9.52	0.85	24.58 (100)	1.97 (8.0)	22 61 (92.0)
3.	2-4	12 47	2.12	7.89	1.70	24.18 (100)	1.77 (7.3)	22.41 (92.7)
4.	Above 4	0.32	0	0 46	0	0.78 (100)	0.19 (24.4)	0.59 (75.6)
5.	Total	60 79	12.83	46.05	2.55	122.22 (100)	6.4 (0.55)	115 82 (99.45)

Figures in parentheses indicate percentage to total fodder consumed in Q-TDH
Source: Primary Survey

TABLE 5.2.22 LIVESTOCK OUTPUT PER ANNUM

S No	Land hold-ing Size (ha)	Animal Pair Labour Days	Milk Yield (Lts)			Dung Manure Produced (Q)				Fibre Produced (kg)
			Buffalo	Cow	Total	Bullock	Buffal	Cow	Total	
1.	0 - 1	2698	1310	280	1590	1101	1942.5	337	3380.5	0
2.	1 - 2	1845	330	90	420	391	574	129	1094	42
3	2 - 4	1790	300	170	470	222	676	104	1002	58
4	Above 4	208	0	0	0	22	16	0	38	0
5.	Total	6541	1940	540	240	1736	3208.5	570	5514.5	100

Source: Primary Survey

v) the inputs in various land holding categories mainly vary in terms of intensity of use of fertilizers and HYV (high yeilding variety seeds) seeds as shown in Table 5.2.19.

vi) inputs such as use of commercial fertilizer and HYV seeds are mainly for wheat and paddy cultivation and only 40 percent of the households are known to use these in small quantities.

vii) the number of households using commercial fertilizers and also the HYV seeds is seen to increase with the increase in landholding size.

viii) the intensity of use of dung as organic manure is higher in the marginal landholding category. The intensity of use decreases with increase in the landholding size.

ix) the intensity of use of commercial fertilizers and HYV seeds is more in case of cash crops compared to other crops, as these are high value crops giving economic returns.

5.2.3 Livestock

Livestock is one of the most important sectors in the agrarian economy which is directly linked with agricultural activity. The study area comprises basically of cattle viz. bullocks, buffaloes and cows. Few households also keep goats. The livestock population has been classified under the heads- working, milch and `others' category.

a) Livestock Population

Table 5.2.20 reveals that all the households irrespective of the land holding size possess on an average a pair each of working cattle and milch cattle. Goats are domesticated by people living on the higher reaches of the watershed, for reasons of economic returns and that goats can feed on fodder growing on steep slopes inaccessible by man and other cattle.

Bullocks are the primary source of draught power in cultivation and account for 36.57 percent of the total livestock population. Milch cattle account for 48.5 percent while goats

account for only 15 percent of the total livestock population.

b) Livestock Input

The fodder requirement of the livestock is met mainly through grazing in the nearby forest lands. Table 5.2.21 reveals that stall fed fodder are mainly crop residue produced after harvesting which accounts for only 5.2 percent of the total fodder intake. Forest lands provide for 94.8 percent of the fodder.

c) Livestock Output

The livestock output as brought out in Table 5.2.22 illustrates that the milch cattle have poor milk yield. Only 1.5 percent of the total milch cattle is crossbred and the remaining is local. Their output is mainly in the form of dung which is used as farm yard manure for maintenance of fertility in agricultural lands. The cattle is mainly domesticated for dung manure reasons. Few households domesticating goats on an average yield 2.5 kg of fibre per goat per annum and earn around Rs. 500 per animal. The advantage experienced by having goats is their low fodder requirement and their tendency to multiply at a fast rate. Households having milch cattle sell of the milk to the dairy to earn whatever little they can.

5.2.4 Infrastructure Development

Analysing the level of development and assigning qualitative values to the social and cultural aspects, such as education, electricity, water supply etc., is challenging because of the problems involved. Certain variables that indicate the presence or condition of phenomenon can be measured directly, while others require indicators which reflect the state of any aspect or component of the development. These indicators must respond to the change in components, for which scaling is a must, to reflect the magnitude of changes. Secondly with a number of indicators depicting the development level, it is necessary to scale all indicators to a common denominator so that all these indicators can be discussed with reference to a standard reference point.

All the eight settlements in the water shed have been studied for analysing the level of development. A stress matrix was prepared considering the availability of the infrastructural facilities in the settlements and depending upon the distance at which they are available. For each indicator the degree of stress is given, rank varying from 0-3 as given in Table 5.2.23 below.

TABLE 5.2.23 : DEGREE OF STRESS FOR INDICATORS OF INFRASTRUCTURAL DEVELOPMENT

S. No.	Indicators ----------> / Availability	Educat-ional Facilities	Medical Facilities	Drinking Water Supply	Post & Telegraph and Communicati-on	Approach Road	Power Supply	Fair price shop and other* infrast-ructure
1	Present	0	0		0			0
2	At distance 1-3 km	1	1		1			1
3	At distance 3-5 km	2	2		2			2
4	At distance 7.5 km	3	3		3			3
5	Fully covered			0			0	
6	Partially covered			1.5			1.5	
7	Not covered			3			3	
8	Pucca Road					0		
9	Kutcha Road					1.5		
10	Pathways					3		

* Others include veterinary facilities, agricultural service centre, loan and banking services, sale and purchase cooperative.

Ranks were then given to each indicator with respect to the distance travelled or its status. The indicators were then given relative weightages to scale them to a common environmental denominator as shown in Table 5.2.24. In this case the common denominator to be used as a reference point is the water supply and the accessibility, which has been given the highest weightage of 100, being the basic requirement for the hill areas. The relative weightage of indicators is subjective and may vary from place to place or person to person. The weightage in the present case has been decided based on preferences of the local population known on conducting field interviews.

TABLE: 5.2.24 RELATIVE WEIGHTAGES GIVEN TO INDICATORS

S.No.	Indicator	Relative Weightage
1	Education	80
2	Medical	80
3	Drinking water	100
4	Post and Telegram	50
5	Approach Road	100
6	Power Supply	90
7	Fair Price Shop	70
8	Veterinary Facilities	60
9	Agricultural Services Centre	60
10	Loan and Banking Facilities	50
11	Sale and Purchase Cooperative	50

On the basis of individual rank and relative weightage of indicators the total stress score for a settlement was worked out. The higher the score the worst is the condition of infrastructural development in the settlement. Three stress categories were prepared on the basis of total score.

Score	Stress Category
> 200	Highly stressed
100-200	Medium stress
< 100	Least stress

The analysis reveals that the major cause of stress is power supply followed by medical facilities, accessibility, agricultural services, and educational facilities. There is no stress due to drinking water supply as all the settlements have covered drinking water facilities. The settlement Chhamroli is the worst hit followed by Saundh, Wan, Manjgaon, Nagal, Gewneti, Sartali and Nowgaon. Nowgaon has the least stress and in the case of highly stressed areas power supply, medical facilities and accessibility are the main cause.

Informal Infrastructure

The survey of the settlements reveals that there are several tea shops scattered in the area. Most of these become operational during the Yatra (pilgrimage) season, when loads of

buses at the rate of 30 buses (30 passenger/bus) per day cross the watershed. Buses halt at Gewneti on their way to `Yamnotri' the pilgrim destination. The informal structure which springs up during the six months of the yatra provides for earning the livelihood. During the period pressure on forests for want of fuel wood increases. About 80 percent of the households earn their living either through tea/snacks stalls, makes shift shelters or other petty jobs and earn on an average Rs. 1000-1500/- per month.

5.3 PROBLEMS AND ISSUES

The various subsystems of the hill system which have been separately analysed bring forth these problems and issues at the grass root level and also reflect the interdependencies.

5.3.1 Household

i) Women folk are the main work force in the area, their low level of literacy and gender bias prevents them from being active members in decision making. The poor education status of the women affects the upbringing of the coming generations. The drudgery of work includes fuel collection and all farm related activities besides the routine household chores, while the men take pride in decision making. The poor economic standing of the women and their insignificant role in decision making calls for immediate attention. The competence, capability and efficiency of the women folk in handling all kinds of jobs needs to be recognized. Their active participation in income generating activities and that of men in sharing her work load would benefit the society in general.

ii) A considerable portion of the population is solely dependent on unproductive agricultural economy mainly because of the lack of other means of livelihood and employment.

iii) Over 70 percent of the population is engaged in primary sector. Analysis of cultivable land per capita reveals that there is high degree of underemployment amongst people specially in the marginal farmers category. Such human resource can be effectively diverted to more productive activities. Also subsistence agriculture with high cropping

intensity, and, low efficiency and productivity, is not able to cater to the excess population and significant employment opportunities need to be created to meet the basic requirements.

iv) The primary investigation for analysing trends of rural outmigration reveals that the highly educated and skilled have permanently settled in other parts of the country. The process of brain drain of enterprising human resource is very unfortunate keeping in development of the region. Such human resource needs to be locally mobilized so as to minimize outmigration.

v) Job oriented education, for generation of new employment potential, is required.

vi) The institutional support by way of subsidies and loans at low rate of interest have inculcated more dependence and subsequent economic burden on local populace. Such short sighted policies have put the people in a debt trap and further worsened the economy of the area. Focus needs to be on long term beneficial policies.

5.3.2 Agriculture

i) Land management techniques have to be worked out with special reference to slope, erosional factors and limited water availability. For this the proposed land utilization needs to be based on land suitability and capability criteria which refers to sustainability without loss of production and productivity.

ii) The important issues for agriculture development are to increase the cropped area and to improve the productivity to bring farming above subsistence level. Both these issues are closely related to the basic problem of irrigation which is of high relevance since modern inputs, such as, HYV seeds and commercial fertilizer are suited only to irrigable lands. Ways and means to improve irrigation gains priority over others.

iii) Multiple and mixed cropping has been a practice in these areas for ages. The basic aim behind this practice is to grow all that is needed and harvest all that is possible under unpredictable circumstances. The traditional practice increases the production per unit area, increases the range of products available to diversify the diet and makes efficient use of soil fertility and water. Thus the traditional practice of cultivation does not leave

much scope for alteration in the cropping pattern.

iv) Irrigation in the area can be improved through management of flow of water as a result of gravitational forces and through harnessing of run-off.

v) As regards the modern agricultural inputs the hill people have certain reservations. The performance of HYV seeds under the local farming and cropping system has not been found satisfactory for reasons of quantum of inputs required to maintain higher yields. The inputs required by way of irrigation and fertilizers makes the choice of HYV seeds unacceptable to the locals. The use of chemical fertilizers is prohibitive for the reasons of their cost and also the inconvenient size of the bags makes it difficult to carry them to remote areas.

vi) Chemical fertilizers strengthen and improve the efficiency of the traditional organic manure but the use of only chemical fertilizers has gradually lead to the loss of soil fertility as experienced by the farmers. Studies reveal that organic manure to the extent of 50 percent of the total requirement needs to be made locally available.

vii) Besides reducing the soil fertility excessive use of chemical fertilizers cause problem of downstream pollution.

viii) Training in farm activities is mainly imparted to the male community although it is the women who carry out almost all operations in crop production.

ix) In view of the physiographic conditions unsuited for the field crops, cultivation of perennial crops and medicinal plants would bring long term benefits, such as, reducing soil erosion, maintaining water balance, meet the rational needs and strengthen local economy. Since sustainability implies meeting the local needs through a self sustaining system, drastic changes in the land use cannot be suggested.

x) The agricultural by-produce is used as fodder for animals and as fuel energy. The agricultural production therefore needs to be made complimentary to the fodder availability and animal husbandry requirements.

xi) The unequitable distribution of land holdings both by size and numbers severely restricts the development process. Since consolidation of land is not practically feasible, option of cooperative farming can be explored to get better results.

xii) The minimum nutritional requirement is not locally met, because of the poor productivity and affordability of the people. Focus therefore needs to be laid simultaneously on two important aspects viz, checking the population growth rate and creating income generating avenues to meet the deficit in food grains.

xiii) The surplus agricultural and horticultural produce is not easily marketed for want of adequate physical infrastructure. For improving the hill agriculture adequate physical infrastructure is a prerequisite.

xiv) Agricultural lands lie abandoned where families have migrated. Cooperative farming would help reap benefits from such lands.

5.3.3 Livestock

i) Livestock is an integral part of the hill farming for reasons that it provides for draught power for small fragmented land holdings, and, animal dung and bedding material as manure for crops.

ii) Open grazing is forest lands by livestock is the main source of fodder in the absence of enough crop residue and grass land fodder.

iii) Potential solutions reconciling the conflicting interests of forestry, agriculture and animal husbandry need to be considered.

iv) Potential solutions include

- Programme for animal husbandry complimentary to the fodder availability, viz, reduction in livestock numbers, introducing livestock giving more returns and requiring less fodder.
- The requirement of draught power can be efficiently met by animal pooling. The practice to some extent exists where bullock power is provided in exchange for money to the owner and fodder for the livestock.
- The dung availability to be supplemented by use of chemical fertilizers, and since excessive use of fertilizers is not desirable a suitable cropping pattern is the answer.
- Minimum nutritional requirement to be met by introduction of cross bred

livestock yielding higher returns.

v) Adequate infrastructure be provided for supporting the livestock and for marketing of its surplus output in the form of milk, fibre, wool, meat etc.

5.3.4 Infrastructure

The infrastructure includes health care, water supply, education, transportation and communication, and special services to the target groups. The stress matrix formed for analysis of infrastructure development reveals that the major cause of stress is power supply followed by medical facilities, accessibility and educational facilities. The lack or absence of the basic facilities has its impact on the hill environment.

a) **Power/Energy supply**

i) the main source of energy in the area is the fuel wood used for cooking, water heating and lighting; because it is cheap and easily available from the forest.

ii) Absence of alternate sources of energy pose severe management problems as

- the forests are exploited indiscriminately for want of fuel wood.
- the industrial development in the area is hampered.

iii) The productivity of the forest resource needs to be increased to a level higher than the demand but because of the limitation of putting additional land under forest use and the limited regenerative capacity of the forests, alternatives ought to be thought of.

iv) Alternative available in the area include

- the vast water potential which can be exploited for generating power through small hydro projects,
- technical knowhow to harness wind and solar energy, and
- the introduction of LPG, Kerosene and fuel efficient gadgets.

b) **Accessibility**

i) Most settlements in the area are at a distance of less than five kilometres. The hilly tracks are difficult to manoeuvre with head loads of heavy items, such as, surplus agricultural produce mainly cash crops, the

horticultural produce and also the items of day to day use.

ii) The absence of these `nerves of development' have their impact on female education, early schooling and necessary medical care.

iii) Instances of ecological damage have been reported where road networks have been planned. In order to gain maximum benefits with least damage, the road networks need to be carefully formulated on the basis of geotechnical feasibility, instead of pressure from influential people as has been the case most often. Broadening of existing foot paths or bridle paths aggravates the ecological problems and therefore needs to be restricted.

iv) Options to improve accessibility in the area include introducing suitable transport, such as, rope ways. These are excellent alternatives to roads in steep and remote areas for transportation of both goods and humans. These are environmentally suitable and also are cheaper in long run. These can be coupled with eco-tourism aspects for revenue earning.

c) **Medical and Educational Facilities**

Introduction of suitable transport would reduce the stress because of these facilities. However, for medical care

i) Arrangement of mobile health units can be made which would visit the area in specified intervals.

ii) One community health worker can be retained for each or a group of villages subject to population size and distance between settlements.

For educational facilities.

iii) Balwaries (Day nurseries) can be introduced in every settlement.

iv) Residential accommodation for female students can be provided close to schools/colleges.

5.3.5 Industries

i) Industries include the various income generating avenues. At present the area, also the district and the region are industrially backward and a cause of the

socio-economic backwardness.

ii) The area is constrained by physical limitations and offer too little by way of livelihood.

iii) The human resource in the area is underemployed and can be utilized for improving the economy of the area.

iv) Cottage industries in the area are not well developed because of the lack of specific programmes for their promotions, and, trade and commerce at appropriate levels.

v) Area has good potential for tourism but requires supporting infrastructure and enough publicity to attract a wider section.

vi) Hills are not suitable for highly diversified economic structure and any industrial establishment proposed needs to consider that

- raw material is locally available.
- employment would be generated keeping in mind the available human resource in the area so that benefits flow locally and outmigration hampered.
- industrial set up are labour intensive and capital saving.
- the development induced in the area does not have adverse environmental impact.

5.4 CONCLUSION

The apparent conflict in the area is between three principal components.

i) Ecological issues

ii) Fulfilment of basic needs of the local people viz, food, fodder and fuel, and

iii) Economic issues, such as, lack of off-farm employment and total dependence on primary sector with cash crops grown in forests. This is an unsustainable practice but contribute a major share to the total income.

The basic needs of food, fodder, and fuel; and economic support systems (dependence on cash crops) of the people become primary issues. These being natural resource based, there is an acute need to ensure maximum productivity and economic returns without jeopardizing the ecological processes.

CHAPTER VI

SITUATION ANALYSIS

6.0 GENERAL

It has been observed in the preceding chapters that the land use pattern in these hills is changing with more and more area coming under distress cultivation and pastures, at the cost of delicate ecological balance of the hills. This chapter examines the development potential and the pattern of interaction to arrive at the key factors affecting sustainability. Dominant decision variables affecting each key factor are then identified for developing a model for sustainable development planning in hills (SDPH).

6.1 POPULATION PROJECTION

a) **Human Population**

The total population in the watershed during 1991 was 2278 persons (1991) and that of 1997 is 3198 (survey estimate). Based on this the population projected using the Geometrical Progression Method is 3872 persons for the year 2001 and 4918 persons for the year 2005. Assuming the average family size of seven persons there would be a total of 553 and 702 households in the year 2001 and 2005 respectively.

b) **Distribution of households**

Considering i) the distribution of household for 1997 in the proportion as revealed in the primary survey, and, ii) the rate of change in different landholding categories over the years in proportion to the change as that given for the district, the distribution of households in different categories for the years 2001 and 2005 would be as given in Table 6.1.1.

TABLE 6.1.1 PROJECTED POPULATION AND HH DISTRIBUTION FOR 2001 AND 2005

Year	Total Population	No. of HH	Category of farmer			
			Marginal	Small	Medium	Large
1997	3198	456	309 (1992)	87 (609)	59 (590)	1 (7)
2001	3872	553	412 (2714)	83 (581)	57 (570)	1 (7)
2005	4918	702	567 (3805)	77 (539)	56 (560)	2 (14)

Figures in parentheses (....) indicate the expected population @ of the present average family size.

c) **Livestock Population**

Cattle population in the watershed for 1995 as per the survey by the Soil and Conservation Unit, Uttarkashi is

Sheep	116 nos.
Goats	111 nos.
Cows	876 nos.
Bullocks	832 nos.
Buffaloes	613 nos.

To convert all categories into cattle heads the conversion factor used is as defined by the Working Plan for Uttarkashi Forest Area, where

Sheep	=	1 unit
Goat	=	2 units
Cow, bullock, Pony, Horse	=	3 units each
Buffalo	=	6 units

The total livestock population in the watershed is thus estimated to be 9140 cattle heads. Considering an annual growth rate of 0.4 percent per annum (Census 1991) and assuming the distribution of cattle head units (x) in the ratio of 0.23 x , 0.31 x and 0.46 x

for the marginal, small and medium farmers respectively (Table 5.2.20). The livestock population in years 2001 and 2005 is expected to be as follows.

TABLE 6.1.2 PROJECTED LIVESTOCK POPULATION FOR 2001 AND 2005

Year	Total Cattle head units	Cattle head distribution			
		Marginal farmer category	Small farmer category	Medium farmer category	Large farmer category*
1997	9140	2102	2834	4204	12
2001	9286	2136	2878	4272	-
2005	9435	2170	2925	4340	-

* negligible as there is only one household in this category.

6.2 DEVELOPMENT POTENTIAL AND GROWTH ALTERNATIVES

6.2.1 Natural Resource Potential

The region under study faces the problem of high altitudinal and slope variation. Studies reveal that major portion of the *land under agricultural use* qualifies for horticultural use. As per the land suitability and capability criteria, land which can be irrigated subject to certain remedial measures to stop soil erosion can only be put to agricultural use. Thus only 16.33 percent (net irrigated area) of the present land under agriculture is suited for it . Suggesting drastic changes in the land use pattern is not a healthy solution and attempts need to be made to

i. increase the area under irrigation

ii. promote a cropping pattern suited to rainfed areas

Studies reveal that *land under irrigation* can be increased to 33.6 percent through water harvesting techniques (Soil Conservation Unit, 1995). This implies that 66.4 percent of the present agricultural land remains rainfed. Interestingly traditional farming systems have evolved cropping combinations suited to the climatic and physiographic conditions of the area.

This indigenous knowhow needs to be consciously integrated into planning. Total yield of crops is low by nearly 20 percent in the unirrigated land compared to the irrigated, also the use of chemical fertilizers are more suited to irrigated lands. In such a situation attempts to further increase the area under irrigation need to be explored.

Present *area under forest* cover is 3857.6 hectares which is 81.2 percent of the total area in the watershed. The entire region has major portion of the land under forest cover. As per the Planning Commission norms a total of 60 percent of the total land should be under forests. Considering this to be an acceptable norm 21.2 percent i.e. 1006.46 hectares of the forest land can be exploited and gradually brought under suitable non-forest use considering the land suitability and capability. The present area of 96.40 hectares under degraded forests can be put to afforestation through fruit or fodder trees or mulberry plantation.

Forest resource also needs to be viewed from two angles i) fuel requirement, and, ii) fodder requirement. Assuming the fuel wood yield rate with 100 percent crown density as, 1.25 air dry tonnes (adt)/ha for conifer forests, 3.75 adt/ha for mixed forests and 3.5 adt/ha for farm trees, the sustainable yield is estimated to be i) from Oak forest (with >0.7 crown density and 1641.6 hectares of area covered) as 4309 tonnes i.e. 43780 Quintals, and, ii) from Pine forest (with 0.5 crown density and 2216 hectares of area covered) as 1325 tonnes i.e. 16886 Quintals. Considering the fuel wood consumption @ 3.5 kg/capita/day to continue the fuel wood requirement by 2001 and 2005 would be 49,465 Quintals and 62,827 Quintals, respectively.

Grazing land in the watershed is not defined and for the district it is 13930 hectares for approximately 5,50,000 cattle heads, i.e. 0.025 hectares per cattle head or one cattle head per 0.06 acres as against the norm specified as one cattle head per 3 acres (Working Plan, Uttarkashi Forest Area, 1964).

The fodder yield rate in terms of TDN (total digestible nutrient) from different

sources is (Sen et al., 1964) as follows:

Forest lands	=	4.3 Q/ha
Grass lands	=	2.8 Q/ha
Tree plantation	=	14.4 Q/ha
Crop residue	=	0.45 TDN/Q of crop residue (average)

or 0.41 TDN/Q of Paddy crop residue

0.28 TDN/Q of Maize crop residue

0.48 TDN/Q of Wheat crop residue

0.60 TDN/Q of Millet crop residue

Based on this the sustainable yield of fodder in terms of Q-TDN from all sources is calculated as equal to [(area under forest x fodder yield rate in TDN) + (area under each crop x productivity x fodder yield rate x nutritive value in TDN)] = [(3857.6 x 4.3)+3041] = 19628 Q-TDN.

6.2.2 Agriculture Potential

a) Crop Potential

Distribution of cultivable land under different landholding categories for the year 1997 is considered in the proportion as revealed in the primary survey. The district level data reveals an increase in marginal and large land holding, while a decrease in small and medium land holding over the years. Considering the same rate of change the distribution of cultivable land for the year 2001 and 2005 is expected to be as follows.

TABLE 6.2.1 DISTRIBUTION OF CULTIVABLE LAND UNDER DIFFERENT FARM CATEGORIES FOR 2001 AND 2005

Year	Total cultivable land (ha)	Land under different categories (ha)			
		Marginal	Small	Medium	Large
1997	307.05 (100)	104 (34)	89 (29)	109.05(35.5)	5 (1.6)
2001	312.05(100*)	125 (40)	77 (24.7)	105.05(33.7)	5 (1.6)
2005	312.05 (100*)	147 (47)	64 (20.5)	94.05(30)	8 (2.5)

Figures in parentheses (...) indicate the percentage to the row total.
* culturable waste is brought under cultivation.

Considering the foodgrain requirement as 190.9 kg/capita/annum, based on the standard as defined by the National Commission on Agriculture for the rural areas, the foodgrain required for different farm categories is estimated to be as follows for the years 2001 and 2005.

TABLE 6.2.2 PROJECTED FOODGRAIN REQUIREMENT FOR 2001 AND 2005

Year	Total food grain requirement	Foodgrain requirement in quintals for			
		Marginal farmers	Small farmers	Medium farmers	Large farmers
1997	6104	3803	1162	1126	13
2001	7391	5181	1109	1088	13
2005	9389	7264	1029	1069	27

The average food grain production per hectare for the year 1997 based on the percentage distribution of cultivable land under different crops and their productivity as given by Tables 5.2.17 and 5.2.12. is 12.6 Q/ha for marginal farmers, 11.83 Q/ha and 9.22 Q/ha for the small and medium farmers respectively, and, 5.4 Q/ha for the large category farmers. The productivity decreases as the irrigated area decreases with increase in landholding category. For large farmers' category the decrease is also because of low cropping intensity. Considering the average foodgrain production the food grain deficit/surplus for the years 2001 and 2005 is expected to be as follows.

TABLE 6.2.3 FOODGRAIN DEFICIT/SURPLUS FOR 2001 AND 2005

Year	Total deficit/ surplus (Quintals)	Deficit/Surplus for different farmers category (Qtls)			
		Marginal	Small	Medium	Large
1997	-2702	-2488	-109	-119	+14
2001	-3910	- 3606	- 198	-120*	+14
2005	- 5869	- 5411	- 272	-202	+16

*Culturable waste brought under cultivation

It is observed that the marginal farmers are the worst hit. Small and medium category farmers also do not grow sufficient to support themselves but the deficit is not as alarming

as in case of marginal farmers. The deficit over the years increases and requires to be taken care of for which the viable options are

i. to check the increase in population.

ii. to promote economic activity to improve the farmers affordability.

iii. exercise alternatives to improve the produce i.e. improved farming techniques integrating with the traditional know how.

b) **Livestock Potential**

The watershed has a total of 9140 cattle heads and a sustainable yield of fodder from all sources is 19628 Q-TDN. The projected fodder requirement @ 1.25 kg TDN/cattle head/day (Sen, et al., 1964) and, the gap between supply and demand of fodder is given in Table 6.2.4.

TABLE 6.2.4 PROJECTED FODDER REQUIREMENT FOR 2001 AND 2005

Year	Cattle heads (nos.)	Fodder requirement (Q-TDN)	Deficit (Q-TDN)
1997	9140	41701	-22073
2001	9286	42367	-22739
2005	9435	43047	-23419

This suggests that overgrazing is a principal factor in deterioration of forest lands. The process is aggravated by droughts and would become irreversible if not timely checked. The solution lies in adequate grazing management, which involves striking a balance between plant intake by animals and the rate of regrowth, thus obtaining sustainable levels of production of animal products - mainly meat and milk; while holding soil losses within reasonable limits. In the forest division of Uttarkashi about 4000 sheep/goat of the nomadic grazier come every year for the two summer months. The number of livestock possessed by these people also needs to be considered while accounting for the ecological carrying capacity. To meet this crisis and

to meet the grazing land requirement there is a need to

i) practice stall feeding.

ii. promote fodder cultivation to catch up with the requirement.

iii. introduce cattle mix compatible to the sustainable yield.

6.2.3 Human Resource Potential

Considering the total work-force in each category as given in table 5.2.6 and the present average family size as given in Table 5.2.2 to continue the human resource availability and distribution for the years 2001 and 2005, would be as follows.

TABLE 6.2.5 PROJECTED WORKFORCE IN PRIMARY SECTOR FOR 2001 AND 2005

Year	Total Work-force				Work force in Primary Sector				Surplus (+)/Deficit(-)*				Total
	Mr	S	M	L	Mr	S	M	L	Mr	S	M	L	
1997	1394	445	490	6	1255	400	441	5	+735	-45	-104	-19	+567 (24.3)
2001	1899	424	473	6	1709	382	426	5	+1084	-3	-99	-19	+988 (35.3)
2005	2663	393	465	12	2397	354	419	11	+1665	+34	-51	-38	+1622 (46.06)

*Based on the criteria of 0.2 ha of cultivable land per capita.
Figures in parentheses indicate the percentage to total work force.
Mr-marginal, S-small, M-medium, L-large

The table reveals that the total underemployed population by 2005 would be nearly 50 percent of the total work force and about one third of the total population. With the present employment and occupation structure the population would have to solely depend on agriculture which already is in a deplorable state. Considering the present trend of population increase alternative employment avenues need to be thought of urgently.

6.2.4 Infrastructure Potential

a. Power Supply

The region under study has vast potential for power generation. The watershed has a total potential for 450 kW of electric power generation and seven such sites have been identified where (2 x 100+ 5 x 50) kW projects can come up. There is also potential for tapping solar energy. The potential estimated from all these sources is as presented in Table 6.2.6.

TABLE 6.2.6 ENERGY POTENTIAL IN THE WATERSHED

Source	Potential	Investment Cost	Benefits
Small hydro projects	450 kW	Rs. 70,000/kW	*Power *Water for irrigation *Pisciculture *Recreation *Water mills
Solar energy	Area x 700 W/m^2	Rs. 3.5 lakh/kW	* Power

* Based on estimates by Alternate Hydro Energy Centre, University of Roorkee, Roorkee.

Adequate supply of power would make possible the task of setting up small scale industries, besides reducing the pressure on forests for fuel energy and lighting.

b) Accessibility

The topographical and geographical conditions constrain the accessibility within the settlements as a whole although the main road network is well laid out for defence reasons (the region being a bordering one). Alternative means of transport like rope ways, etc. for movement within the settlements can be explored.

6.2.5 Industrial Development

The area is industrially underdeveloped. However, there is great potential for income and employment through,

i. Forest based industries, viz., sports goods manufacturing, resin and turpentine

extraction, ayurvedic medicines, agriculture etc.

ii. Horticulture based industries, viz., fruit processing and canning.

iii. Supporting units, viz., repair shops, can making and packaging, cold storage plant, small hydro projects, livestock feed manufacturing, etc.

Besides the above said industries, owing to the favourable atmospheric condition of the hills there is potential for developing electronic, scientific and precision instruments. Also considering the livestock population tannery for hides and skins, foot wear and leather goods, etc., can be considered as potential avenues for income generation.

6.2.6 Tourism Potential

The study area is gifted with scenic beauty and holy shrines. There is vast potential for tourism which needs to be exploited and can play a significant role in the economic development of the area. Study reveals that a number of tourists are pilgrims. Using the information of the Tourism Department Uttarkashi, the average share of foreign tourists is only 2 percent and of the rest it is mainly the pilgrims.

It is estimated that over 60,000 tourists cross the watershed and over 10 percent halt overnight on their way to Yamnotri a holy shrine. Local people are believed to vacate their houses to accommodate the tourists. The income that accrues to the local people per tourist is at the rate of Rs. 25 for services rendered as porter, Rs. 100 from food and lodging and Rs. 25 on an average from way side refreshments. All this gives an annual income of Rs. 22.5 lakhs. while 80 percent of the household are involved in tourism related activities an average of Rs. 1000 to 1500 per month is earned by each household during the Yatra season of four months.

The watershed also has a potential skiing resort and is likely to attract about 50 percent of the tourists presently queuing up for the Auli Skiing Resort in Joshimath block . These tourists are estimated to be about 1000 during the two months. Such a development would add another Rs. 1,00,000 to the income of the watershed. But tourism provides only seasonal

employment. There is also stress on infrastructure which if improved would promote tourism further.

6.3 PATTERN OF INTERACTION

The carrying capacity examined with respect to food, fuel wood and a number of other natural resources clearly underscores the need for strong demand and supply management in order to move towards a sustainable path. The pressure of population in the study area is generated essentially by sustenance or survival requirements. The sustenance requirements create pressure on economic base, both agricultural and non-agricultural. Aspirations for better quality of living generate pressure on infrastructure. The sustenance requirements constitute a major determinant of the pressure on economic base and prompt out-migration. Restricted economic and development activities result in uncontrolled and incompatible use of land causing land and resource degradation.

Marginal and small farmers form the bulk of population in the area and possess about two third of the land. This category has been on an increase revealing the trend of marginal holdings in future. These poor farmers are unable to produce sufficient food to sustain themselves and their families on the very small plots of land that they possess and consequently resort to unsustainable practices, for example, cultivation on steep slopes and in forest lands, employment in non-farm sector or out migration. The low returns from off farm work are mostly used for consumption, meeting natural calamities and distress, and, for religious expenses. In the event of lack of off-farm employment opportunities, these people are lured to avail subsidies designed by the government thereby putting the households under greater economic stress.

The major brunt of increasing poverty, population growth is borne by forest resources. Large areas of the forests are deprived of their forest cover to grow cash crops and extract the cheapest source of fuel energy, as a result the destruction of forests exceeds their natural growth rate. Deforestation occurs mainly as a consequence of the people's need for fuel wood,

fodder, timber for construction and land for cultivation. Over exploitation of the biomass is believed to result in problems like soil erosion decrease in soil fertility, increasing degradation of forests and pastures and even disruption in the availability of water resources and consequently have negative effect on agricultural productivity. Loss in quality and quantity of forest resources and the agricultural productivity have direct implications for the well being of the households as these are the primary resources for their sustenance. Since crop production, livestock rearing and forestry activities are all interlinked and sustained by the transfer of biomass resources, improper functioning of one adversely affects the other and thereby the sustainability.

The industrial facilities and production technology in the region are underdeveloped and the inadequacy of marketing facilities and energy sector also form bottlenecks. These are obvious defects and restrictions in economic development, which hampers further development. All these factors together determine the standard of living of the farm families, their income and employment levels, their surrounding environments and eventually sustainability. Because of these interlinkages the area is seen to be caught in a vicious cycle of under/uncoordinated development, population pressure, environmental degradation, poverty, marginalisation and scarcity.

6.3.1 Key Factors Affecting Sustainability and Their Interlinkages

From the above discussions it is obvious that requirement of 4 F i.e. food, fodder and fuel on the one hand and the financial standing of the people on the other are the basic elements causing unsustainability in the area. While carrying capacity of the area provides limits to the availability of these basic resources, the absence of income generating/career development avenues result in poor and inefficient management of natural resources leading to ecological crisis in the area.

These sustenance requirements are conflicting goals as regards land use development. Needs and priorities of the people define the process of landuse operated by them. Unscientific

and irrational use of land for meeting the conflicting goals destabilizes the geo-ecological process in the area and also endangers its sustainability. In order to control the irrational use of land sustainable solutions for agriculture, biomass and career development (ABCd) are necessary. These are therefore the key factors affecting landuse of the area. These solutions for ABCd besides meeting the basic requirements need to be consistent with the resource potential and ecological frame of the area to arrive at SD. Thus the key factors affecting the SDPH are ABCd along with the physical environment within which they function.

Based on the study for the region Table 6.3.1 outlines the potentials, problems, opportunities and threats with respect to the key factors ABCd. This reveals that the three are inextricably linked (Fig. 6.3.1) and sustenance of hill system depends on the performance of the individual systems taken together with due consideration for the physical environment. This also leads to identifying the decision variables affecting each key factor. The interdependence is explained by the mutual casual relationship that exists between hill sub-systems (Figure 6.3.2).

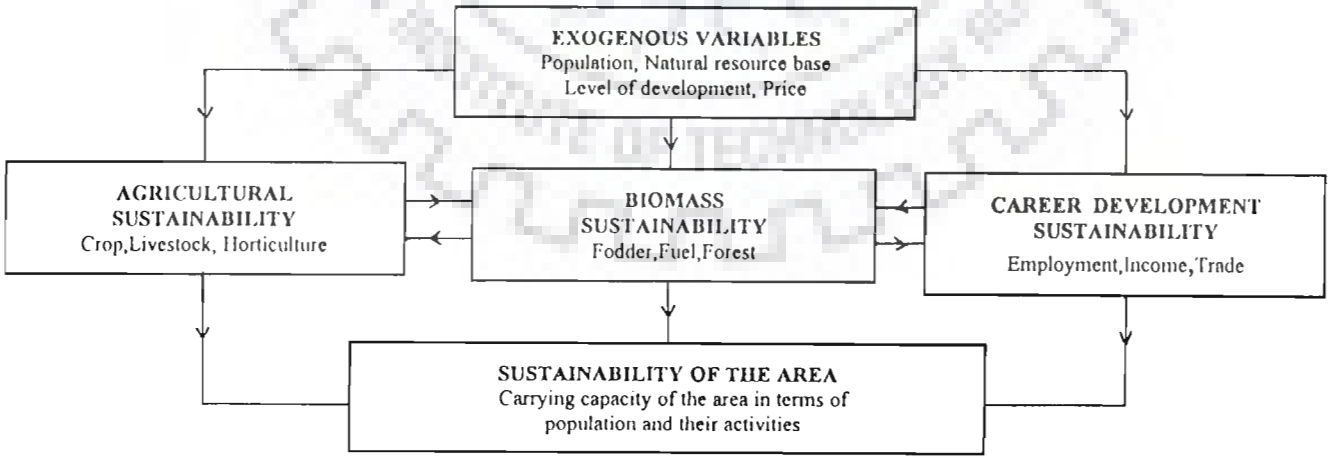


FIGURE 6.3.1 INTERDEPENDENCE OF KEY FACTORS

TABLE 6.3.1 (A) AGRICULTURE SUSTAINABILITY

S No.	Potential available	S. No.	Problem faced	S. No	Opportunities provided	S. No.	Threats created
1	Favourable agroclimatic conditions suited for farming profitable cash crops	1	Harsh conditions such a inaccessibility, fragility marginality and climate restrict the activity.	1	Cash crops and off-season vegetables would improve cash incomes and employment.	1.	Food scarcity leads to exploiting marginal lands leading to soil erosion and disturbing the environment eventually.
2.	To grow off-season vegetables when plains have hot-humid conditions.	2.	Land holdings which are fragile marginal and vertical constrain the use of modern technology.	2.	To improve household incomes for food security reasons the off-farm employment plays a major role.	2.	Excessive use of inorganic fertilizers and pesticides eliminates the biological component of the soil and reduce their biodiversity thereby converting fertile soils into barren land .
3.	For producing disease free seeds and planting material.	3.	People migrate in search of food security.	3.	Availability of good seeds and plant material would help upgrading the plant stock.	3.	Production system characterised by yield maximization associated with HYV of seeds and intensive use of chemical fertilizers has succeeded only in irrigated areas and promoted monoculture.
4.	Livestock connects croplands and forests by converting fodder into draught power and dung nutrients.	4.	Irrigation is a constraint and agriculture is mainly rainfed.	4.	Infrastructural inputs such as credit availability, plant protection measures, storage, processing and marketing shall improve the food availability.	4.	Engineering structures based soil conservation technology often interferes with agricultural operations by way of surface ponding & water logging.
5.	Promoting livestock provides products viz milk, ghee, wool, manure, field work.	5.	Increase in population increases food & energy needs.	5.	Highly decentralized, reliable and affordable public distribution system would support the adequate and appropriate supply of food commodities.	5.	Aiming only at intensification of agriculture is irrational as benefits accrue in proportion to land held by different groups.

TABLE 6.3.1 (a) AGRICULTURE SUSTAINABILITY (CONTINUED)

S. No.	Potential available	S. No.	Problem faced	S. No.	Opportunities provided	S. No.	Threats created
6.	Green manures along with inorganic fertilizers improve the crop productivity compared to the pure use of inorganic fertilizers.	6.	House hold access to food is constrained by income and relative prices of crops.	6.	Changes in cropping patterns, introduction of high value low volume crops & off season crops, would fetch good prices.	6.	Number of occupational engagements and migration affects the availability of labour.
		7.	Hill farmers raise livestock and depend heavily on forests to support them.	7.	Because of the limited scope of canal system and ground water. *Water harvesting *Promoting crops which are not water intensive. *Economizing on use of water (water recycling) shall prove useful.		
		8.	Unproductive cattle reared mainly for manure.	8.	Optimal use of inorganic fertilizers in combination with organic would improve the productivity and also retain the soil fertility.		
		9.	Large travel distances to collect leaf litter for composting and for grazing animals	9.	Consolidation of land holdings or cooperative farming would make production units viable.		
		10.	Lack of appropriate technology reduces the productive efficiency.	10.	Local knowledge and local technologies dovetailed with modern knowledge and technology proves beneficial, viz. *Low cost vegetative conservation measures. *Sunken dugout for water and silt harvesting to recharge ground water and for storing water for dry spells. *More reliance on vegetation to control erosion from falling and flowing water thereby promoting in-situ moisture conservation. *Use of bulky organic manures to improve moisture holding capacity of soil.		
		11.	Farming on slopes induces soil erosion.	11.	Slope management to make land suitable for cultivation thereby reducing soil erosion.		
		12.	While aiming at food security the benefits accrue in proportion to the land held by people.				

TABLE 6.3.1 (b) BIOMASS SUSTAINABILITY

S No.	Potential available	S. No.	Problem faced	S No.	Opportunities provided	S. No.	Threats created
1.	Biomass is a renewable resources.	1.	People depend on forests in one way or the other for subsistence and the rate of deforestation depends upon the magnitude of the unfulfilled demand.	1.	Controlled use of fuelwood and fodder serve as a potent means of biomass conservation and production.	1.	Landslips occur where land is broken for agriculture cultivation.
2	Forests also consist of low evergreen scrub growth usually 2-3 ft. high forming a dense cover over big patches broken by grass land while herbs cover the soil between scrub growth.	2.	Rapid destruction of trees results in soil erosion affecting the green house effect and concentration of CO_2.	2.	Plantation of areas with fast growing and valuable species - indigenous or exotic would yield higher returns/unit area.	2.	Cutting of herbs and fuel have lead to deterioration of the botanical composition of grass lands.
3.	Chir forests are the only fodder resources of the hill cattle.	3.	Farmers slash and burn patches of forests to grow crops and once the soil gets depleted of nutrients they move to clear another patch.	3.	Mass area plantation encompasses providing soil cover and thus reducing the pressure on forests for fuel, fodder and other forest products. These also provide employment opportunities to the local people and above all involve them in restoration of the environment.		
4.	Gentler slopes are set aside for grazing and more inaccessible parts for grass cutting.	4.	Forests close to the human settlements are pressurized for want of fodder , fuel wood and trees are lopped and felled, and ground grazed.	4.	Offering incentives and support would encourage investment in mass plantations and go a long way to transform the rural landscape.		
5.	Alpine grassy lands at heights 4000-5000 mts. through warmer slopes contain medicinal herbs and alpine plants and also provide good pasture to sheep, goat and small ponies of gujjars and local villagers.	5.	During monsoons trees are uprooted by erosion and land slips.	5.	Development of sustainable energy use patterns (cooking energy, smokeless chullas), energy from renewable sources respecting the regenerative capacity of forests can improve the supply of biomass.		
6.	Crop residue from agricultural lands provide biomass as fodder and fuel.	6.	Snow damages occur during severe winter in the form of snow breaks and snow bends.	6.	Crop residue from agricultural lands can be used for fuel and fodder both.		
7.	Potential for afforestation work with social forestry schemes in degraded area.	7.	Drought causes disappearance of newly germinating seeds and also makes the forests liable to suffer from fire particularly in hot and exposed slopes.	7.	Herbs can be exploited for commercial gains.		

TABLE 6.3.1 (b) BIOMASS SUSTAINABILITY (CONTINUED)

S. No.	Potential available	S. No.	Problem faced	S No.	Opportunities provided	S. No.	Threats created
		8.	Above 3500 mts avalanches cause significant damage.	8.	Excessive grazing does a great harm to the chir regeneration while light grazing helps regeneration by exposing soil for the reception of seeds.		
		9.	Pure trees suffer isolation shocks .	9	Forest areas excess over the required 60 % can be in phases put to other suitable non-forest use.		
		10.	Standing 'chir' trees are damaged by cutting deeply at the base and scooping out the resinous torch wood from them. This damges the tree which are at times blown over by the storm.				

TABLE 6.3.1 (c) CAREER DEVELOPMENT SUSTAINABILITY

S. No.	Potential available	S. No.	Problem faced	S. No.	Opportunities provided	S. No.	Threats created
1	Under development of economic activities and unutilized human resource leaves a great potential for career development avenues.	1.	Economic diversification in mountain areas is constrained by inaccessibility and deficient infrastructure.	1.	Remote and mostly resource poor mountain communities provide novel opportunities for development.	1.	Development process based on specialization and production from the outside market introduces commercialization resulting in erosion of traditional principles of collectivity and mutual obligation.
		2.	Dispersed and often fragile nature of resource base.	2.	Also see table 6.4.1.	2.	Leads to stronger economic differences among individuals and households on the basis of their resource endowments, education, social skills - access to public officials etc.
		3.	Lack of commercial enterprise.			3.	Manpower gets diverted from agricultural occupation.
		4.	With men migrating in search of better opportunities mainly women share the maximum burden of running a house.				
		5.	Lack of education and skills prevents women from participating in productive and income earning activities in a commercial market oriented economy and non-farm activities.				

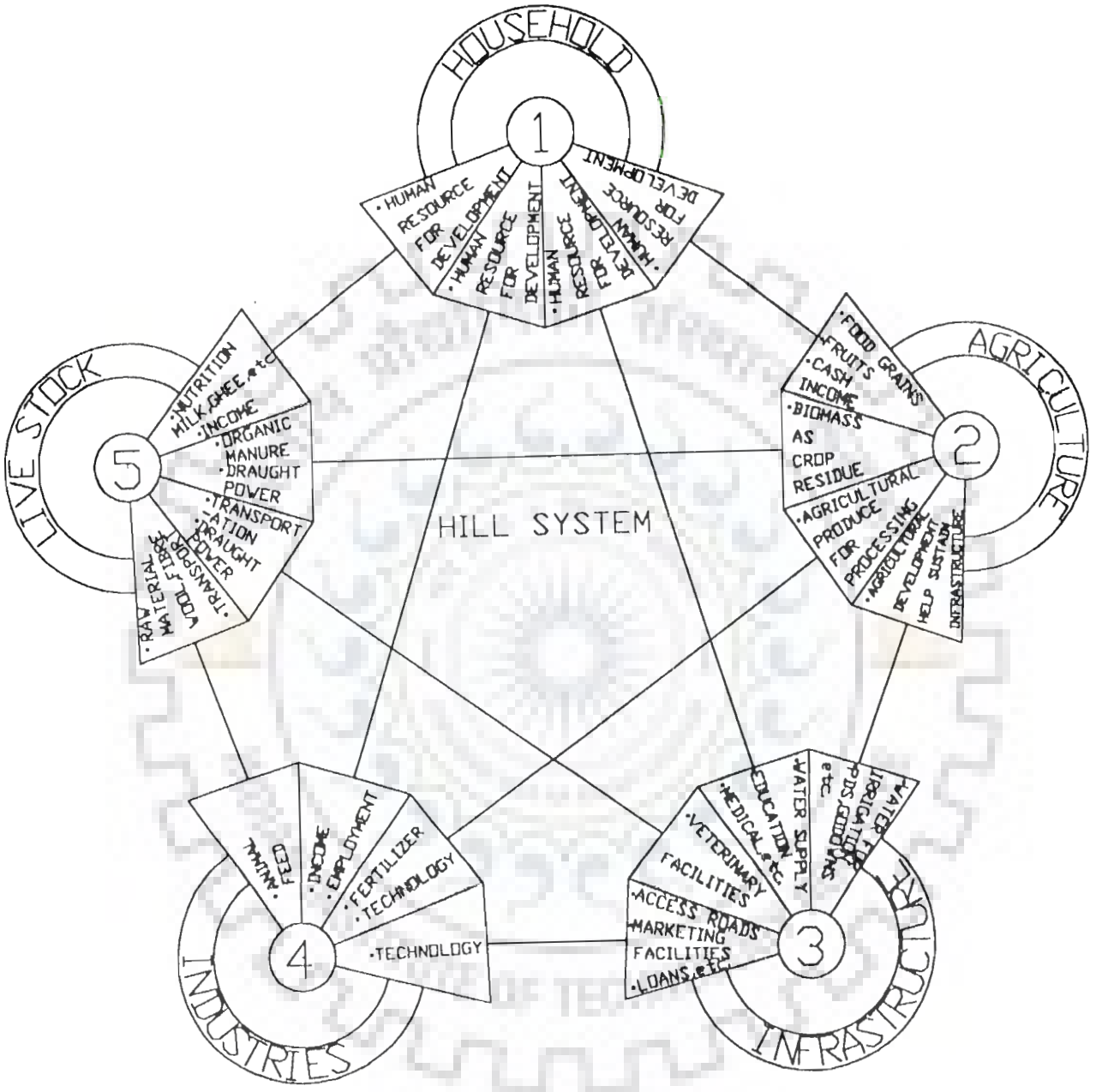


FIGURE 6.3.2 CYCLIC LINKAGES BETWEEN SUBSYSTEMS

6.4 IDENTIFICATION OF DOMINANT DECISION VARIABLES

Dominant decision variables affecting the performance of the key factors- Agricultural, Biomass and Career Development sustainability, and the constraints to basically assess the dynamic consequences of the decision variables for environmental parameters, have been identified in the foregoing text.

6.4.1 Agricultural Sustainability

Food security essentially means a state of affair in which people have access to sufficient and nutritious food in order to maintain a healthy and active life throughout the year. Population pressure and food deficit, are common concern in the area. Per capita requirement of balanced diet and the existence of wide disparities in the income/consumption pattern leads to exploitation of land not suited for the purpose. The welfare of people lies in increasing the production, productivity and nutritional quality of food to more sustainable levels. A number of variables influence the agricultural sustainability. For sustainability these variables should not adversely affect the social, economic and ecological milieu of the area.

Dominant decision variables

1. Per capita requirement for a balanced diet.
2. Availability of suitable land for agriculture.
3. Land use efficiency in terms of
   - (i) Percentage of cultivated area
   - (ii) Cropping intensity
   - (iii) Irrigation intensity
   - (iv) Other cultivable land
   - (v) Land holding size and fragmentation of land.
4. Relative changes in inputs of
   - (i) Labour
   - (ii) Modern agricultural implements

(iii) Chemical/inorganic fertilizers

(iv) Use of organic fertilizers

(v) Irrigation measures

(vi) Slope management by way of terracing, planting hedge row plants.

5. Per capita income from

(i) Off farm activities

(ii) Direct intervention in agriculture (cash crops, off-season crops, horticulture etc.)

6. Relative prices of crops

7. Influence of socio-economic factors

(i) Education score

(ii) Occupational engagements

(iii) Migration

Constraints

1. Land under forest should not drop below the standard required level.
2. Land under homestead must not be reduced.
3. Land under cultivation should not exceed the land area capable for agriculture.

6.4.2 Biomass Sustainability

Biomass is a renewable resource. Forest lands and pasture lands are the main source of biomass for fuel and fodder. The crop residue from the farm lands also provides for fuel and fodder, and is dependent on the agricultural produce which is quite unpredictable in the harsh climatic conditions. The livestock pressure and the absence of alternate energy sources affect the biomass sustainability. The livestock density in the area is quite high which is mainly kept for its output as dung manure and for animal labour in the absence of mechanized farming. Fuel wood is the cheapest and easily available source of energy in the absence of alternate sources of energy coupled with their poor affordability. The biomass resource in the area is being exploited beyond its regenerative capacity which leads to environmental degradation and subsequently affects the agriculture and livestock in the area which is the

primary source of livelihood for the locals. Alternatives for biomass sustainability must consider the basic requirements of the local people and also their impact on overall environment.

Dominant decision variables

1. Daily per capita requirement of forest produce as fuel wood, fodder, timber for construction etc.
2. Sustainable yield of biomass
   (i) Total annual firewood available
   (ii) Total annual fodder available from trees.
   (iii) Total annual fodder available from pasture lands.
3. Total annual crop residue available as fodder and fuel.
4. Availability of alternate sources of energy.
   (i) Total animal dung available as fuel
   (ii) Potential for small hydro projects.
   (iii) Solar energy potential
   (iv) Access to LPG, kerosene etc.
   (v) Potential for wind energy.
5. Increasing productivity by varying species and treatment of potential sites.
6. Availability of land
7. Replacement of local livestock with cross bred.

Constraints

1. Total land available under different categories of land, namely cultivable, grazing, forest and homestead must always be equal to the total area in the watershed.
2. Land under forest should not drop below the standard required level.
3. Use of biomass should not exceed their natural regeneration rate.
4. Alternative sources of energy should perform with respect to the sustainability criteria.

6.4.3 Career Development Sustainability

The prevailing pattern of economic activities centred on subsistence-based food crop production is highly unsustainable both economically and ecologically. Diversification into activities based on a special advantage for production of high value commodities for the market is, therefore essential for improvement in the livelihood of mountain people. Off-farm employment and income opportunities in the food deficit region would contribute to a significant rise in the living standards of the local people. These activities while playing an important role in the economy would also have an impact and effect on the very environment - the nature, people and culture of the area. For sustainability these therefore need to contribute to environmental and socio-cultural development in a positive way, by considering the local resource base potential, both natural and manmade.

Decision variables

1. Income and consumption inequalities.
2. Degree of urbanization.
3. Government programmes and policies.
4. Industrial development and its revenue earning capability viz:
5. Indigenous resource availability.

Dominant decision variables and constraints with respect to SDPH income generating avenues identified for the area are given as follows in Table 6.4.1.

6.5 CONCLUSION

The key factors affecting SDPH are varied but interrelated . For restoring the balance of the hill system it is necessary to coordinate, integrate and phase these.

TABLE 6.4.1 DOMINANT DECISION VARIABLES AND CONSTRAINTS WITH RESPECT TO CAREER DEVELOPMENT AVENUES

S. No.	AVENUE (Potential)	OUTPUT (Income and Employment from)	DECISION VARIABLES	CONSTRAINTS
I (i)	PRIMARY SECTOR Agriculture (Agro-climatic conditions)	Cash crops, high value low volume crops.	* Availability of surplus land over and above that required for minimum food grain production. * Availability of irrigation, agriculture service centres, transportation, marketing facility, etc	* Minimum food requirement to be met. * Area under forest not to reduce below the present level. * Benefit to cost ratio should be greater than one
(ii)	Horticulture (Physiography)	Fruits, processed fruits, fodder grass, Afforestation.	* Availability of surplus land. * Irrigation, horticulture service centres, cold storage, godowns, marketing facility, transportation facility. * Climate and topography	* Minimum food grains requirement to be met. * Area under forest not to reduce below the present level. * Benefit to cost ratio greater than one.
(iii)	Animal Husbandry a) dairy farming b) sheep/goat rearing c) rabbit rearing d) poultry farming (suited to agrarian economy)	a) Improved milk yield, organic manure. b) Wool, milk, sale of lambs, sale of sheep/goat, hide, droppings as manure. c) Wool, hide meat, sale of rabbits d) Eggs, broiler, organic manure.	* Biomass availability, * Milk processing plant * Infrastructure availability-marketing, transportation, processing.	* Biomass consumption not to exceed the ecological carrying capacity.
(iv)	Sericulture (Mulberry grows on wide range of soils, hardy plant capable of thriving under variety of agroclimatic conditions)	Sale of silk cocoons, silk-worm pupae for animal feed.	* Silk seeds availability. * Mulberry plantation. * Oak trees for tusar silk.	* None
(v)	Beekeeping	Honey production, bees wax production, sale of bee colonies.	* Flat site with sufficient clean water, air, sun and shade. * Appropriate plants for bees within the two kilometre range.	* None
(vi)	Fisheries (available sources of water, ponds etc.)	Sale of fish, water for irrigation	* Water availability. * 500-1300 mts attitude where water temperature does not drop below 4°C	--
(vii)	Mining	Extraction of minerals and their processing.	*Stocks of mineral resource *Appropriate technology for mineral extraction. *Consent of local people. *Ecological status Transportation network. *Time profile in assessing the depletion effects. *Price and cost of extraction. *Extent of substitution between renewable and non-renewable.	* Economic efficiency. * Ecological harmony.

TABLE 6.4.1 DOMINANT DECISION VARIABLES AND CONSTRAINTS WITH RESPECT TO CAREER DEVELOPMENT AVENUES(continued)

S. No	AVENUE (Potential)	OUTPUT (Income and Employment from)	DECISION VARIABLES	CONSTRAINTS
II (i)	SECONDARY SECTOR (i) Energy generation a) Micro Hydel b) Solar photo voltaic system c) Biogas d) Wind energy conversion system	a)* Generation of non polluting energy. * Fisheries development. * Irrigation * Meeting requirement of local industries, * Hydroelectricity for lighting. b)* Power generation in a highly modular fashion close to the load. * No pollutants emitted. * Little attention for operation and maintenance. c)* Gas produced which can be used for cooking. * Manure produced more compared to the traditional way.	a)*Availability of water i.e. the level of the river. * Local geological and technical conditions * Minimum reserved flow b)* Solar insolation. c)* Dung availability. * Suitable climate/temperature for biodegradation. d)* Energy content of the wind.	a)Transmission efficiency. b)None c)None d)Wind machine to be shut down at cut out speed of the wind.
(ii)	Construction activity	* Building activity	* Resource availability. * Development potential * Degree of urbanization. degree of industrialization *Percapita disposable income * Number of settlements with transportation.	* Capacity of structure to withstand hazards. * Site planning should be compatible to the physiography and spatial distribution. * Land use and production system of the area should not be affected. * Architectural style and building material should not be alien.
(iii)	Manufacturing/ Handicrafts	*Biomass and agroprocessing-basket making, rope making, cottage scale food processing. *Production of bio-fertilizers *Ethnic craft. * Precision instrument industry.	*Raw material availability *Marketing facility *Hydroelectric power	* Biomass use subject to natural regeneration capacity. *Ratio of recycled to non-recycled waste should be more.
III	TERTIARY SECTOR a) Personal/ domestic service b) Recreation/ eco t ourism c) Transportat-ion, public services viz, medical, law administra-tion etc.	a)carpentry, blacksmithy, farming equipments, boarding/lodging services.	a)*Indigenous resource availability * Marketing facility * Demand b)*Potential for attracting ascetics/pilgrims/naturalists/explorers/trekkers/mountaineers/cultural tourists. * Seasonality * Infrastructure availability, viz lodges, hotel keeping. * Agitation in the area w.r.t. separate hill state dampens the tourist inflow c)* Govt. programmes and policies.	*Assimilative capacity of the environment should be taken care of w.r.t. the sustainability criteria. *Should not result in environmental stress, therefore recyclable waste should be more *Provision of infrastructure should not be at the expense of natural beauty. *Identity of the place should not be eroded thru' alien architectural style and building material.

CHAPTER VII

MODEL FOR SUSTAINABLE DEVELOPMENT PLANNING IN HILLS

7.0 GENERAL

In the preceding chapters goals and objectives for SD have been identified and so also the need for effective instrument for implementing the programmes at the micro level to achieve a desired level of development. This is also one of the objectives of the present study.In order to achieve this, a micro watershed, Khurmola Gad representative of the case study area has been studied in detail. The carrying capacity analysed for this watershed reflects the potential conflict that occurs between SD aspects and the landuse pattern. The analysis indicates that food, fodder, fuel and financial standing of the people (4Fs) form the basic issues which cause unsustainability in the area. For sustainability, there is a need to coordinate,integrate and phase the sustenance requirements of Agriculture, Biomass and Career development, thereby aiming at sufficiency in food, fodder, fuel and also financial wellbeing of the local people.Empirical analysis, however, indicates that these sustenance requirements are conflicting goals and the irrational use of land for meeting these goals destabilizes the geo-ecological process in the region thereby endangering its sustainability.

In this chapter a model has been proposed which would help arrive at sustainable solutions for Agriculture, Biomass and Career development.Based on the degree and magnitude of association measured and interpreted between the variables of land transformation process, a framework has been modelled.

Involvement of multiple goals and their interconnection, integrating environment and

development requires an interactive, multidimensional and dynamic approach .It is also understood that aiming at optimal state of the system is an unrealistic concept (Nijkamp et. al., 1982) since there do not exist any clearly identifiable and unambiguous parameters to define the capacity of the nature. In order to arrive at sustainable development it has therefore been considered more appropriate to identify how developmental activities can take place without disturbing the ecological balance. Consequently focus on decision making processes is laid which would enable various disciplines dealing with SDPH to understand the dynamics of development and thereby contribute more effectively to it. Considering this the suggested model **LUC in ABCds** (landuse control integrating the sustenance requirements viz Agriculture, Biomass and Career development sustainability) has been developed which would help understand the dynamics of development processes.

7.1 BASIC FEATURES FOR MODEL DEVELOPMENT

In order to understand that whether a particular development proposal is sustainable or not, there is a need to examine its pros and cons.In the Garhwal hills the key factors affecting sustainability are the options available for Agriculture ,Biomass and Career development.These are conflicting sustenance requirements and require to be resolved in a manner such that the distributive impact of any policy measure taken does not adversely affect the environment. Agricultural sustainability requires meeting the minimum food grain requirement, Biomass sustainability requires maximizing the sustainable production of biomass resources for fodder and fuel and sustenance requirement of Career development sustainability requires minimizing the income and expenditure inequality.All this is required to take place with due consideration to the physical environment.

For formulating a framework to address how management decisions/measures influence the dynamics of these sustainability aspects an understanding of interlinkages and interdependencies of these sustenance requirements is required. Along with it, it is necessary to incorporate the natural resource potential and the basic needs/aspiration levels by way of constraints designed basically to check/assess the dynamic consequences of decisions/measures

taken. Interdependencies and interlinkages among the various subsystems of the hill system is given in Fig. 6.3.2 and dominant decision variables affecting the performance of sustenance requirements is given in section 6.4.

Various alternatives are usually available to achieve a desired goal. For meeting the sustenance requirement and to arrive at the desired solution, however, feasible combinations can be worked out with choice of best alternative based on the fact that it does not have adverse effect on socio-cultural,economic and physical milieu of the area.

7.1.1 PARAMETERS FOR MODELLING FRAMEWORK FOR SDPH OF GARHWAL

Based on the dominant decision variables and constraints identified in the previous chapter the parameters pertaining to the sustainability aspects and those incorporated in the model are as follows:-

a) **Landuse (physical environment) Related Parameters**

i) Area of the watershed

ii) Area under forests

iii) Area under homestead

iv) Area under agriculture, horticulture, culturable waste, fallow land, and unculturable waste.

b) **Agricultural Resource Related Parameters**

i) Area under different land holding categories

ii) Availability of land capable for agriculture

iii) Area under various crops

iii) Land type (irrigated/unirrigated)

iv) Intensity of use of seeds - local and high yielding variety (HYV)

v) Intensity of use of fertilizers (organic/inorganic)

vi) Yield of the different crops in different land types

vii) Price of agricultural inputs

- Price for fertilizer
- Price for seeds
- Price for animal labour

viii) Price of the main produce

ix) Standard per capita requirement of food grains

x) Total population in each category of landholding

xi) Quantity of crop residue as fodder and fuel

c. Biomass Related Parameters

i) Land type, i.e. forest, agriculture, horticulture, and pasture land

ii) Livestock population in the watershed

iii) Time spent in grazing by different animals

iv) Fodder intake in kg by different animals for one hour of grazing

v) Quantity of crop residue produced as fodder from unit mass of different crops expressed as TDN equivalent

vi) Quantity of crop residue produced as fuel from unit mass of different crops expressed as calorific (heating value in terms of coal replacement) equivalent

vii) Sustainable yield of fodder from various land types

viii) Total population in the watershed

ix) Daily energy requirement per household for cooking, water heating and lighting

x) Sustainable yield of fuel wood from different types of land

d. Career Development Related Parameters

i) Quantification of income and expenditure inequality in monetary terms for each land holding category

ii) Available human resource potential in each land holding category

iii) Government programmes and policies for income generating activities

iv) Existing occupation and returns therefrom

v) Potential economic activities and returns therefrom

vi) Infrastructure availability - (marketing facility, hydro-electric power availability, transportation, etc.)

vii) Resource availability in terms of raw material

vii) Demand of commodity and relative prices

The parameters for constraints are defined by the landuse (physical environment) related parameters and the basic needs related parameters.The landuse (physical environment) related parameter define the physical constraints and provide primary input into the SD planning process with respect to which the development is governed. The constraints identified are:

i) the total area in the watershed remains constant

ii) total area under homestead, cultivation and forest should not exceed the total area in the watershed

iii) total area under cultivation should not exceed the land area capable for the purpose(defined by land suitability and capability criteria)

iv) forest cover should not drop below the specified level

v) Percapita requirement of foodgrains should be met

vi) Use of biomass should not exceed the natural regeneration rate

vi) Financial wellbeing of the people atleast to the extent that they are able to meet their basic requirements

7.2 MODEL DEVELOPMENT

The parameters related to physical environment, agriculture, biomass and career development individually provide description of existing development and trends but very little insight into the aspect of sustainability. For operationalizing the concept of sustainability the proposed model integrates the interdependence among the parameters. Models to study the

interdependence between systems have been discussed by Nijkamp et al. (1982), Brix (1980) and Patkar (1992). The concept has been extended here to simultaneously consider all the parameters of the sustenance requirements to result in an interactive framework.

Let S_1, S_2, S_3 and S_4 be the conflicting sustainability aspects affecting SDPH, where S_1 represents landuse / physical environment, S_2 the agricultural potential, S_3 the biomass potential and S_4 the career development potential of the hill system interacting with each other as shown in Figure 7.1.1. The interaction among these is understood in terms of forward and backward interactions. While S_1 provides primary input by way of land suitable for use by other sustainaility aspects S_2, S_3, and S_4; it also accommodates the various human functions and influences their activities. Sustainability aspect S_2 receives the input from S_1 whereby the agricultural potential is dependent on land capable for cultivation and the livestock that the land supports. The agricultural potential influences biomass potential S_3 in terms of the crop residue produce used both as fodder and fuel, and it also influences S_4 in terms of revenue earned from the crop produce, crop residue and livestock output (subject to first meeting the per capita basic requirement of food grain and animal produce for sustainability). This gives the forward interaction.

Agricultural potential (S_2) of an area depends on the extent of land put to agricultural use. This relationship explains how agricultural potential affects the physical environment S_1 thereby defining the backward interaction.

In a similar manner the forward and backward interaction amongst the various sustenance requirements can be established.Biomass potential (S_3) is dependent on sustainable yeild of biomass as fodder and fuel from different land types viz, forest , agricultural, homestead, horticultural etc. defined by S_1 and S_2. The sustainable biomass produce influences the pressure on forest lands and the requirement for alternative energy. The two together help assess the shortfall/surplus of biomass in monetary terms thereby influencing the career development sustainability (S_4). This explains the forward interaction. In the backward interaction the fodder

produce influences the agricultural potential in terms of defining the number of livestock the area can support and whose output in terms of manure, draught power and milk etc. affects the agricultural produce. Influence of S_3 on the landuse(sustainability aspect S_1) is explained by the option of bringing more area under grazing and exploiting of the forests for fuelwood to meet the biomass requirement.

The Career Development potential (S_4) receives inputs from system S_1, S_2, and S_3 as defined by land availability/suitability for particular use and by shortfall/surplus of finances in attaining the agricultural sustainability and the biomass sustainability. The existing source of income and the difference in income and consumption pattern justifies the career development requirement.

The various career development options in order to be sustainable must meet the sustainability criteria of utilizing human resource potential , making use of indigenous resource available and overcoming income expenditure inequality. These options influence S_1, S_2, and S_3 not only in terms of filling the gap between income and expenditure but the varied options have in them inbuilt linkages with other sustenance requirements. For example the promotion of small hydros would not only provide income/employment but also water for irrigation and pisciculture thereby influencing the agricultural potential (S_2). It would also affect the biomass potential and the land use pattern.This explains the backward interaction.Such an association among various career development activities and the sustainability issues has been brought out in Table 6.4.1

Thus it is understood that sustenance requirement S_1 provides primary input for S_2, S_3 and S_4 . S_2 receives the input of S_1 while it influences the activities of S_3 and S_4 . Similarly S_3 , while receiving the inputs from S_1 and S_2 , influences the activity of S_4. This gives the forward interactions.

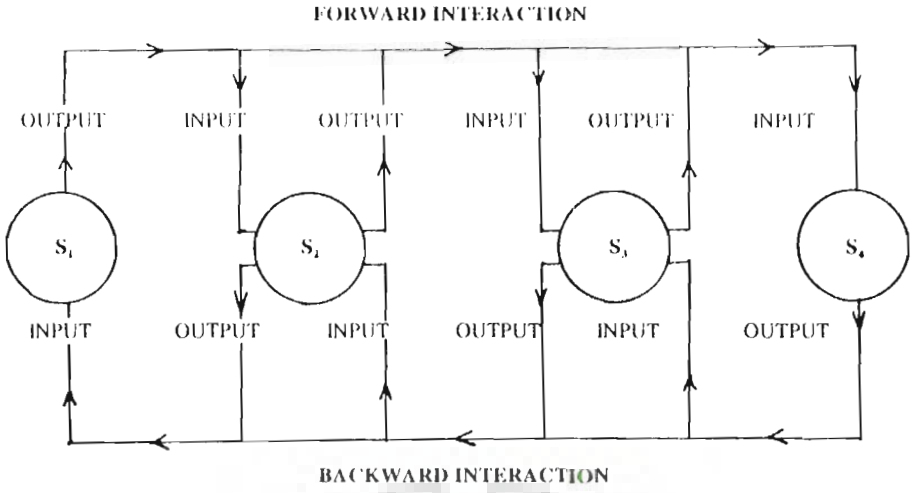


FIGURE 7.1.1 FORWARD AND BACKWARD INTERACTION BETWEEN SUSTENANCE REQUIREMENTS

The outputs of S_2, S_3 and S_4 also influence individually the activity of S_1; S_2 and S_1; S_3, S_2 and S_1 respectively in the reverse direction. This defines the backward interactions. This way the influence of a factor comes back to itself traversing through different paths. In such a representation there is no hierarchy and directly or indirectly the mutual casual relationships between hill systems is established, and systems dynamics is sustained over the time period through cyclical influences.

Corresponding to different values of the influence on each sustainability aspect, different states of the hill system at any point of time can be ascertained. The possibility of sustainable and unsustainable exchanges can be identified, and necessary action to modify those can be initiated to achieve sustainability. The approach is composed of a series of steps where meaningful and feasible trial solutions based onwell defined alternatives can be worked out until unless the proposed compromise is satisfactory. The dynamic framework of the model would thus helps identify the direction of impact each sustainability aspect receives while interacting with each other under the given environment. The understanding hence provided would help environmental management in which time delay between problem awareness, technological solutions and remedial action is minimised and the concept of sustainable development operationalized.

7.2.1 Mathematical formulation of the model

As discussed in detail in section 7.2, the various sustainability aspects of the proposed model can be represented by following equations.

(I) Landuse potential - sustainability aspect S_1

The landuse/physical environment sustainability with respect to the land suitability and land capability criteria is the one where total area of the watershed is sum of area under forests,area capable for cultivation (agriculture and horticulture), area under homestead, area under pastures, and area under unculturable waste.Such that

$$W_a = F_a + C_a + H_{sa} + P_a + U_{wa} \qquad (7.2.1)$$

where, W_a = area of the watershed expressed, ha

F_a = area under forests, ha

C_a = area capable for cultivation (agriculture and horticulture), ha

H_{sa} = area under homestead, ha

P_a = area under pastures, ha

U_{wa} = area under unculturable waste, ha

(II) Agricultural potential-Sustainability apect S_2

The potential of agriculture in the watershed is estimated by the total benefits gained in terms of crop production and livestock yield and is defined as

$$A_P = C_P + L_P \qquad (7.2.2)$$

where,

A_P = Potential of agriculture in the watershed, Rs

C_P = Potential of crop produce in the watershed, Rs

L_P = Potential of livestock output in the watershed, Rs

and expressed as,

$$C_p = \int_{c_1}^{c_n} l_c\, y_c\, P_c - \int_{c_1}^{c_n} (l\, f\, P_f + l\, s\, P_s)_c \qquad (7.2.3)$$

$$\text{and } L_p = \int_{a_1}^{a_n} \int_{y_1}^{y_n} y_a\, n_a \qquad (7.2.4)$$

The following notations are used to describe the sustainability aspect S_2

c	=	Crop type(1...n)
l_c	=	l_{th} land area under the C_{th} crop, ha
y_c	=	Yield of the C_{th} crop, kg/ha
P_c	=	Price of the C_{th} crop, Rs/kg
f	=	Fertilizer input both organic (f_o) and inorganic (f_i), kg/ha
P_f	=	Price of the fertilizer (N,P,K), Rs/kg
s	=	Seed input both local (S_l) and hybrid (S_h), kg/ha
P_s	=	Price of the seeds (local and hybrid), Rs/kg
P	=	Population in the watershed, equivalent adult consumption units
B_c	=	Per capita basic requirement of the C_{th} crop, kg per capita
c_k	=	Nutritive value of C_{th} crop, Calories/kg
a	=	Animal type (1...n)
y_a	=	Out put from the a_{th} animal
n_a	=	Numbers of a_{th} animal
P_{ak}	=	Price of the a_{th} animal produce, Rs/kg
B_a	=	Per capita basic requirement of a_{th} animal produce, kg per capita
Ca	=	Area capable for cultivation

a) For *food grain sustainability* the total production of the crops should be equal to or

more than the basic requirement of carbohydrates in terms of wheat, rice, millets taken together and the basic requirement of proteins in terms of pulses for a balanced diet and is given by

$$\int_{c_1}^{c_n} Y_c \, l_c \, c_k \geq P \int_{c_1}^{c_n} B_c \, c_k \qquad (7.2.5)$$

or

$$\int_{c_1}^{c_n} l_c \, y_c \, P_c - \int_{c_1}^{c_n} (l_f P_f + l_s P_s)_c \geq P \int_{c_1}^{c_n} B_c \, P_c \qquad (7.2.6)$$

subject to the conditions that total land under crops/cultivation should not exceed the land area capable for cultivation and also that the use of inorganic fertilizer should not exceed 50% of the total requirement of fertilizer

$$C_a \geq \int_{c_1}^{c_n} l_c \qquad (7.2.7)$$

and $$\int_{c_1}^{c_n} f_o \geq \int_{c_1}^{c_n} f_i \qquad (7.2.8)$$

b) For *sustainability of animal produce* the yield of livestock should be equal to or more than the basic requirement as given by

$$\int_{a_1}^{a_n} y_a n_a \geq P \int_{a_1}^{a_n} B_a \qquad (7.2.9)$$

or $$\int_{a_1}^{a_n} (y_a n_a) P_{ak} \geq P \int_{a_1}^{a_n} B_a P_{ak} \qquad (7.2.10)$$

Influence of Sustainability apect S_2

The output of Agricultural potential S_2 will influence the physical environment , biomass potential and career development potential as detailed below.

(i) Influence on landuse /physical environment (S_1)

The land under crops, the cropping mix practised etc. affect the soil fertility, erosion intensity and ultimately the landuse and the choice should be made based on land suitbility and capability criteria

(ii) Influence on biomass potential (S_3)

The agricultural produce defines the availability of crop residue which can be used as fodder and /or fuel. This availability is expressed as follows in terms of total digestible nutrient (TDN) and calorific value for fodder and fuel respectively.

$$Cr_a = \int_{c_1}^{c_n} Cr_{cl} (y_c l_c) \qquad (7.2.11)$$

and $$Cr_f = \int_{c_1}^{c_n} Cr_{cf} (y_c l_c) \qquad (7.2.12)$$

where,

Cr_a = crop residue available as fodder, kg TDN

Cr_f = crop residue available as fuel, kJ

Cr_{cl} = straw to grain ratio of C_{th} crop as fodder for the livestock

Cr_{cf} = straw to grain ratio of the C_{th} crop as fuel for energy use

y_c = yield of the C_{th} crop, kg/ha

l_c = land under C_{th} crop, ha

(iii) Influence on career development potential (S_4)

The agricultural potential influences the career development potential by way of income from and requirement of agricultural produce. The difference between the total revenue earned from agriculture and the amount required to meet the basic requirement of the agricultural produce defines the surplus or deficit in monetary terms. The surplus of agricultural produce defines an addition to the total household income while the deficit calls for an additional amount to be spent for meeting the requirement.

$$\int_{c_1}^{c_n} l_c\, y_c\, P_c - \int_{c_1}^{c_n} (l\, f\, P_f + l\, s\, P_s)_c \pm \text{surplus/deficit} = P \int_{c_1}^{c_n} B_c\, P_c \qquad (7.2.13a)$$

and $$\int_{a_1}^{a_n} (y_a\, n_a\, a_k)\, P_{ak} \pm \text{surplus/deficit} = P \int_{a_1}^{a_n} B_a\, P_{ak} \qquad (7.2.13b)$$

where, indices are as defined in Equation 7.2.6.

(III) Biomass potential - Sustainability apect S_3

The potential for biomass production in the watershed is related to sustainable yield of fodder and fuel wood as represented below.

$$BP = B_{P1} + B_{P2} \qquad (7.2.14)$$

where,

BP = potential for production of biomass as fodder and fuel

B_{P1} = potential for production of biomass as fodder

B_{P2} = potential for production of biomass as fuel

and B_{P1} and B_{P2} are given by

$$B_{P1} = Syf_L \int_{l_1}^{l_n} l_{th} + Cr_a \qquad (7.2.15)$$

$$B_{P2} = Syf_w \int_{l_1}^{l_n} l_{th} + Cr_f \qquad (7.2.16)$$

For sustainability

$$B_{P1} \geq \int_{a_1}^{a_n} (f_a t_a n_a) \qquad (7.2.17)$$

$$B_{P2} \geq \int_{c_1}^{c_n} (f_c P) \qquad (7.2.18)$$

subject to $$\int_{l_1}^{l_n} l_{th} \leq W_a \qquad (7.2.19)$$

The following notations have been used in the above equations.

Syf_L = sustainable yield of fodder for livestock expressed in kg/ha

l_{th} = land type area viz. forest, agricultural, homestead, horticultural etc., ha

Syf_w = sustainable yield of fuel wood, kg/ha

f_a = fodder intake by the a_{th} animal, kg/hour

t_a = time spent in grazing by the a_{th} animal, hours

a_{th} = animal type defined as cow, buffalo, bullock, sheep, goat, ponies etc.

n_a = numbers of a_{th} animal

f_c = fuel energy requirement per capita for different end uses as calorific equivalent, kJ

P = population in the watershed expressed as adult consumption unit

c = different end uses viz. cooking, lighting and heating

Influence of Sustainability apect S_3

The biomass potential S_3 influences the physical environment, agricultural potential and career development potential which is expressed below.

(i) Influence on physical environment (S_1)

As per the Government of India Planning Commission norms the forest cover should not drop below 60% of the area of the watershed which has been defined in the model as a constraint and is given by:

$$F_a \geq 0.6\, W_a \qquad (7.2.20)$$

where, F_a = area under forests in the watershed, ha

W_a = area of the watershed, ha

(ii) Influence on agriculture potential (S_2)

Sustainable yield of biomass limits the number of livestock that can sustain in the watershed and is defined as

$$\frac{Syf_L \int_{l_1}^{l_n} l_{th} + Cr_a}{\bar{f}_a} = \text{sustainable cattle head units(c.h.u.)} \qquad (7.2.21)$$

where, Syf_L = sustainable yield of fodder, TDN/ha per annum

l_{th} = land type in hectares, ha

Cr_a = crop residue from farm land as fodder, TDN per annum

f_a^- = average fodder intake per cattle head, TDN per annum

The output of the livestock is directly proportional to their numbers. The change in livestock numbers subject to the availability of fodder would influence their output in the watershed. Livestock output is available in the form of draught power, milk, meat, dung manure , wool etc. For sustainability there is a need to calculate trade off between the different animal types to arrive at sustainable livestock numbers and the required animal output(s)

(iii) Influence on career development potential (S_4)

The biomass system influences the career development potential in terms of its availability or shortage in monetary terms. The economic estimation of the surplus and deficit would be defined by the alternatives selected for meeting the shortfall while surplus of biomass would not benefit the households by way of income. The following equations can be given an economic expression.

$$B_{P1} \pm \text{surplus/deficit} = \int_{a_1}^{a_n} f_a t_a n_a \qquad (7.2.22a)$$

and

$$B_{P2} \pm \text{surplus/deficit} = \int_{e_1}^{e_2} f_e P \qquad (7.2.22b)$$

where, notations are as defined for Eqs. (7.2.17) and (7.2.18).

The surplus and deficit thus defined has an influence on career development potential.

(IV) Career development potential - Sustainability apect S_4

Equations (7.2.13 a, b) and (7.2.22 a, b) along with income from other sources define the surplus and shortfall in economic terms which befalls any household. The gap between income and expenditure per house hold would be given by

[total earnings per HH from agriculture and other sources]	minus	[income required per HH to meet the basic requirements]	(7.2.23)

For sustainability considering the needs and aspirations of the local people the total earnings per household should be equal to the median income of an average Indian household given by :

Total earnings per household per annum	≥	Median income per annum of an average Indian household	(7.2.24)

For income generation, required are various career development options and their selection has to be subject to sustainability criteria. Steps involved for selection of career development avenues are:

a) Categorize the deficit per landholding category so as to suggest alternatives suited to each class, with respect to their human resource potential.

b) Identify the influence of each alternative on other ssustainability aspects.

c) Select options based on their resultant impact in socio-cultural, economic and environmental terms viz.

   (i) Impact in socio-cultural terms include impact on human health, social pattern and lifestyle, psychological, personal security, religion and traditional beliefs, economic and occupational status, aesthetics etc.

   (ii) Impact in economic terms imply economic estimation stating the significance for the economy.

   (iii) Impact in environmental terms include impacts on climate, water quality, landuse, etc. and these can be quantified in monetary units such that

$$E = C_m + D_r \quad (7.2.25)$$

where,

E = cost of overcoming environmental stress, Rs

C_m = cost of nature-protection measures, Rs

D_r = residual damage, Rs

For sustainability

$$B/E > 1 \quad (7.2.26)$$

where,

B = benefits in economic terms, Rs

Equations 7.2.1 through 7.2.26 provide comprehensive functional relationships between the variables of land transformation process and the physical environment. This integrated framework aims at land use control integrating the conflicting sustenance requirements of agriculture, biomass and career development sustainability. This framework developed is the model for SDPH of Garhwal and is abbreviated as **Luc in ABCds**, i.e. model for **L**and use control **In**tegrating **A**griculture, **B**iomass and **C**areer development sustainability. The framework can be used as a means of sensitivity analysis on a range of policies i.e. as a means of testing how much the policies may be varied without deviating significantly from the desired goal of SDPH. The application of the model has been illustrated by use of computers (Microsoft Excel Software).The use of modern computing facilities would however solve the model equations from 7.2.1 through 7.2.26 simultaneously and generate various scenarios depending upon the set goal.

7.3 SALIENT FEATURES OF THE MODEL

1. The model has been derived on a consultative process and involves all priority issues whose incorporation is required for both implementation and maintenance.
2. The coherent and strategic framework encourages greater sharing of decision making by ordinary people and focuses on decision making process which enables the various disciplines dealing with physical planning / built environment to understand how management decisions / policy measures influence the

sustenance requirements.

3. The constraints defined in the model help analyse the scarce and exploited resources , and, evaluate the extent of demand reduction and supply management needed to promote sustainable development.

4. The model is flexible and can readily be extended to integrate the socio-economic issues such as education, health, drinking water etc

CHAPTER VIII

MODEL APPLICATION FOR SCIENTIFIC AREA DEVELOPMENT PLAN

8.0 GENERAL

For any development process to be sustainable careful consideration needs to be given to all the aspects of development,particularly the following:

- the population of the area and its ultimate holding capacity,
- whether the area can take any further load, if not what is to be done, and
- what will be the effects and benefits of development on the people.

This is important as improper use of land may lead to deterioration of the environment and dislocation of indigenous population.

The proposed model considers these aspects with respect to key issues prevailing in the Garhwal hills and helps suggest alternative management measures and strategies. While the policy options address the issue of sustainable development, the model provides a valuable tool for exploring the implications of these management strategies under alternative assumptions. This chapter illustrates the application of the model so as to arrive at a scientific development plan for the area.

8.1 MODEL APPLICATION FOR PREPRATION OF A SCIENTIFIC DEVELOPMENT PLAN

The application of the model has been illustrated in this section first to arrive at a planning and development strategy based on 'business as usual' scenario and it is then applied for exploring the implications of a selected set of policy options. The analysis details out a set of developmental activities at the micro level so that the interventions can be systematic. The model has been simulated using the Microsoft Excel Software. The input data is as given in Annexure 'B' and the scenario results in Table 8.1.1

8.1.1 SCENARIO-I

Analysis of business as usual (BAU) situation

Under the `BAU Policy –Scenario I, the model reveals that within the existing landuse parameters the problem areas are food, fodder, fuel and finances involving economic activities suited to the area. There is pressure on the area to sustain the ever increasing human and livestock population. The cultivation is at a subsistence level with marginal farmers being the worst affected. The shortfall in monetary terms to meet the basic requirement of food grains of the marginal farmers is Rs. 17,41,605. Subsequent to low agricultural produce the crop residue as fodder is negligible with cattle mainly dependent on forest lands. Scenario results reveal that the sustainable livestock is almost half the existing cattle head units in the watershed, while the livestock output as dung manure is in excess of the required quantity of N:P:K. the output as milk is minuscule compared to the cattle reared. This suggests an alternative to reduce the local cattle population by introducing crossbred variety. Small number of better breed cattle would not only provide better returns but would also reduce the total fodder consumption.

Alternative sources of energy are absent in the area and so the pressure on forests is enormous. Considering the entire forest land as being exploited by the people there is an excess of sustainable yield, but in practice households collect fuel wood from adjoining forest lands, within 3-4 kms range. Pine forests fall under the range and the analysis considering only the pine forests reveals very high pressure on them. Alternatives therefore to reduce the use of fuel wood need to be incorporated to prevent degradation of forest land . The total shortfall of finances in case of marginal farmers amounts to Rs14,000/HH/per annum in order to provide for food, fodder and fuel. This is worked out on the basis of (a) food grains being purchased from the open market, (b) consideration of sustainable livestock to avoid purchase of cattle feed which would otherwise put pressure on finances, and (c) use of fuelwood for cooking purposes.

Most of the income of the local people comes from production of cash crops grown in forests which is an unsustainable practice and if such incomes are excluded there is a severe impact on their net income and thereby their financial standing. All this, coupled with the high level of under employment and the lack of off-farm employment opportunities, suggests

advancement towards an unsustainable path. The gap between the supply and demand of food, fodder, fuel and finances (4F), implies over exploitation of forests and marginal lands, ultimately leading to environmental degradation. In order to mitigate the pressure on resource base it is necessary to realize a high level of growth in real income with mainly increasing the employment opportunities.Alternatively joint policy options for supply and demand management need to be promoted.

8.1.1.1 *PROBABLE POLICY OPTIONS*

Based on the model results (Scenario 1) and the situation analysis a broad planning and development strategy that emerges for SD of the Garhwal hills is the need for joint policy measures for supply management and demand management. These include

I) **Supply management measures**

a) For Agricultural Sustainability

to increase the area under cultivation

to increase the productivity of food grains through either

- irrigation
- use of inorganic fertilizers
- high yielding variety seeds
- or, a combination of all these

to optimize the cropping pattern

b) For Biomass Sustainability

to increase the area under forests and grasslands

to increase productivity of biomass by varying species for fodder and timber

c) For Career development Sustainability

to suggest career development alternatives which are

- complimentary to the human resource potential
- complimentary to the natural resource potential
- proportionate to the income consumption inequality

all subject to sustainability criteria

II) Demand management measures

a) For Agricultural Sustainability

to supplement the requirement of food grains through purchase

to consider population stablization

b) For Biomass Sustainability

to suggest alternatives for fuel wood / energy

to suggest livestock numbers complimentary to the biomass production through

- promotion of crossbred cattle
- promotion of cattle feed substitute

c) For Career development Sustainability

Alternative career development options as in table 6.4.1

8.1.2 SCENARIO II

Supply management and demand management measures

For SD the efforts of the priority sectors are integrated and emphasis is thereby laid on joint policy options for supply management and demand management. The model is simulated for situation where (i) the population of the area remains the same, (ii) area (as per GIS analysis) under cultivation cannot be increased while prevention of soil erosion and treatment works for the same area are considered through vegetative measures and stone construction, in a limited way to bring land under cultivation to proper use. Improvement in agriculture is possible mainly through irrigation as HYV seeds and use of inorganic fertilizers yield better results only in irrigated land, (iii) considering the present scenario of income generation and high costs involved in purchase of cattle feed, reduction in cattle population has been considered , (iv) consideration has been given to the SHP(small hydro project) potential in the area besides promoting use of LPG (liquidified petroleum gas) cylinders to reduce the pressure on forests, and (v) economic activities are manned and managed by the local people and do not require large number of trained manpower from outside.

8.1.2.1 *Scenario Results*

I) Promotion of SHP

The area has 450 kW power generation capacity and about 250 kW i.e. 5 x 50 kW small hydro projects (SHP) are proposed to be made functional.This results in a changed landscape of the area and also works as a catalyst for various socio-economic activities.

i) Impact on socio-economic aspects:

The SHP would generate about 26.55 x 10^6 MJ of electricity. This would provide a connected load of 500 W per household in the watershed. Assuming the supply from 8 AM to 10 AM and 6 PM to 10 PM i.e. for 6 hours/day/HH and the electricity consumption @ of sanctioned load of 500 W the financial burden per household amounts to

$$\frac{500\ W \times 6\ hrs \times Rs.\ 2/kWh \times 30\ days}{1000}$$

= Rs. 180/- per month

The benefits gained are the reduction in use of fuel wood for cooking to the extent of 2.35 x 10^6 MJ, considering the energy use pattern based on their needs as

a) for illumination using high lumen low watt bulbs/tubes say @ 14 W x 5=70 W

b) for Television @ 60 W x 1 = 60 W

c) for cooking/heating @ 250 W

d) for miscellaneous works @ 120 W

The remaining shortfall of energy can be met through supply of LPG cylinders, 5 kg/cylinder @Rs.55/-.

The electricity supply during the day can be used for running select industries which would add to income generation say to the tune of Rs. 20 lakhs per annum.The SHPs would also help promote pisiculture and employment.

ii) Impact on Agriculture: Promotion of SHP is estimated to provide water for irrigation using the `hydram' technology (conveying water under pressure through pipes to higher elevations) for irrigating a total of about 30 hectares of land around the SHP sites. The results reveal an increase

of nearly 4 percent in the agricultural produce over the BAU potential.

iii) Impact on Biomass: As a result of promoting SHPs the pressure on biomass as fuelwood is reduced to the extent of 2.35x 10^6 MJ considering the present energy use pattern.Increase in agricultural produce as a consequence of SHPs has also resulted in an increase in crop residue (as fodder) by 3% .

iv) Impact on Career development:Promotion of SHPs generates employment in the area and thereby reduces the income required through other career development options.

ii) Promotion of Crossbred cattle:

The model considers reducing the total cattle heads wherein every two cows/ buffaloes are replaced by one each of crossbred variety. Consequently there is reduction in the unsustainable livestock numbers. The output as manure has reduced causing a shortage of about 15% of the standard quantity required. However as studies reveal that a combination of organic and inorganic fertilizers improves the crop productivity, the option is considered viable. While the expenses for commercial fertilizers increase, there is an increase in agricultural produce and milk produc in the same proportion. The excess milk produce used for promoting dairy products are to be sold off to the dairy cooperative which is operational in the vicinity of the watershed.This option provides a balancing effect to the economy of the area.

Other policy options can similarly be simulated to see their net effect on SDPH. The options can then be reviewed accordingly.

8.2 CONCLUSIONS

The values generated by the model in Scenaio -I and those observed have no disparity.The analysis clearly signifies excess population and livestock pressure considering the state of environment. It is also seen that single policy measure is not a viable option and a combination of demand and supply management measures as in Scenario-II have a more sustainable impact. It is necessary to realize a high level growth in real income. The model can also help evaluate at what level of income per household SD is likely to occur. Table 8.1.1 gives an example of the validity of the model LUC in ABCds. In order to match development interventions to the

imperitives of specific mountain conditions the recommended measures would vary. A number of alternatives are feasible to arrive at desired results. The model helps identify the gaps in the development approach and thus involve a reiterative process of making and revising the focus on key issues considering the constraints and opportunities characterizing the development area.The model can further be simulated for alternative career development options to arrive at sustainable solutions.

With the present day computing techniques the model results can be generated simultaneously for a set of policy options. This programming however is not under the purview of present study.

S. No	PARAM-ETERS EVALUATED	UNITS	SCENARIO I				SCENARIO II	
			Marginal Farmers	Small farmers	Medium farmers	Large farmers	Results	Remarks
1a)	Agriculture Potential	Rs.	78,400	565,014	537,672	16,828	1979,156	Agricultural potential increased as irrigated land increases with introduction of SHP and use of fertilizer possible.
b)	Shortfall (+)/surplus (-)	Rs.	+1741,605	+98,049	+83,839	-9,955	+1838,695	
2a)	Fodder potential							Increased crop residue with increased agricultural produce.
	* Crop residue	Q-TDN	1196.60	883.76	931.09	29.64	3141.76	
	*Forest produce	Q-TDN	16587.6				16587.6	
b)	Dependence on forest	Q-TDN	8393.77	12046.36	18249.66	14.64	7586.3	
c)	Shortfall(+)/ surplus (-)	Q-TDN	+2,2073				+9001	Cow/buffalo population reduced to half by introducing crossbred cattle.
d)	Unsustainable Livestock	Cattle head units	4,837				1972	
e)	Shortfall (+)/Surplus(-) in livestock output							Remaining fertilizer requirement to be met by inorganic fertilizer in Scenario II while milk produce increased with introduction of crossbred variety cattle.
	* Manure	kg/ha	-2,500	-200	-100	+300	1062(75:20:10)	
	* Milk	kg	+118,041	+23,957	+39,300	+438	-6,33,454	
f)	Shortfall(+)/ surplus(-)	Rs.	+110,410	+247,580	+58,900	+6180	-62,80,205	Higher yield of milk from crossbred cattle

TABLE 8.1.1 SCENARIO RESULTS (continuid)

3a)	Fuel wood potential	Coal replacement value in MJ	Total forest=58.16 x 10^6 ; Pine forest=16.18 x 10^6				16.18 x 10^6	
b)	Alternate energy available	MJ	-	-	-	-	26.55x10^6	Small hydro project of 5 x 50 kW capacity
c)	Energy requirement for HHs	MJ	24.93x10^6	7.55x10^6	7.28 x 10^6	0.74 x 10^6	39.84x10^6	Considering energy for cooking and illumination
d)	Shortfall (+)/surplus (-) for HH use	MJ	Total forest = 18.32 x 10^6; Pine forest =+23.66 x 10^6				+20.84x10^6	Considering electricity is used only for 6 hrs with connected load of 500 W/HH
e)	Shortfall (+)/surplus(-) per HH	Rs.	+8068	+8678	+12338	+7400	+1436.400	Considering the electricity charges and expenditure on LPG cylinders.
4.	Income generated per HH		-	-	-	-22900	820.205	Small scale industries run, pisciculture practised and water mills run.
5.	Income required per HH	Rs.	+14004	+10255	+14359	+2680	-	Resultant income from SHP is more than expenditure per HH.
6.	Shortfall (+)/surplus(-) per HH							
a)	<Rs.18000 category [A]	Rs.	+6004	+255	-	-	+400	Since few HH are still below the poverty line, income alternatives for them needs to be thought of.
b)	>Rs.18000 category [B]	Rs.	-19996	-29745	-35641	-41820	-16600	Households with improved incomes.
7.	Shortfall(+)/surplus(-) excluding income from cash crops	Rs.	+8964	+4755	-		-	Cash crops not grown.

CHAPTER IX

CONCLUSIONS AND RECOMMENDATIONS

9.0 PREAMBLE

Hill areas in India have fragile eco-system and physical development over space to satisfy human needs has been largely responsible for building up crisis as regards sustainable management of resources. The challenge faced by planners is not just to accelerate the economic development alone but with it, maintaining the essential integrity of earth's ecological system. The conventional planning models, for plains are based on a steady state and determine demand- supply balance without internalizing the environmental parameters, and therefore it is realized that these models cannot be applied to hills.On the other hand,the regional and area level plans for hills which are a recent development, identify broad development issues and imperatives in terms of environmental sensitivity without addressing to the effective instruments of plan implementation at micro level.

9.1 CONCLUSIONS

Considering the significance of hill area development the study has focused on formulating a planning model for SD of Garhwal hill region in the newly formed state of Uttaranchal. Uttarkashi district in Garhwal region has been taken as case study. Recognising the need of effective instruments for implementation of plans at the micro level a watershed (Khurmola Gad) representative of the case study area has been selected for conducting an indepth study of the micro level hill system. The research has been aimed at (i) evolving a theoretical framework for working out plans for hills keeping the socio-economic and ecological parameters in view, and (ii) constructing a planning model for SD in Garhwal hills..

9.1.1 HILL SPECIFIC

i) The study concludes that holistic programmes and land policies are needed so that the ultimate goal of sustainable development is achieved.This is based on the fact that complex interdependencies and interlinkages between various systems pose the basic challenge in planning for hill areas.

ii) For achieving sustainability, linkages between the different sectors need to be studied systematically and therefore the concept of carrying capacity is identified.

iii) With due regard to the dynamics of natural processes, elements that should underlie the synthesis of a suitable approach have been identified, and the need for an interactive, multi-dimensional, dynamic and open ended systems approach recommended.

iv) For arriving at an integrated framework for judging the alternative policy options, parameters that help assess carrying capacity (CC) have been defined. The parameters identified are i) the indicators of the environmental status, ii) the indicators of level of development of various manmade systems iii) the expected growth indicators, and iv) the development potential indicators.These parameters are useful in determining causes of unsustainability.

v) Various steps are identified for a coherent assessment and systematic management process at the micro level.This includes assessment of existing functions and their carrying capacity, identification of key factors and decision variables affecting sustainability, functional relationship between variables, and analysis of solutions for arriving at desired goal.

9.1.2 AREA SPECIFIC

An empirical analysis of the problem to define a model planning process for Garhwal hills

has been carried out. Survey research methods have been applied for acquiring a comprehensive information about various physical, socio-economic and other factors concerning development. An extensive household level survey was conducted using survey schedules (questionnaires) so as to identify the various control parameters and their functions with respect to sustainability. The data was then fed into the computer and processed using the SPSS (Statistical Package for Social Scientists) software. The natural resource base information based on Landsat imagery has been analysed by making use of the GIS (Geographical Information Systems). The analysis reveals:

i) The requirement of 4 F i.e. food, fodder and fuel on the one hand and the financial standing of the people on the other are the basic elements causing unsustainability in the area. While carrying capacity of the area provides limits to the availability of these basic resources, the absence of income generating/career development avenues result in poor and inefficient management of natural resources leading to ecological crisis in the area. The apparent conflict in the area is between the three principal components i) ecological issues, ii) fulfilment of basic needs of local people viz, food, fodder and fuel, and iii) economic issues such as lack of off-farm employment and total dependence on primary sector with cash crops grown in forest lands which is an unsustainable practice. The basic needs and the economic support systems of the people are thus the primary issues. Agriculture, Biomass, Career development (ABCd) are identified as key factors or the indicators of sustainability addressing the problems of 4F's.

ii) Based on the study for the region potentials, problems, opportunities and threats with respect to the key factors ABCd are outlined. This reveals that the three are inextricably linked and sustenance of hill system depends on the performance of the individual systems taken together with due consideration for the physical environment. This also lead to identifying the decision variables affecting each key factor. In order to control the irrational use of land sustainable solutions for agriculture, biomass and career

development has been suggested. For sustainability the solutions for agriculture, biomass and career development need to be consistent with the resource potential and ecological framework of the area. A functional relationship between the variables of land transformation process and the physical environment has been established for modelling an integrative framework for choosing consistent compromise solutions causing minimum damage to the environment.

iii) Finally, to address the problems of 4Fs and to avoid the negative impact on landuse an integrative model "Land use control Integrating 'Agriculture', 'Biomass' and 'Career development' sustainability (Luc In ABCds) has been proposed as a tool for progression towards SD. The model has been derived on a consultative process and helps gauge the distributive impacts of policy measures thereby identifying plausible solutions.

9.1.3 MODEL SPECIFIC

i) The coherent and strategic framework of the model encourages greater sharing of decision making by ordinary people and focuses on decision making process which enables the various disciplines dealing with physical planning / built environment to understand how management decisions / policy measures influence the sustenance requirements.

ii) The constraints defined in the model help analyse the scarce and exploited sources, and, evaluates the extent of demand reduction and supply management needed to promote sustainable development.

9.2 RECOMMENDATIONS

The proposed integrative model helps indicate gaps in prevailing development approaches and serves as a tool for designing development interventions in mountain areas. In order to promote wider application over time and space the following

aspects need to be given priority.

i) **Model review and monitoring:**

Integrative model requires evaluating the priorities for implementation, regular assessment and testing the achievement of objectives.The complexity of development processes demand a constant update of the responses to the changes initiated in any of the inputs and necessiates redefining goals and redesigning specific strategies and tactics.Studies, therfore, need be carried out and model updated from time to time incorporating renewed understanding about the hill system.

ii) **Developing Survey and documentation capabilities:**

In view of the complexity of mountain environment updating the recommended measures and policies to suit the then prevailing conditions is essential. For ensuring effective implementation of the model, a system of developing a database involving systematic and periodical evaluation of the sustainability aspects needs to be evolved. Updating of geophysical characteristics, landuse pattern and socio-economic parameters through GIS would serve as a potent and useful tool to develop survey and documentation capabilities. The infrastructural facilities and capacity building for survey, data collection, processing,utilisation, monitoring and evaluation would develop a techno-economic basis for future project planning.

iii) **Institutionalizing the planning process:**

This can be enabled only when a free flow of information and knowledge exists between the several stake holders. The critical linkages are at the level of local communities,institutions and professionals.The planning departments have to be involved in organizing periodic meetings at different levels and one-to-one exchange with different elected members in order to identify the priorities of the local people.Members of the block panchayat (local governing body), NGOs working in specific fields in specific locations and other key persons shall be instrumental in proposing specific activities in

selected areas.In order to integrate various ongoing development programmes and to find a common ground leading to area development the inputs required include:

a) Need for NGOs and other voluntary organisations to fill the gap between human resources development and training needs:

There is a general lack of basic understanding by project implementing agencies at various levels about the project concepts, programme measures and overall strategies for sustainable development. With a view to find plausible solution to various issues concerning knowledge gaps and the larger question of human resource development, there is a need to conduct comprehensive training courses of grass root level project functionaries especially those of NGOs and voluntary organisations operating in the area. These trained personnel would act as link resource persons for the purpose of generating a better spirit of understanding and coordination between not only implementing project staff at the watershed level and project authorities at higher levels but would also get good quality output and reach the target group.

b) Operation and Management through people's participation:

Local people have cumulative wisdom, skills and knowledge of the production environment encompassing land, water, vegetation etc. There is a need for all actors viz, government, non-governmental organisation and water shed communities to join hands with the object of enabling the local communities to organise themselves and develop self help culture. Since voluntary agencies are well poised in approaching the people and motivating them, they can contribute substantially by organising them into self help groups (SHGs) . The SHGs can then render needed assistance and guidance in promoting traditional knowhow, management of common property resources where people manage resources not only as common property but also as common responsibility for deriving common benefits. Active participation of such groups would accelerate the pace of implementation of sustainable development.

c) Constitution of a multi-disciplinary team:

Under each of the key factors affecting sustainability are a number of conceptual and technical issues which need to be developed to elaborate and resolve them. Specific efforts must be made for constitution of a multi disciplinary team to harness, in a planned manner, the objective of sustainability.

9.3 The area under study is part of a newly formed state Uttaranchal which is still a developing one. The investigator is of the view that if the proposed model is implemented from the outset then SD can be anticipated in the region. Various kinds of relationships emanating as development proceeds can also be approriately dealt with using the defined framework.

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ANNEXURE A

HOUSEHOLD SCHEDULE

Name of the Village .....:..... Name of Gram Sabha .....
Whether electrified ..... Household No. .....

1.0	Name of the head of family	.....	4.1	Men who can read and write (Nos.)	.....
2.0	Family size	.....	4.2	Women who can read and write (Nos.)	.....
3.0	Total persons residing permanently	.....	4.3	Graduates (Nos.)	.....
3.1	Population Men (above 15 years)	.....	4.4	Post graduates (Nos.)	.....
3.2	Population Women (above 15 years)	.....	4.5	Technical (Nos.)	.....
3.3	Population Children (below 15 years)	.....	4.6	Medical (Nos.)	.....
4.0	Number of School going children	.....	5.0	Primary occupation of the family	.....
			5.1	Secondary occupation of the family	.....

LAND HOLDING SIZE AND UTILIZATION PATTERN

A.	LAND HOLDING DETAILS		B.	LAND USE DETAILS	
				Total area of land use under	
1	Total area owned	.....	1.	Homestead	.....
2.	Total area under cultivation	.....	2.	Agriculture	.....
3.	Total area leased in	.....	3.	Forest	.....
4.	Total area leased out	.....	4.	Horticulture	.....
			5.	Grazing	.....
			6.	Unused (reason)	.....
			7.	Cattleshed	.....
			8.	Others	

SOURCES AND MODES OF IRRIGATION

S. No.	Sources of irrigation	Total area served (ha)	Number of land holdings
1	Canal		
2.	River		
3.	Pond		
4.	Rainfed		
5.	Open well		
6.	Tube well		

S. No.		Mode of irrigation	Seasons		
			Kharif (ha)	Rabi (ha)	Summer (ha)
1.		Direct flow			
2	lift irrigation	by manual power			
		by animal power			
		Diesel energy			
		Electricity			

AGRICULTURE INPUT

S. No.	Type of Crop	Seeds kg/ha	Human Labour Nos/ha	Animal Labour Nos/ha	Pesticides		Leaf Litter kg/ha	Dung (farm) kg/ha	FERTILISER					
					Powder kg/ha	Liquid lt/ha			Commercial Organic, kg/ha			Inorganic, kg/ha		
									N	P	K	N	P	K
Kharif														
1														
2														
3														
Rabi														
1														
2														
3														
Summer														
1														
2														
3														

CROPPING PATTERN

S No	Crops in Kharif season					Crops in Rabi season					Crops in summer				
	Name of the crop	variety Local/ Hybrid	Area in hactare			Name of the crop	Variety Local/ Hybrid	Area in hectare			Name of the crop	Variety Local/ Hybrid	Area in hectare		
			Irrig ated	Rain fed	Total			Irrigated	Rain fed	Total			Irrigated	Rainfed	Total
1															
2															
3															

AGRICULTURAL OUTPUT

Crop Name	Kharif From.. .. to					Rabi From..... to					Summer From..... .. to.. . ..				
	Total area sown (ha)	Average yield, quintal/ha		Price Rs/ Quintal		Total area sown (ha)	Average yield, quintal/ha		Price Rs/ quintal		Total area sown (ha)	Average yield, quintal/ha		Price Rs/ quintal	
		M	B	M	B		M	B	M	B		M	B	M	B

Note: M : main produce; B : By product

PLANTATION CROP OUTPUT

S. No.	Area under plantation	Type of Plantation	MAJOR PRODUCE			By product		
			Produce (Quintal)	Price Rs/ quintal	Value Rs	Produce (quintal)	Price Rs/ quintal	Value Rs
1								
2								
3								

LIVESTOCK STATITICS

S No	Type of Animal	Nos.	Age		Stall fed	Grazing	Usage			Fodder consumed daily animal for stall fed animals		Grazing		production per month		
			Heifer	Adult			Animal labour	Meat	Milking	Paddy	wheat straw	time spent in grazing (hrs)	grazing area (ha)	dung (kg)	Milk (kg)	meat (kg)

BIOMASS COLLECTION

S. No.	Type	Source	Distance of house from source (m)	Total quantity (quintal per annum)	Usages			
					Construction	Agricult-ural implements	Sale	Any other

FOREST OUTPUT

S.No.	Type of output	Quantity (quintal/ month)	Price Rs/ quintal	Value in Rs
1.	Timber			
2.	Fuel wood			
3.	Twigs			
4.	Resin			
5.	FYM			

DOMESTIC ENERGY CONSUMPTION

	Fuel Type and unit	Cooking			Water heating			Space heating			Lighting			Total		
		S	W	M	S	W	M	S	W	M	S	W	M	S	W	M
1	Dung cake, Nos./day															
2.	Firewood: (logs),															
3.	Firewood:															
4.	Crop residue, kg/day															
5.	Soft coke, kg/day															
6.	Kerosene, lit/day															
7.	Electricity, kWh/hay															
8.	L.P.G.,															
9.	Other															

Note: **S = summer, W = winter, M = monsoon**

1. Weight of LPG cylinder in kg....
2. Monthly bill of electricity for domestic purpose during:
   Summer Rs.....Winter Rs.....Monsoon Rs.....
3. Monthly kerosene consumption during:
   Summer Lt.....Winter Lt.....Monsoon Lt.....

INCOME , EXPENDITURE AND SAVINGS
(Rs per annum)

A. Source of Income	
1. Agriculture	
2. Livestock	
3. Service	
4. Business	
5. Rent	
6. Intrest	
B. Expentiture	
1. Household	
* Food	* Elecrticity
* Health	* Fuel wood
* Education	* LPG
* Clothing	* Kerosene
* Essentials	
2 Recreation	
3 Agriculture	
4 Livestock	
5 Transport	
C. Savings	
1. Banks	
2 Chitfunds	
3. GIC/LIC	

FOOD CONSUMPTION PER HOUSEHOLD

S No	Item	Quantity
1	Rice	
2	Wheat	
3	Maize	
4	Others	
5.	Masoor	
6	Pea	
7	Soyabean	
8	Potato	
9	Ramdana	
10	Madua	
11	Toria	
12	Tobacco	
13	Oil seeds	
	Sarso	
	Til	
14	Others	

ASSETS

S. No.	Assets	Value, Rs
1	House	
2.	Livestock	
3	Land	
4.	Household appliances & Gadgets	
Cooking		
	Gas stove	
	Heater	
	Pressure cooker	
Farm		
	Tractor	
	Tharasher	
	Others	
Others		
	Fan	
	TV	
	Cycles/scooters	
	Jeep/Bus/truck	

ANNEXURE B

I. INPUT DATA CATEGORY WISE

PARAMETER	CATEGORY WISE DESCRIPTION			
	Marginal farmers	Small farmers	Medium farmers	Large Farmers
* Population (P)	1992	602	590	6
* Households	309	87	59	1
* Family size	6 5	7	10	6
* Cultivable Land (l)	104	89	109 05	5
Irrigated Land (ha)	24 8	18.73	5 91	0 346
Unirrigated land (ha)	79 2	70.27	103.14	4 654
* Land distribution under different crops and commercial fertilizer use [N P K (kg ha)]				
Wheat total area	46 59	29 11	31 30	1 09
Irrigated area	24 8[0]	18 73 [10:10.0]	5 91 [25 25 0]	0.346 [50 50 0]
Paddy total area	53 91	45 08	36 34	1 45
Irrigated area	24 8[0]	18.73 [10:10:0]	5 91 [25 25:0]	0 346[50 50 0]
-Madua	30 78	26.31	34.23	1.50
- Sawan	9 33	5.37	14.39	0 10
Organic fertilizers used [N:P:K (kg/ha)]	4500 [315:45.22]	1800 [126:18:9]	1600 [112 16.8]	600 [42:6:3]
* Livestock (cattlehead units)	2102	2834	4204	12
* Food grain consumption ratio	1/3 wheat, 1/3 rice 1/3 millets	-do-	-do-	-do-
Average expenditure per HH on non-food items	Rs 300	Rs. 450	Rs 600	Rs 1000
* Energy requirement /HH	* 2 Flourscent tubes 20 W each illuminating five hours a day and 365 days a year * 3 5 kg/capita/day of fuel wood for cooking and heating			

II. PHYSICAL ENVIRONMENT SECTOR INPUTS

NOTATION	PARAMETER	DESCRIPTION (ha)
W_a	= area of the watershed expressed in hectares	4751.9
F_a	= area under forests (Oak forest & pine forest)	1641.6+2216
H_a	=area under horticulture*	
C_a	=area under cultivation	312.05
H_{sa}	=area under homestead	317.95
P_a	= area under pastures	-
U_{Wa}	=area under unculturable waste	264.3

* Area under horticulture is negligible.

III. INPUT DATA AGRICULTURE SECTOR

NOTATION	PARAMETERS	DESCRIPTION PER CROP			
c	Crop type	Wheat	Paddy	Madua	Sawan
l_c =	lth type land area under the Cth crop in hectares Total	108.0	136 78	92.82	29.19
	irrigated land	49.786	49.786	-	-
y_c =	Yield of the Cth crop in hectare in the land type * Irrigated land * Unirrigated land	15.86 13.21	15.25 12 70	10.12 8 44	15.67 13 6
	Food grain with loss factor as	15%	40%	15%	40%
P_c =	Price of theC th crop in rupees per kg	Rs 7	Rs 6	Rs.4	Rs.3
f_s =	Standard fertilizer requirement of N:P:K in kg per hectare *irrigated land *Unirrigated land	120 60:40 60 30:20	120 60.40 60:30:20	- 40:20:13	- 60:30.20
f_o =	Fertilizer input organic expressed as kg/ha	170:25:50	190:25:50	130:20.40	120:20:40
f_i =	Fertilizer input inorganic in kg/ha	15.8 14 9 0	15 4:15.6 0	2..34 1.7:0	1 3:1 2 0
p_f =	Price of the fertilizer (N,P,K) in Rupees/kg (Pottash not used)	N= Rs.4 DAP=Rs 8 50	-do-	-do-	-do-
s =	Seed input both local and hybrid expressed as kg/ha	100	100	20	40
P_s =	Price of the seeds (local and hybrid)expressed in rupees/kg	Local seed not bought from market Hybrid seed for wheat Rs 10/- per kg	Local seed not bought from the market Hybrid seed for paddy Rs. 20/- per kg.	Local seed used	Local seed used
B_c =	Basic requirement of food grains expressed as kg per capita	190 9 in total	-	-	-
Cr_{cf} =	Straw to grain ratio of Cth crop as fodder for the livestock	1 43	1.47	1.19	1 27
	Fodder yields rate expressed in Q-TDN	0 48	0 41	0.60	0 60
Cr_{cf} =	Straw to grain ratio of the Cth crop as fuel for energy use	-	-	-	-
a =	animal type	Bullock	Cow	Buffalo	Goat and Sheep
y_a	Yield type from the ath animal (average)	Bullock pair/HH	0 5 lit per animal	1.0 lit. per animal	0.5 kg/fibre meat 0.5 kg wool
n_a	Numbers of ath animal	832	876	613	111 & 116
P_{ch}	Price of the ath animal output in Rs./unit	Rs 800/-	Rs 8/-	Rs 12/-	Rs 200 and Rs 500
D	Dung produced for use as manure per cattle head in kgs.	8	8	12	-
B_a	Basic requirement of milk expressed as kg/capita	200 gm/ capita			
P	Population in watershed expressed as adult consumption units.	3198	-	-	-

IV. INPUT DATA BIOMASS SECTOR

NOTATION	PARAMETERS	DESCRIPTION				
a_{th}	animal type	Bullock	Cow	Buffalo	Goat	Sheep
n_a	number of ath animal	832	876	613	111	116
f_a	fodder intake by the ath animal in one hour expressed in kg/hour	24/day	3.5	3.75	0.4	0.5
t_a	time spent in grazing by the ath animal in hours	stall fed	5	8	8	8
l_{th}	land type in hectares under	forest (mixed/pine)	horticulture	pasture	-	-
SY_{ll}	sustainable yield of fodder for livestock expressed in TDN/ha	4.30	2.40	2.80	-	-
	Consumption of fuel wood per capita per annum in kg	3.5				
SY_{fw}	sustainable yield of fuel wood expressed in Q/ha	Conifer forest 12.5	mixed forest 37.5	farm trees 35.0	-	-
e	diferent end uses	Lighting 20 W tube/bulb	Cooking 3.5 kg fuelwood per capita	Heating	-	-
f_e	fuel energy requirement per HH for different end uses expressed in MJ.	538	3355.5			
$\bar{f}_{a\,(a,b\,or\,c)}$	Average fodder intake per cattle unit per day	1.25 kg-TDN/cattle head/day				

V. INPUT DATA CAREER DEVELOPMENT SECTOR

PARAMETERS		DESCRIPTION			
*	Category of farmers	Marginal	Small	Medium	Large
*	Percentage of households with income <Rs 18000/annum	55.7	36.37	-	-
*	Percentage of Households with income >Rs 18000/annum category	44.3	63.63	100	100
*	Average income per household in <Rs 18000/annum category	Rs.8000/-	Rs 10000	-	-
*	Average income per household in Rs 18000/annum category	Rs 30000	Rs 40000	Rs 50000	Rs 44500
*	Average income per household from cashcrops % of total income	37%	45%	45%	30%

LIST OF PUBLICATION FROM THE PRESENT STUDY

1. Najammudin, Tiwari, R.S. and Negi, Manika. 'An Approach to Sustainable Development in Hills', Paper presented at the 29th Annual International Regional Science Conference organised by Department of Geography, Delhi School of Economics, Delhi University, Delhi from 31st January to 2nd February 1997.

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