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INTRODUCTION
1.1. INTRODUCTION

The degradation of the natural environment is intrinsically linked with the development process. Industrial and agricultural development has created many environmental problems largely due to the mismanaged and improper use of technology (Singh and Mishra, 1998). New technologies will certainly increase the carrying capacity of the earth for humans, but, a paradox of our time is the mixed blessing of almost every technological development (Gray, 1989). It is possible that life as we know it on this earth is not sustainable if we continue to live as we do (Wilbanks, 1994). The emphasis of sustainable development is to carry developmental achievements into the future in such a way that future generations are not left worse off (Pearce et al., 1990; World Commission on Environment and Development, 1987). Development must be guided by ecological understanding if degradation of natural system is to be avoided. It should not be regarded and treated as a technical engineering exercise and more attention should be paid to historical, cultural, social, economic and political realities (Stiefel and Wolfe, 1994; Berkes et al., 1998).

Mountain and upland watersheds constitute 25 percent of the earth’s land surface. They in fact provide direct life support for about 10 per cent of the world’s population and indirectly to half, principally because they are the source region for many of the world’s major river systems (Beniston, 2000). However, little understanding of mountain specificity by planners and policy-makers and the inability of development efforts to harness local niches have aggravated economic woes and threatened prospects for mountain development. It is indeed paradoxical that the mountains which metamorphically denote strength, stability and resilience are indeed the exact opposite (Pandey et al., 1998). Increased accessibility, population pressure, economic development and the excessive utilization of the region’s resources for grazing, firewood and timber extraction has resulted in a threat to the health of this mountain ecosystem and its inhabitation (Gupta, 1978) which has led to a number of environmental problems including gradual increase in volume of run-off and hence soil erosion (Yadav, 1984). The population in the mountain areas is comparatively more backward and underdeveloped. Recently, the sustainability issues in these areas are getting more attention because of poor development in the mountain areas.

The Himalayas have been the cradle of everything precious and beautiful in India’s heritage (Madan and Rawat, 2000). These constitute 16.2 per cent of India’s total geographical area and 3.2 per cent of the total population of the country (Census of India, 2001). Over one hundred million people in the Himalayas directly depend on forests and over 80 per cent of the population depends either on full or part time farming for their livelihoods (Xu, 2008). Thus, despite the abundance of natural resources, most of its people are marginalized and still live on subsistence level (Singh, 2006). The Himalayan region is characterized not only by ecological fragility but also by a deep and historical
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geropolitical sensitivity (Stone, 1992). The pace, magnitude and spatial reach of human alterations of the Himalayan region are unprecedented (Ivas and Messerli, 1989). Development priorities for the Himalayan region must focus on improving the life quality of mountain people and also to persuade the people of the plains that the future of the mountains cannot be isolated from their own (Eckholm, 1975). Protection of interests of indigenous population, therefore, must assume the focus as well as priority for interventions aimed for sustainable development in the Himalayan region. Present levels of appropriate technological knowledge as well as capacity to put the existing knowledge in to practice in the Himalayan Region need dramatic improvements for the wellbeing of the people settled in the region and many more settled in the adjoining low lands.

The forests shape our natural environment in various ways as these not only influence micro-climate, soil environment, flood conditions, erosion and human health (Dwivedi, 1980) but also provide shelter for wildlife and play an important role in the ecology of watersheds (Bhati and zingel, 1997). Preserving forests thus contribute to both climate stability and biodiversity goals (World Resources Institute, 1992). Degradation of natural forests is a global problem (Guppy, 1984; Sayer and Whitmore, 1991). Mankind has been destroying forests for millennia ever since agriculture was discovered (William, 1989). In the Himalayan Region deforestation has a long history, being well established in late eighteenth century (Mahat et al., 1986). Forest degradation is a primary problem which gives way to a variety of problems by accelerating many environmental degradation processes. Expansion of agriculture on marginal land and declining crop yields are considered to be major unsustainable trends in the Himalaya (Eckholm, 1979; Ives and Messerli, 1989; Jodha, 1990).

Land use land cover (LULC) studies are of interest to a wide range of social and environmental scientists because land is a key factor in social relationships and resource use. Land use studies provide a powerful rationale for maintaining land. Changing LULC is a fundamental driver of global change (Fischer and O’Neill, 2005) and direct reflections of human activity and impacts (Jolly and Torrey, 1993). Understanding past and present impacts of LULC change is very important to the study of human-driven environmental change (Liu and Chen, 2006). Intensification and diversification of land use, together with advances in technology, have led to rapid changes in the global cycles of carbon, nitrogen and other critical elements (Melillo, Field and Moldan, 2002) which is responsible for a significant proportion of the phenomenon of global climatic change (National Research Council, 1992). By the early 1990’s, human influences on the natural environment were understood to occur through two main processes: change in land cover and land use and “industrial metabolism,” that is, the transformation of materials and energy for industrial production and economic consumption (National Research Council, 1990). In the conceptual framework developed for the Millennium Ecosystem Assessment, changes in LULC figure among the “direct drivers” affecting ecosystem services while demographic
factors among the “indirect drivers” (Alcamo, Bennett and the Millennium Ecosystem Assessment Project, 2003).

Watersheds are ubiquitous units that can be seen as the physical foundation of the nation. They have long been recognized as desirable units for planning and implementing developmental programmes (Brooks et al., 1991, FAO, 1985; 1987; Honore, 1999; Khan, 1999). Different approaches to planning or management of the environment related human activities have been adopted and practiced. Earlier approaches have been and in many cases still are issue based and political area based. Linkages between different subsystems have been ignored or not properly understood and the political areas used as planning units are often not spatially integrated. Drainage basins, catchments, sub-catchments and the watersheds are identified as fundamental development units for planning (Moore et al., 1994) in which all the natural resources like soil, water, vegetation, geomorphology and land use are in harmony thereby facilitating adoption of holistic approach for sustainable development and management of natural resources (Gosain et al., 2004). This kind of planning or management attempts to avoid such activities that lead to negative effects of the environment (Marh, 1998). The river basin can be considered to be functional ecosystem characterized by direct feedbacks from human actions and understood as a naturally evolving complex of environmental components, linked by pathways of energy flows (Pantulu, 1981).

The utilization of the watershed area beyond its carrying capacity has resulted in its deterioration in most parts of the world (Food and Agriculture Organization, 1985) resulting into deforestation and soil erosion increment (Kelly, 1983). Being an integral part, the natural resources and the socio-economic status of a watershed should be paid equal attention (Erickson, 1995). Watershed assessment needs an approach that can handle complex problems but is easy to implement, that is flexible but consistent, that can be applied at different spatial scales, and that can readily be translated into easily communicated descriptions related to management decisions (Shukla et al., 1990). In an operational context, this would mean integrating different uses and management of resources, different departments through an inter-disciplinary approach, and towards alleviation of poverty (Mollinga, 2000). All collective efforts are designed through institutions, and without institutional change we will not move purposefully towards sustainability (Dovers, 2001). Because of the highly complex nature of human and natural systems, the ability to understand them and project future conditions using a watershed approach has increasingly taken a geographic dimension. Geographical Information System (GIS) technology has played critical roles in all aspects of watershed management, from assessing watershed conditions through modeling impacts of human activities on watersheds to visualizing impacts of alternative management scenarios. The integrated and holistic approach of watershed development has been focused for sustainable development of the society. The planners, academicians, development professionals, NGO activists, and
national and international funding agencies like Government of India and World Bank have led a major emphasis on development through watershed management approach with people’s participation as a key to sustainable watershed development.

Over the past two decades, there have been numerous applications of integrated watershed management worldwide. For example, integrated watershed management approaches have been recently used for combating drought in the Jhabua watershed in India (Singh et al. 2002), assessing and managing water resources in the upper Chao Phraya in Thailand (Padma et al. 2001), assessing and managing agricultural phosphorus pollution on the Chesapeake Bay (Sharpley 2000), tackling the problem of land degradation in Australia (Ewing 1999), and managing the Truckee River in Nevada (Cobourn 1999). Also, in the United States, the USEPA has been quite instrumental in promoting the integrated watershed approach to management (National Research Council 1999). The lessons learned from these and other initiatives indicate that in order to succeed, integrated watershed management must be participatory, adaptive and experimental, integrating all the relevant scientific knowledge and user-supplied information regarding the social, economic and environmental processes affecting natural resources at the watershed level.

The present study focuses on research in which LULC change is a key mediator of human-environment interactions, in which demographic variables figure prominently among the driving forces investigated, and in which efforts are made to investigate the causal mechanisms by which human population changes affect land use and environmental outcomes at the watershed level. The watershed prioritization is carried out by integrating various socio-economic and bio-physical indicators for the management of the natural resources of the Lidder catchment in order to achieve sustainable development. Besides, the catchment being one of the important tourist destinations of Kashmir valley receiving more than 50 percent of the tourists to Kashmir valley, it was imperative to evaluate the tourist carrying capacity and demarcate different tourist potential regions of the catchment for sustainable tourism development of the region.

1.2. CONCEPT OF WATERSHED

Watershed is an independent (Maitra, 2001) geo-hydrological unit demarcated through water divide lines separating one drainage basin from another. A watershed is defined as a topographically delineated geographical area in which the entire run-off tends to coverage, through the existing drainage system, to the common outlet of the area for sub-sequent disposal (Corn, 1993; Swallow et al., 2001). One watershed is separated from another by a natural boundary known as the water divide or the ridge line. It is a land area that captures rainfall and conveys the overland flow and runoff to an outlet in the main flow channel. Essentially watershed is all land and water which contributes water to a common point. Watershed is defined as a geographic area drained by stream or a system of connecting streams such that all surface runoff originating due to the precipitation in
this area leaves the area in a concentrated flow through a single outlet (Singh, 2000). While a simple or a first-order watershed comprises a single stream, a multi-order watershed comprises several such single-order watersheds. The entire drainage area of a major river system is referred to commonly as a river basin, which in fact comprises a large number of watersheds. Thus a watershed is an area from which all water drains to a common point, making it an attractive unit for technical efforts to manage water and conserve soil for improving production and conservation.

A watershed has a third dimension—height (or depth). The depth of a watershed may extend from the top of the vegetation to the confining geological strata beneath. Every watershed in the world is as unique as a fingerprint. No two watersheds are exactly same. A watershed in alpine region would be very different from dry and dusty watershed of an arid region. Two contiguous watersheds, lying side by side, are actually different in detail, even though they may look alike. The watershed above any point on a defined drainage channel can easily be identified. Hence it comprises of a catchment area (recharge zone), a command area (transition zone) and a delta area (discharge zone). Therefore, watershed is the area encompassing the catchment, command and delta of a stream. Hydrologically the shape of the watershed is important because it controls the time taken for the run-off to concentrate at the outlet. Watersheds may also be categorized as hill or flat watersheds; humid or arid watersheds; red soil watershed or black soil watershed based on criteria like soil, slope, climate etc.

The above definitions are mostly postulated by the hydrologists depicting watershed as a hydrological unit. But it is beyond doubt that watershed is more complex; in fact it is a physical, biological, economic and social system bounded vertically by the area influenced by human activities and horizontally by the water that drains into a point in this channel. It has a profound influence on forestry, agriculture and other aspects of ecology, economic and social aspect. It is a resource region where the ecosystem is closely interconnected around basic resource i.e. water. Watershed controls the rainfall and climate, soil development, ecosystem and thus environment. The watershed is therefore an ideal spatial management unit for integrated development of its resource potentialities.

1.3. INTEGRATED WATERSHED MANAGEMENT

During the last few decades, degraded watersheds have posed serious problems to environment and people, both upstream and downstream (Mountain, 2002). It was realized that land degradation was a serious threat to the environment and to the well being of millions of people (Ives and Messerli, 1989; Oldeman, 1994; Jodha, 1995; Lal, 1998). As it is often the result of human activities, it can therefore, be prevented or controlled by human efforts. One such effort is the management of natural resources at watershed level. Originating from the science of hydrology, the term watershed management has over the years acquired much wider implications. The term is now used for a variety of development projects involving natural resources management. In the early days
watershed management had a narrow focus primarily for controlling erosion, floods and maintaining sustainability of useable water yield (Ozyuvaci et al., 1997). However, in the present context, watershed management is not only for managing or conserving natural resources in a holistic manner, but also to involve local people for betterment of their lives (Mountain, 2002). Thus, modern watershed management is more people oriented and process based to fit into the farmers’ lifestyles rather than merely fulfilling the purposes of donors, governments or non-government agencies (Sen et al., 1997). The implications of watershed degradation and its management are understood differently by different persons. The conceptual differences arise primarily due to the adoption of different thrust areas. Soil, water and vegetation are the main important and vital natural resources and watershed affects all of them. Judicious and efficient management of these resources in the watershed can ensure the sustained productivity of food, fuel, fodder, forage, fiber, fruits and timber. However watershed planning can be difficult because of the complex array of interactive physical and social forces (National Research Council, 1999a).

Watershed management can be regarded as both a science and an art (Swallow et al., 2001). Broadly, it is the process of guiding and organizing land and other resource use in a watershed to provide desired goods and services without adversely affecting land resources. It integrates various aspects of hydrology, ecology, soils, physical climatology and other sciences to provide guidelines for choosing acceptable management alternatives within the socio-economic context taking into consideration the interactions and implications among land resources and the linkages between uplands and downstream areas (Brooks et al., 1991; Sen et al., 1997). Watershed Management provides direction to human activities in the protection and rehabilitation of water and associated aquatic and terrestrial resources within the watershed while recognizing the benefits of orderly growth and development. The goal is to contribute to the environmental, social and economic well being of the area on a sustainable basis. Watershed Management is a tool to aid land and water use decision makers. Water is the most critical resource as the efficient utilization of other resources is dependent upon its spatio-temporal availability. Thus, efficient and economic use of water becomes an important factor in improving the livelihood of the watershed inhabitants. Watershed management develops a holistic perspective on the local ecosystem and its stressors, “Emphasizing the importance of the whole and the interdependence of its parts” (Webster’s II, 1995), by compiling and analyzing environmental data along with other natural, cultural, and historical information.

Integrated watershed management (IWM) is the process of managing human activities and natural resources in an area defined by watershed boundaries. It is an evolving and continuous process through which decisions are made for the sustainable use, development, restoration and protection of ecosystem features, functions and linkages. IWM allows us to address multiple issues and objectives; and enables us to plan within a very complex and uncertain environment. It is based on the perception of water as an
integral part of the ecosystem, a natural resource and social and economic good. The emergence of IWM in several countries throughout the world reflects a growing recognition of the multiple—often competing—uses of water, and the increased awareness of the interrelationships of water systems with other physical and socioeconomic systems. IWM is a holistic area-based planning process that extends the government’s policy on sustainable natural resources management and development activities. It has emerged as a new paradigm for planning, development and management of land, water and vegetation resources with a focus on social and institutional aspects apart from bio-physical aspects following a participatory ‘bottom up’ approach. Sustainability and replicability of the watershed management programmes call upon people’s participation in the planning, implementation, management and equitable sharing of benefits and responsibilities (Aplet et al., 1993).

The watershed management approach has been highly recommended by the Indian Council for South Asian Cooperation (ICSAC) for the purpose of environmental protection and sustainable development (Burman and Jaul, 1989). The basic idea in watershed management is to conserve the vegetation cover in the upper part of the watershed and to regulate land use through the rest of the watershed in order to protect the downstream areas (Berkes et al., 1998). In India, the IWM efforts go back to 1970. There have been many changes in the implementation strategies during the following years. Until 1995, watershed development projects were officially coordinated by multi-sectoral programmes (with different objectives) launched by the Government of India. After review in 1999 by the Ministry of Rural Development and Ministry of Agriculture, a common set of operational guidelines, objectives, strategies and expenditure norms were established for watershed development programmes in 2001. These are implemented through programmes such as Drought-Prone Area Programme (DPAP), Desert Development Programme (DDP) and Integrated Watershed Development Programme (IWDP). The guidelines encourage the active involvement of non-governmental organizations, semi-governmental institutions and private enterprises, universities and training institutions. However concerns are being raised that emphasis in watershed development programme is still firmly based on the belief that water is an infinite resource, through development of groundwater extraction and water harvesting techniques (Gosain et al., 2004).

1.4. SUSTAINABLE DEVELOPMENT

The concept of sustainable development integrates environment and development in the long term. Although many discussions about the definition and components of sustainability have been held in the world, it is generally agreed that economy, environment and social equity are three foremost values in sustainability concept. The work program of the 1992 United Nations Conference on Environment and Development in Rio de Janeiro provided a political foundation and action items to facilitate the global
transition towards sustainable development. Sustainable development implies a dynamic balance between maintenance (sustainability) and transformation (development) functions both directed towards human needs (Robinson et al., 1990). Sustainable development requires pragmatic management of natural resources through positive and realistic planning that balances human expectations with the ecosystem’s carrying capacity. It aims not only at environmental harmony, but also at long term sustainability of the natural resource base with economic efficiency in the utilization of non-renewable resources and structural shifts to renewable resource utilization in economic processes.

The definition of sustainable development was given by World Commission on Environment and Development (WCED) as “a development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs” (WCED, 1987). This definition concisely conveys a long term future orientation (Smith, 1993) and acknowledges an ethical intergenerational obligation towards the satisfaction of human needs. However, this definition provides an incomplete representation of the sustainability concept. Any characterization of sustainability forms, whether economic, social, or ecological (Goodland, 1994) reflects the dynamic nature of sustainability (Niu et al., 1993) and acknowledges that sustainability will vary by context (Shearman, 1990) and will take many forms (Robinson et al., 1990). Moreover, this definition is also unclear for operational purpose and ordinary in nature due to three reasons: firstly, it does not specify human needs, secondly, it does not clarify the timeframe for the analysis of future generations needs, and thirdly it does not mention the environment as a key concern in sustainability (Bartelmus, 1997). According to Bartelmus (1997) sustainable development is defined as “the set of development programs that meets the target of human needs satisfaction without violating long-term natural resource capacities and standards of environmental quality and social equity.”

Sustainable development “should be economically viable, socially just, and environmentally appropriate” (Payne and Raiborn, 2001). Harris and Goodwin explain that in the extensive discussion and application of the concept of sustainable development which has taken place since its inception, three essential themes (fig. 1.1) have been recognized (Harris and Goodwin, 2001):

**Economic:** An economically sustainable system must be able to produce goods and services on a continuing basis, to maintain manageable levels of government and external debt, and to avoid extreme sectoral imbalances that damage agricultural or industrial production.

**Environmental:** An environmentally sustainable system must maintain a stable resource base, avoiding overexploitation of renewable resource systems or environmental sink functions and depleting nonrenewable resources only to the extent that investments are made in adequate substitutes. This includes maintenance of biodiversity, atmospheric stability, and other ecosystem functions.
Social: A socially sustainable system must achieve fairness in distribution and opportunity, adequate provision of social services, including health and education, gender equity, and political accountability and participation.

Sustainable development principles have been introduced in existing national frameworks, such as conservation strategies, environmental plans, national vision statements, and national Agenda 21 initiatives. The implementation of Agenda 21 has been slow (United Nations, 2002) but the collection, analysis, and use of geographic information offers a starting point on the path to sustainable development (Brooner, 2002). Geographic data and information have the potential to play a role in the planning, implementation, and monitoring of many of Agenda 21’s action items. The use of geographic data and related technologies will help overcome a number of implementation challenges, in particular the traditional fragmented approach toward sustainable development. Sustainable development is therefore a set of guiding principles whose implementation is reflected in a variety of action programs, of which Agenda 21 is the most prominent.

1.5. WATERSHED AS A SPATIAL UNIT FOR SUSTAINABLE DEVELOPMENT

In any watershed natural and human resources are inter-dependent. Hence, the land and water resources in conjunction with the socioeconomic data serve as a tool for watershed management which ultimately leads to sustainable development of the region. The IWM attempts to enrich the life of the people and improve its quality at gross root level. The introduction of detailed socioeconomic aspects generate public interest, the objectives of which provide protection, development and management of the land and water resources to maximize the economic returns. Hence, watersheds are increasingly recognized as the most applicable spatial units at which the management of natural resources should occur (Davenport, 2003). Watershed level planning is identified as an important tool for sustainable development (Rhoades, 2000; DeBarry, 2004). The importance of ecosystem thinking as a key way to approach watershed planning is stressed.
by several researchers (Soloway and the Township of Mono, 1991). The ecosystems approach involves several core principles: everything is connected to everything else, humans are a part of nature, we are responsible for our own actions, and economic and environmental health are not mutually exclusive, rather, they are mutually dependent (Soloway and the Township of Mono, 1991).

IWM has come to be recognized internationally as an important holistic approach to natural resources management, which seeks to promote the concept of sustainable development. Such an integrated approach has been recommended in Agenda 21 for all sectors dealing with the development and management of water resources. Given the diversity in physical and socioeconomic environments and the spatial variations in the type and severity of resource degradation in the Himalayas, any effort at conservation needs to be site specific. The physically appropriate spatial units for research on resource conservation issues are watersheds (Gregersen et al., 1996; Brooks et al., 1997). The watershed context provides the natural framework for investigating into the complex and reciprocal linkage among land use, soil and water resources, and the interdependence of people in their resource use practices. Because of this physical significance, watersheds are also considered to be the logical spatial constructs for the sustainable and integrated management of the resources with the direct involvement of local population (Brooks et al., 1997; Sharma, 1999; Rhoades, 2000).

Managing watersheds for sustainable rural development in developing countries is a relatively new concept. It is concerned not only with stabilizing soil, water and vegetation, but also with enhancing the productivity of resources in ways that are ecologically and institutionally sustainable (Farrington et al., 1999). Watershed management is practiced as a means to increase rain fed agricultural production, conserve natural resources and reduce poverty in the semi-arid tropical regions of South Asia and Sub-Saharan Africa, which are characterized by low agricultural productivity, severe natural resource degradation and high level of poverty (Kerr, 2002). A holistic approach converging the activities, which could improve livelihoods of rural people including landless dependent on natural resources, is adopted which is critical for sustainable development (Wani et al., 2003; Ramakrishna and Osman, 2004). Watershed management projects begin with the proposition that some natural resources are best managed on a watershed basis. They commonly involve multiple scales and a mix of physical and social dimensions that require an interdisciplinary approach. Watersheds are considered useful units of analysis and action because of several physical and social characteristics (Schreier et al., 2003; Vernooy, 1999). Upper catchments are endowed with rich natural resources and characterized with great physical and cultural diversity where environmental changes are often coupled with severe socio-economic consequences. Conservation of natural resources in these mountainous areas is of utmost concern for sustainable development.
and improving livelihood securities. Blending of remote sensing and GIS technologies has proved to be an efficient tool and have been successfully used by various investigators (Chalam et al., 1996; Chaudhary and Sharma, 1998; Kumar et al., 2001; Ali and Singh, 2002; Singh et al., 2003; Pandey et al., 2004; Suresh et al., 2004) for water resources development and management projects as well as for watershed characterization and prioritization. Thus, it is generally accepted that sustainable land and water management must be approached by taking watershed as the basic management unit.

1.6. SIGNIFICANCE OF THE STUDY

The mountainous areas are experiencing the triple revolution of industrial, transportation and tourism revolution, which has created havoc with the ecological setting of these regions. Successful intervention to halt the spiralling process of population growth, environmental degradation and poverty in mountain regions of the developing world requires an understanding of the reciprocal relationship between environment and development in mountain areas (Karan, 1989). Sustainable development of natural resources of the Himalayas has acquired added importance with the deepening anxiety at the disruption of the ecological balance in the mountains and its attendant deleterious effects on the environment. With the rapid increase in population during the recent years, the demand for food, fuel, fodder and grazing land has increased considerably, putting increased biotic stress on the critical environmental components, like land, water and forests. Consequently, the human transformation process of bio-physical components has brought about drastic changes in the resource use practices and land use pattern of the region (Tiwari, 1997). Agriculture is being pushed to forests, marginal and sub-marginal areas and areas with very steep slopes, without taking into consideration the suitability of these lands for crop farming.

LULC studies have been designed to improve understanding of the human and biophysical forces that shape LULC change. Thus, linking human behavior and social structures to biophysical attributes of the land is a fundamental aspect of LULC change research. Knowledge of the nature of LULC change and their configuration across spatial and temporal scales is consequently indispensable for sustainable environmental management and development (Turner et al., 1994). Cumulative watershed effects are the response to multiple land use activities that are caused by, or result in, altered watershed function (Reid, 1993). The spatial information on LULC and their pattern of change is essential for planning, utilization and management of the natural resources. LULC inventories are extremely important in the various resource sectors like agricultural planning, settlement and cadastral surveys, environmental studies and operational planning. Information on LULC permits a better understanding of the land utilization aspects on cropping pattern, fallow land, forest and grazing land, waste land, surface water bodies etc, which is very vital for sustainable developmental planning.
Advancement in science and technology together with restructuring of institutional mechanisms for implementation of development activities is needed for enhancing the element of sustainability in Himalayan scenario. Multiple facets of problems and potentials in Himalaya demand integrated approaches. Environmental issues should be dealt together. Isolated measures to cope with one of them can sometimes make others worse (Tickell, 1993). The overall land and resource use system is an integrated system because of the interdependence of forest, pasture and farmland. An understanding of the system would not be complete without a proper understanding of the component subsystem. Since the system we are trying to handle and modify is integrated and spatial in nature, the method of its management should also be integrative (all encompassing) and spatial (Geographic). Such a method of management and planning is provided by the watershed management approach. The area of the catchment forms a viable unit for planning as all the settlements located in the area are interlinked and interconnected physically, socially and economically more closely than their connections with those located out of the catchment area (Marh, 1998).

The watershed is the smallest unit where the evaluation of human induced impacts upon natural resources becomes possible. Watershed prioritization is an important aspect of planning for implementation of the watershed management programme (Gosain and Rao, 2004). Change detection in watersheds help in enhancing the capacity of local governments to implement sound environmental management (Prenzel et al., 2004). In this regard, Geographical Information System (GIS) holds great promise with a provision to handle spatial and temporal data and aid as an integrative planning tool for watershed management. During the past decades, more and more of the complex environmental challenges have been addressed by using a watershed approach. According to the U.S. Environmental Protection Agency (EPA), environmental management using a watershed approach constitutes “a coordinating framework for environmental management that focuses public and private sector efforts to address the highest priority problems within hydrologically defined geographic areas”.

In the present study watershed prioritization is carried out by integrating various bio-physical and socio-economic characteristics of different watersheds which would certainly help to address the current environmental problems of the catchment. The study also identifies the major contributing factors which are responsible for the environmental degradation in different watersheds of the catchment. The study site is a reflection of watershed degradation in many ways and studies made in this site may have wider application not only to other catchments of Kashmir valley but to the entire Himalayan Region. The evaluation of tourism carrying capacity is very important to achieve sustainable tourism development. In fact it stresses on the maximum number of tourists who could visit a tourist destination without creating any environmental problems.
1.7. OBJECTIVES

The study aims to accomplish the following objectives:

i. To assess the socio-economic character of Lidder catchment.
ii. To evaluate the geo-physical environment of Lidder catchment.
iii. To analyse the dynamics of land use land cover change in Lidder catchment.
iv. To devise management plan by evaluating tourist carrying capacity and watershed prioritization for sustainable development of Lidder catchment.

1.8. REVIEW OF LITERATURE

Most literature dealing with the Himalayan environmental change can be divided into three categories by the supported theories of different researches: Catastrophic, Normal process and Greening trends. The picture of the Himalaya presented by several authors (Eckholm, 1975; Claire, 1976; Moddie, 1981; Reiger, 1981; World Bank, 1984; Messerschmidt, 1987) supported the theory of catastrophic degradation indicate among several explanations the eastward movement of the mountain deserts of the western Himalayas. The authors indicate the possibility of catastrophic degradation based on their observations of rapidly rising population, limits of forest resources and agricultural extension, soil loss and the loss of soil fertility and increasing natural disasters in the region (Smith, 1988). Several researchers challenge the “Theory of Himalayan Degradation” described above (Bajracharya, 1983; Bruijnzeel and Bremmer, 1989; Gilmour, 1991; Ives and Messerli, 1989; Kattlemann, 1990). They argue that the human influence in the Himalayas is insignificant compared to the scale of natural processes. Most reasons behind the contrasting theories of the Himalayan environment can either be due to inadequate information on environmental assessment in the region or the lack of synthesis of available information.

The Himalayan environmental problems, their causes and consequences have been studied by several researchers in order to address these problems. But the study area (Lidder catchment) has been ignored to a large extent. Gupta (1978) analyzed the impact of humans in terms of agriculture, forest fires and overgrazing on the vegetation of western Himalayas. Bishop (1978) and Masri (1995) highlights the human impact in terms of soil, air and water pollution and the loss of species and forest cover due to increasing human population and urbanization. They came to the conclusion that fertile lands are quickly disappearing due to urbanization. Karan and Lijima (1985) divided the Himalaya region into various geo-ecological zones and studied their environment problems. Ahmad, Rawat and Rai (1990) have classified the Himalayan environmental problems into physical, biological and socio-economic and have presented a detailed management plan for all the three components to achieve sustainable development. Singh and Singh (1986), Tucker (1987), Dewan (1987) and Kant (1998) are of the opinion that the environmental problems in the Himalaya are increasing because of growing population, economic changes like tourism, construction of roads, execution of river valley projects and
extension of agriculture into steep slopes, forest fires, overgrazing etc. They concluded that the ecological problems have been aggravated under the impact of modern development process. Chadha (1990) discussed various environmental problems emerging in Kashmir Himalayas due to growing human interferences as air pollution, water pollution, problem of landslides, deforestation etc.

Pant (2003) suggested that all development efforts for the Himalayan region should be made according to demographic traits and needs, and keeping in mind the availability of the resources and ecologically fragile and geologically sensitive nature of the Himalayan environment. A separate population policy should be framed for the Himalayas. Any approach adopted for planning in this region must consider the aspects of man and his environment. The Asian Development Bank/ICIMOD (2006) estimated that while 47 percent of the denudation and landslides are of natural causes while the remaining 53 percent are manmade. Joshi et al. (2006) observed that soil loss and surface flow is very low under forest cover while the human disturbed slope (agricultural land) is leading in soil loss. Sati (2006) concludes that Rapid growth in the population of the Uttarakhand Himalayas has had a negative impact on the sustainability of the environment and economy.

The analysis of LULC change, its driving forces, techniques of analysis and its impact on the natural environment has been thoroughly analyzed in the past three decades especially after the introduction of remote sensing technology (for example Hamilton 1987; Hrabovszky et al., 1987; Turner et al., 1994; Ruiz et al., 1996; Dale et al., 1998; Berkes et al., 1998; Walsh et al., 1999; Meyer and Turner, 1994; Lambin et al., 1999; Wickham et al., 2000; Mather and Needle, 2000; Burgi and Turner, 2001; Hietel et al., 2005; Jingan et al., 2005; Ojima, Galvin and Turner-II, 2008). Much attention has been paid to the issues of human induced LULC change within the last few decades as evidenced by such multi-disciplinary, multi-national programs as NASA’s Land Cover Land Use Change (LCLUC) programs or the International Geosphere Biosphere Programmes. Since LULC change is regarded as an important indicator of environmental change (Turner et al., 1994), these studies have acquired significance in the Himalayan region as well. Rawat et al. (1996) and Singh (2006) are of the opinion that rapid population growth is the main driver of land use change. Singh (1998) attributed the expansion of agricultural land to population growth and urbanization to tourism. Ahmad (1998) discussed various environmental components under stress in the Himalayas. Singh and Tingal (1998) studied various interactions of physical and socio-economic factors and found that natural hazards are increasing because of human interventions like tourism and agriculture and critical environmental zone is expanding. Tiwari (2000) argued that irrational land transformation process has not only disturbed the ecological balance is Himalayan watersheds but has also aversely affected the ecology and economy of the indo-gangetic plain region by recurrent floods and decreased irrigation potential. Singh et
al. (2005) in their work have assessed the forest resources using remote sensing and GIS techniques and have established the socio-economic factors responsible for deforestation. Pandit et al. (2007) in their work reported an alarming rate of deforestation using remote sensing and GIS. They concluded that Western Himalayan region is expected to suffer high losses in forest cover than the Eastern Himalayan region because of higher human population densities in the Western Himalayan provinces. Munsi et al. (2009) found that anthropogenic disturbances are the main drivers of land use change in the form of increased agricultural activities and human settlements. Kasereka et al. (2010) used remote sensing and GIS to infer LULC change and argued that such kind of research will benefit society through the creation of reliable land cover information for better decision making. They concluded that the integration of visual interpretation and digital classification lead to significant improvement in overall accuracy.

Concern over the ecological effects of tourism started to mount during the 1960’s and 1970’s, through the realization that the industry has had the capability of either moderately altering or completely transformation destination regions in adverse ways. Crittendon (1975) illustrates that while tourism has transformed much of the world’s natural beauty into gold, the industry may have planted the seeds of its own destruction. The studies on the environmental impact of tourism in Kashmir valley carried out by Bhat (1992) emphasized a three-tier strategy blending economy, society and ecology harmoniously for sustainable tourism development in Kashmir valley. Kanth and Bhat (1997) compared the tourist flow and chemical characteristics of water in Dal lake. Dutta (1992) suggested that tourism activities in each season must be regulated and spread over the whole year, so that the pressure during summer and autumn is eased. Karan and Mather (1985), Chadha (1990), Forsyth (1991) and Savage (1993) have discussed tourism related environmental problems attributed to large number of visitors, use of fire wood, trekking and tourist related sewage and waste disposal. They are of the opinion that the income from the tourism and trekking rarely reaches the bulk of the local population, but they do receive the negative side effects like trailside litter and erosion. Cater (1995) concluded that given the multitude of interests involved in environment and tourism development completely sustainable outcome is likely to remain more of an ideal than a reality. Sharma (1998) stated that the environmental impact of tourism depends pretty much on the type of tourism being promoted, the magnitude or scale of tourism prevalent, seasonality of the activity, extent of concentration in particular areas, and the monitoring and management regime in place. Tosun (2001) identified the main challenges to sustainable tourism development and concluded that environmental codes should be developed and enforced to protect unique and fragile natural resources and cultural heritage. Parizzi et al. (2001) concluded that the risk of water contamination has increased, caused by the increase of tourist activities.
Since the focus of geography is on man environment relationship, geographers have provided new approaches to the practice of natural resource management. They have identified natural resources management as a method both for assessing resource potential and planning resource use (Burton, 1961; Burton and Kates, 1964; Burton, Kates and White, 1963, 1997; Kates, 1962). Because natural resources management also focuses on people environment interactions, it shares a concern with this geographical tradition. Much work in resource management by geographers emerged with the behavioral revolution in the discipline in the 1960s. For example, White (1963) maintained that the study of resources was fundamental to the geographic tradition. He opined that it is important to recognize the intellectual problems which call for solution and which, because of their relation to spatial distributions and human adjustment to differences in the physical environment, are of interest to geographers.

The acceptance of watershed as a natural hydrologic unit for multi-resources development planning stems from the fact that sustainability of development based on soil and land use depends on their interaction with water in all the activities that takes place throughout the watershed. The watershed development approach in India was first adopted in 1974 when the Government of India enforced the scheme for 'Soil Conservation in the watershed of river valley projects". In 1982 Government of India launched another ambitious programme for the development of dry land Agriculture on watershed basis under which 47 Model watersheds were identified under different Agro-climatic zones all over the country.

Many agencies, natural resource managers and academicians have supported planning and managing water and related land resources on a watershed basis and the approach is now being widely adopted (Anonymous, 1997; Batchelor, 1999; Bellamy et al., 1999; Born and Margerum, 1995; Born and Sonzogni, 1995; Burton, J. 1986; Downs et al., 1991; Environmental Protection Agency, 1993; Gonzales and Arias, 2001; Heathcote, 1998; Hooper and Margerum, 2000; Jonch-Clausen and Fugl, 2001; Margerum and Born, 2000; Mitchell and Hollick, 1993; Rogers; 1993; White, 1997). The conceptual development of IWM was extended recently by the Global Water Partnership (Global Water Partnership, 2000; Jonch-Clausen and Fugl, 2001). Moreover, international endorsement of the concept has now been seen at the highest levels, including the 2003 Summit on Sustainable Development in Johannesburg, South Africa as well as the Second (2000) and Third (2003) World Water Forums in Kyoto, Japan. At the latter, “IWRM and the Basin Management Theme” was issued. Band, 1986; Moore et al., 1988; Famiglietti and Wood, 1994 developed spatially distributed models of watershed hydrological processes to incorporate the spatial patterns of terrain, soils and vegetation as estimated with the use of remote sensing and GIS.

Nataraj et al. (1988); Srinivasa (1988); Ingle and Wayazade (1989) and Agnihotri et al. (1989) analyzed different watershed development projects along the Shiwalik foot
hills for increasing agricultural production, economic development, rehabilitating and found that the watershed approach was economically feasible. Singh et al. (1991) revealed that the forestry, animal husbandry, soil conservation and horticultural components of the integrated watershed development project in the Kandi tract of the Punjab were economically viable. Rajput (1991) analyzed the differences in the output of soybean, sorghum, wheat and gram between watershed and non-watershed areas in the Indore district of Madhya Pradesh. The paper suggested increased access of technology and education while infrastructure development and price policies needed to be pursued more actively.

Singh (1993) analyzed that lack of adequate information, absence of people’s participation, subsidies, inadequate supply of modern inputs, lack of group action, poor marketing and processing facilities of new products, inadequate price incentives, lack of timely and adequate credit facilities were the constraints that plague watershed technological adoption. Dhyani et al. (1993) studied the various soil and water conservation measures undertaken in the Bhaintan watershed at Fakot in Tehri Garhwal of Uttar Pradesh. The study revealed that the rehabilitation of the Himalaya region with soil and water conservation technologies on a watershed basis was economically beneficial. They also concluded that adoption of soil and water conservation technology on farmer’s fields on watershed basis in the outer Himalayan region was economical as benefit cost ratio was higher than unity (1.93).

Rajput et al. (1994) studied the impact of watershed development programme in western Madhya Pradesh. The study revealed that the productivity levels were higher in watershed development area over non-watershed development area. The watershed development programme played a significant role in accelerating agricultural production and bringing about change in the cropping pattern in favour of remunerative crops. Swarnalatha et al. (1994) reported that in the Aravali foot hills of watershed project of Haryana reported that agriculture, animal husbandry and horticultural components of the watershed project were economically viable. Moreover the land use pattern revealed a decline in the area under wastelands while increase in the area under irrigated agriculture, forestry and horticulture.

Jally et al. (1995) studied the impact of watershed development at Nartora watershed, Madhya Pradesh and reported that yield of groundnut, paddy and wheat increased by 30, 25 and 10 per cent respectively during the post-project period, compared to the pre-project period. Sharma (1995) while studying the elements of the successful implementation of watershed management at Falkot watershed observed that, non-agricultural land brought under horticulture, agro-forestry, forestry and grasses resulted in an increase in their productivity by 200 to 800 per cent. Singh et al. (1995) studied soil conservation and management of marginal lands of Mahi ravines and found that the programme not only helped to overcome the problem of soil and water conservation on
marginal lands of Mahi ravines but also increased and stabilized the productivity and net returns.

Krishna (1996) discussed the usefulness of remotely sensing data for watershed management in the Sikkim Himalaya. The bio-physical conditions were assessed based on field experience while LULC categories as well as physiographic unit's were identified from the satellite imagery. Shah and Patel (1996) studied the impact of watershed development project in Kaira district of Gujarat and found that the watershed project contributed positively in enhancing agriculture productivity, moisture retention capacity of the soil, recharging of ground water, crop income and employment generation. It also improved the environment and prevented degradation of soil. Rajput et al. (1996) based on their study on economic evaluation of watershed programme on crop yields in Madhya Pradesh reported that the crop yields with in watershed area were higher as compared to non-watershed area.

Pendke et al. (1998) in their study on Wagarwadi watershed of Parbhani district in Maharashtra found an increase in educational status by 20 per cent after the implementation of watershed development project. The cultivated area increased by 24 per cent in addition to the increase in agricultural production which resulted in the higher standard of living of the local population. Moreover, the livestock population increased by 30 per cent after post implementation stage of watershed. Nag (1998) carried out Morphometric analysis of Chakra-river basin of West Bengal using satellite data and delineated different hydro-geomorphological units. The parameters worked out in the study included bifurcation ratio, stream length, form factor, circulatory ratio and drainage density. The study suggests that the area is covered by fractured, resistant, permeable rocks and the drainage network is not so much affected by tectonic disturbances. Kumar and Tomar (1998) carried out a study on the ground water assessment in Godavan Sub watershed Bihar using remote sensing and GIS. Correlation between different hydro-geomorphic units and top soil resistivity were attempted which has helped in better understanding the surface resistivity pattern. Arun Kumar (1998) found that the implementation of watershed development project resulted in the employment generation as an additional employment of 46,550 man days was generated by the watershed project at Kuthanagere in four years.

Biswas et al. (1999) carried out the prioritization of sub-watersheds based on morphometric analysis of drainage basin by using remote sensing and GIS. The prioritization was carried out on the basis of stream length, bifurcation ratio, drainage density, stream frequency, texture ratio, form factor, circulatory ratio and elongation ratio. Babu et al. (1999) suggested a catchment treatment plan by multi-thematic analysis based on different physical parameters of slope, LULC, drainage, relative relief and soil using remote sensing and GIS. Nalini et al. (1999) studied the Aril watershed in Bareilly district of Uttar Pradesh and found that the land use pattern revealed a decline in the area under
wasteland while there was increase in the area under irrigated agriculture, forestry and horticulture. Singh (1999) studied the Chajawa watershed and adjacent villages of Baren district of Rajasthan. The study revealed that family income inside the watershed was 21.5 per cent higher as compared to those outside the watershed.

The expert group statement on Integrated River Basin Management for the Second World Water Forum and Ministerial Conference in Hague, 2000, maintained that sustainable river basin management required proper study, understanding, and effective management within the context of social, economic and environmental resources.

Ramanna and Chandrakanth (2000) while studying the watershed programme implemented by the government, reported that lack of knowledge of programme, uneven distribution of incentives, supply of poor inputs and materials, favoritism and politics at village level, poor quality of work by implementing agency, improper location of soil and water conservation structures as major problems/constraints of implementation in the watershed project as expressed by beneficiary farmers. Pal (2000) Evaluated the water discharge and sediment budget in the lesser Himalaya based on the morphometric analysis. Drainage pattern in three catchments was mapped through the interpretation of aerial photographs. The study concluded that most of the suspended load was transported between June and September and during rest of the year the concentration of sediment load was close to zero. Pratap et al. (2000) studied the groundwater prospect in Uttar Pradesh. Thematic maps in respect of geology, geomorphology, slope, drainage, LULC and lineament were prepared by remote sensing and GIS. Each theme was assigned a weightage depending on its influence on the movement and storage of groundwater and hence the ground water potential map was prepared.

Sarkar et al. (2001) emphasized the role of various parameters namely, drainage, lineaments, lithology, slope and land use for delineation of groundwater potential zones. The resultant map indicates a high groundwater potentiality in the flood plains, river terraces and river channels. Carios et al. (2001) carried out the erosion risk zonation in a river basin using remote sensing data, GIS and Universal Soil Loss Equation. Soil and water conservation practices are developed especially for the areas of highest erosion risk. Chakrabarthy and Datta (2001) observed the land use pattern of watershed in arid region, Western Rajasthan using remote sensing and GIS and concluded that the vegetation and biomass has been deteriorated over the years. Durbude and Purandara (2001) estimated the runoff potential under geomorphic set-up. After the analysis of satellite imagery, topographical maps, ground truth data verification and runoff calculation, different water harvesting as well as storage structures are proposed. Rao and Pant (2001) have employed remote sensing and GIS to quantify LULC change in a central Himalayan watershed. The study has revealed that the forest cover has substantially reduced in the 33 years of study period due to increase in population pressure and wood extraction. Khan et al. (2001)
prioritized the different watersheds of Guhai catchment on the basis of sediment yield index using remote sensing and GIS.

Tripati et al. (2002) conducted a study for the Nagwan watershed of the Damodar valley Corporation, Bihar to prepare Runoff modeling. The model is helpful in the designing of conservation structures and evaluating the effect on these structures. Sen et al. (2002) studied the patterns and implications of LULC in a Himalayan watershed from 1963 to 1993 using satellite data and archival records. They found that agriculture has increased by more than 4 percent and more than 50 percent of the agricultural expansion was on community forests. Srinivas et al. (2002) estimated soil erosion by USLE method using remote sensing and GIS in Nagapur district, Maharastra for prioritization and delineation of conservation units. The study revealed that the implementation of Universal Soil Loss Equation using integration procedures of GIS enabled the prediction of potential and actual conditions respectively. Suitable agronomic and mechanical measures are suggested for soil conservation.

Zacharias et al. (2004) demonstrated that land use alterations have significant impact on the hydrology of catchments and remote sensing and GIS has proved to be very useful to analyze this phenomenon. Singh and Jain (2004) while studying the Kandi Watershed and Area Development Project (KWADP) of Punjab observed that the cultivated area, cropping intensity and the productivity of maize, wheat and milk increased from 1979-80 to 2000-01. Joshi and Gairola (2004) have studied LULC dynamics in a micro-watershed of Garhwal Himalayas with reference to topography and concluded that the slope and altitude is not a major determining factor of LULC change as is the aspect of the land because of sun illumination. Gosain and Roa (2004) put forward a scientific approach to handle integrated watershed management strategy through a case study implemented to demonstrate the watershed prioritization exercise. Watershed prioritization approach is advocated in order to manage the deteriorating environmental quality of Himalayan region in a sustainable manner.

Shetty et al. (2005) demonstrated that how satellite data can be displayed and manipulated using digital technology in a rugged forested watershed. A detailed account of methodology for supervised classification is also provided while classifying the watershed in different LULC classes. Saha et al. (2005) classified satellite data using maximum livelihood classified in a rugged Himalayan terrain. The study demonstrated that use of Digital Elevation Model (DEM) as ancillary data significantly improved the accuracy of image classification. Mishra (2005) is of the opinion that watershed management involves the management of all the natural resources including human beings by ensuring their complete participation. Without people’s participation the watershed management objectives are unachievable. He suggests that we should try our best to work to minimizing the adverse effects simultaneously ensuring the higher productivity and sustainability of the natural resources. Joshi et al. (2005) observed that the forests, grazing
lands and grasslands in Himalayan region are facing immense biotic pressure, because of removal of higher rate of biomass and timber. They suggested that the grass production at agriculture terrace risers might be encouraged to maintain the fertility of the agricultural land and reducing the pressure in grazing and over-grazed patches within the watershed. O’Neill (2005) states that successful watershed management depends on local socio-political conditions and support. Thus, watershed planning requires an integration of sound scientific and social processes in order to be successful.

Singh et al. (2006) are of the opinion that proper land use in conjunction with mechanical soil conservation measures when adopted within the boundary of watershed can enhance sustainability of the production system in the region. Mottet et al. (2006) studied the role of various bio-physical and socio-economic factors in LULC change in a mountain landscape of Pyrenees. Jasrotia and Singh (2006) in their work estimated soil loss and prioritized the watershed area. They compared soil loss with LULC and found that highest soil loss is from barren land and open forests. Katiyar et al. (2006) divided Ramganga reservoir into nine sub-watersheds to determine the sub-watershed most prone to soil erosion using remote sensing and GIS software for the assessment of reservoir sedimentation. An approach, based on land surface factors mainly responsible for erosion, which include slope, land use, brightness and greenness are used in the study. The integrated effect of all the parameters is evaluated to find sedimentation rate in the reservoir.

Vittala et al. (2008) integrated various physical and socio-economic variables for watershed prioritization using remote sensing and GIS. Chowdary et al. (2008) advocate the role of remote sensing and GIS for integrated watershed management and sustainable development. They argue that integrated watershed management requires a host of interrelated information to be generated and studied in relation to each other. Calder et al. (2008) concluded that intensification of water retention and use within watershed areas can lead to downstream water shortages. They argued that planning methodologies and approaches which were appropriate 20 years ago for planning water harvesting within watershed development projects are no longer appropriate today.

Ma et al. (2010) simulated the coupled effect of land use and climate change on hydrology of a Himalayan watershed and the study revealed the likelihood of increase in vulnerability of mountain watershed to anthropogenic land use and climate change.

Very few studies relevant to the present study were carried out on the Lidder catchment. Ahmad and Hashimi (1974) provided a detailed account of the historical dynamics of Kolahoi glacier and concluded that in the Pleistocene there were three advances of Kolahoi glacier and the last advance was the major one when the glacier extended as far as Pahalgam. They estimated the length of glacier as 5 kilometers and total area of 35 km². Wani (2004) opined that deforestation, unplanned construction and neglect about the maintenance of rivers, lakes and streams are responsible for water and air
pollution. The waste generated at tourist places lead to the spread of vital diseases like jaundice and other disorders at Salar, Kular and Kangan villages in Lidder and Sind valleys. Sherring et al. (2009) used stochastic time series model for catchment and concluded that the autoregressive modal can be used to estimate the rainfall and runoff of the catchment. Jeelani et al. (2010) studied the relation between stream discharge, temperature perception and $\delta^{18}O$ isotope in Lidder catchment. Kanth et al. (2011) studied the receding trend of Kolhoi glacier using Survey of India toposheets and land set data and estimated that the glacier is receding at a rate of 0.07 km$^2$ per year. A brief account of various geomorphologic features of the glacier is also presented. Sheikh et al. (2011) used USLE integrated into GIS to estimate the soil loss in one of the watersheds of Lidder catchment and concluded that the soil loss is highest in agricultural regions (26 tons/hectare/year) and was lowest in forest areas (0.99 tons/hectare/year).

1.9. ORGANIZATIONAL FRAMEWORK

The present study has been organized in nine chapters. The first chapter is devoted to the introduction and the significance, major objectives and review of the existing literature. The second chapter deals with the description of the study area. A brief account of physiographic divisions with climate and soil characteristics is followed by major drainage and vegetation types. At the end of the chapter an account of the human habitation with major economic activity is provided. The third chapter discusses in detail the methodology used in the present study. The first part of the chapter is devoted to the type, source and characteristics of the various data sets used and the sample frame for the present study. The second part discusses the various methodological steps, different indicators and the formulas used for various calculations. The fourth chapter provides the geo-physical profile of the catchment which includes the description of the geology and geomorphological features, slope and altitude analysis with drainage morphometry. A detailed account of various climatic and hydrological characteristics of the catchment is also presented. The fifth chapter provides description about the socio-economic and demographic characteristics of the study area. Chapter sixth is devoted to the analysis of tourism development in the catchment. The delineation of different tourist potential regions and the tourist carrying capacity is also evaluated. The seventh chapter provides spatio-temporal analysis of LULC change. In the eighth chapter watershed prioritization based on different socio-economic and bio-physical indicators has been devised. The conclusion of the study is given in the ninth chapter along with major findings and suggestions. The references cited in the text are provided in a separate section at the end of the report.