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Anthropogenic Impact on Forest Cover in the Western Himalayas A Case Study of Lidder Catchment in Kashmir Valley

M. Imran Malik, M. Sultan Bhat and Nissar A. Kuchay

Abstract

The Himalayas, being among one of the richest ecosystems in terms of biodiversity, are becoming highly vulnerable and most threatened life support system due to excessive anthropogenic interference and rising demand for food, fodder and energy. The present study has been carried out using census of India population data, Survey of India toposheets (1:50000 scale) and pan sharpened LISS-III satellite data. The analysis has shown that the ever increasing demographic pressure with the growing energy demands for domestic (13.12 kg/day/household) and tourism sectors (62 kg/day/hotel) coupled with over grazing (9.02 livestock units/household) have resulted in heavy pressure on the available forest stock thus posing a serious threat to the ecological sustainability of the catchment.

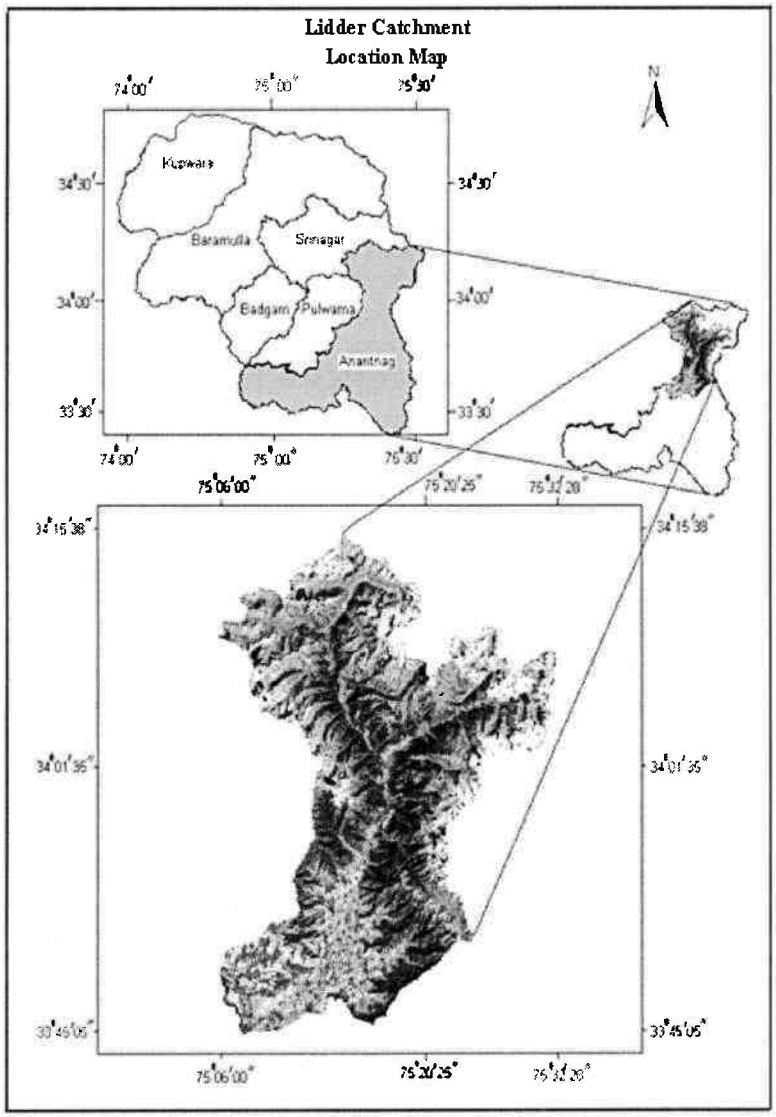
Introduction

Human beings with increasing numbers and technological skills have surpassed the prevailing natural forces in determining the face of the earth and the nature of life and biosphere on it. Environment is being used in three ways by human beings - as living space, as a source of resources and as a sink for wastes. The human impact is the product of the number of people, the level at which they consume and the character of the material and energy flow in production and consumption (Holdren and Ehrlich, 1974). However, the history of human impact has not been a simple process of increasing change in response to linear population growth over time as the growth in culture and technology is of equal importance (Kumar and Turner-II, 1994). Thus the driving forces of environmental change should include all realms of social life.

The importance of mountains as a major resource for humankind is generally underestimated. Mountains 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). The forests help in shaping our natural environment in various ways as it not only influences micro-climate, soil environment, flood conditions, erosion and human health but also provide shelter for wildlife and play an important role in the ecology of watersheds. Preserving forests thus contribute to both climate stability and biodiversity goals. The Himalayas have been the cradle of everything precious and beautiful in India's heritage. 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.

The Himalayan region is characterised not only by ecological fragility but also by a deep and historical geopolitical sensitivity (Stone, 1992). The growing anthropogenic interference due to escalating population growth coupled with mass tourism has led to the adverse impact on mountain ecosystem and biological resource base which has assumed alarming dimensions. It is indeed paradoxical that the mountains which metamorphically denote strength, stability and resilience are indeed the exact opposite. The pace, magnitude and spatial reach of human alterations of the Himalayan region are unprecedented (Ivas and Messerli, 1989). Increased accessibility,

Fig. 1: Location map of Lidder catchment.

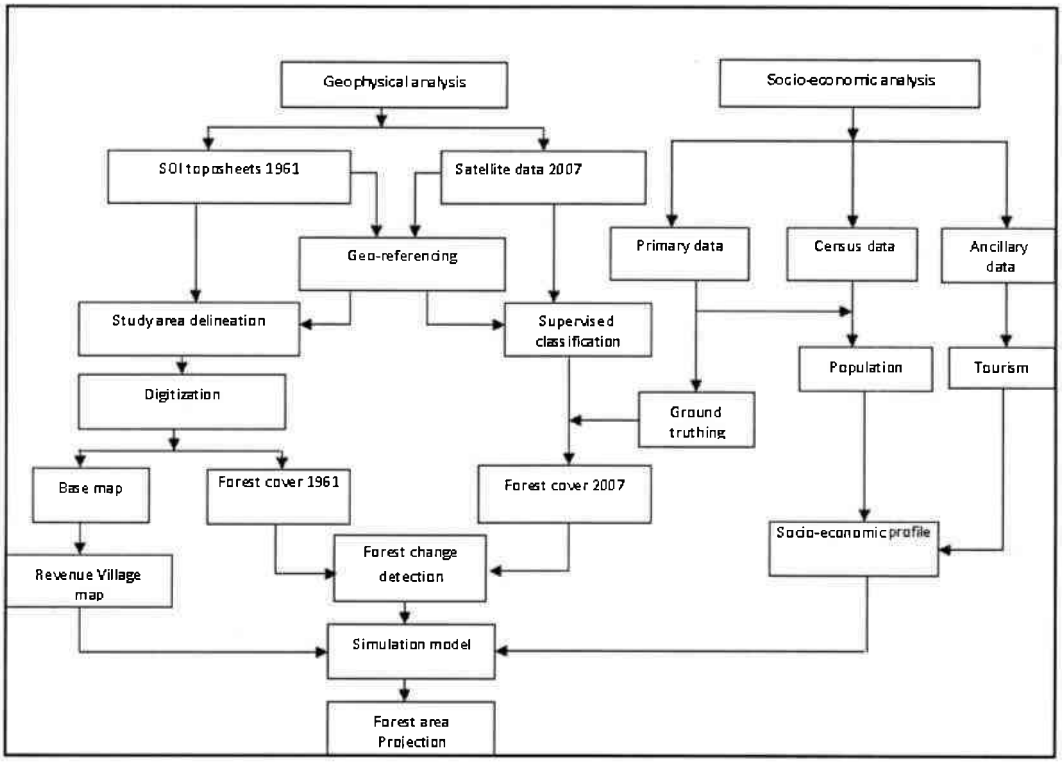


population pressure, economic development and the excessive utilisation of the region's resources for grazing, firewood and timber extraction has resulted in a threat to the health of this mountain ecosystem and its inhabitation (Gupta, 1978) which has led to gradual increase in volume of run-off and hence soil erosion. Forest clearance for agriculture driven by population growth is the primary reason of deforestation in most of the biodiversity rich tropical forest countries (Williams, 1997) as 13 million hectares of forest land is used for agricultural purposes per year (Food and Agriculture Organization, 2005).

Environmental sustainability of the Himalayan region is significant for the welfare of the people who depend on its resources as the Himalayan environmental change affects the ability of biological systems to support 1.3 billion people in the ten river basins in the region (Xu *et al.*, 2007). Efforts to arrest the escalation process of population growth, environmental degradation and poverty in mountain regions of the developing world require an understanding of the reciprocal relationship between environment and development. In view of the growing threat to biological diversity, 11 per cent of the world's forests are designated for the conservation of biological diversity and some 10 million people are employed in forest conservation and management activities (Food and Agriculture Organization, 2005).

Study Area

The Lidder catchment occupies the south eastern part of the Kashmir valley (Fig. 1) and is situated between 33° 45□ 01□ N - 34°



15□ 35□ N and 75° 06□ 00□ E – 75° 32□ 29□ E. The Lidder valley forms part of the middle Himalayas and lies between the Pir Panjal range in the south and south-east, the north Kashmir range in the north-east and Zanskar range in the south-west. The area gradually rises in elevation from south (1600 metres) to north (5425 metres).

The Lidder valley has been carved out by river Lidder, a right bank tributary of river Jhelum. It has a catchment area of 1159.38 km^2 (Bhat et al., 2007) which constitute about 10 per cent of the total catchment area of river Jhelum. The valley begins from the base of the two snow fields, the Kola hoi and the Shish ram where from its two main upper streams, the West and the East Lidder originate and join near the famous tourist town of Pahalgam. It joins the Jhelum (upper stream of Indus river) at Gur village after traveling a course of 70 kms.

The study area reveals a variegated topography due to the combined action of glaciers and rivers. The valley possesses distinctive climatic characteristics because of its high altitude location and its geophysical setting, being enclosed on all sides by high mountain ranges. The valley is characterized by sub-Mediterranean type of climate with nearly 70 per cent of its annual precipitation concentrated in winter and spring months. The temperature variations suggest marked seasonality in the weather, with a long cold season lasting for nearly seven months and a short summer season. The mean minimum temperature ranges between 2°C to 4°C and mean maximum between 16°C to 18°C. The precipitation is mostly in the form of snowfall caused by the western disturbances.

The vegetation of the study region displays characteristic mixture of temperate and alpine flora. The phytogeographic composition of plant communities is different at different elevations due to microclimatic, biotic and other environmental conditions. The dominant arboreal vegetation includes *pinus wallichiana*, *picea smithiana*, *Abies pindrow*, *Betula bhojpatra*, *juniperus communis* and *Rhododendron anthopogon* (Kachroo, 1985).

Objective

To assess and simulate the impact of anthropogenic activities on the available forest resource of Lidder catchment.

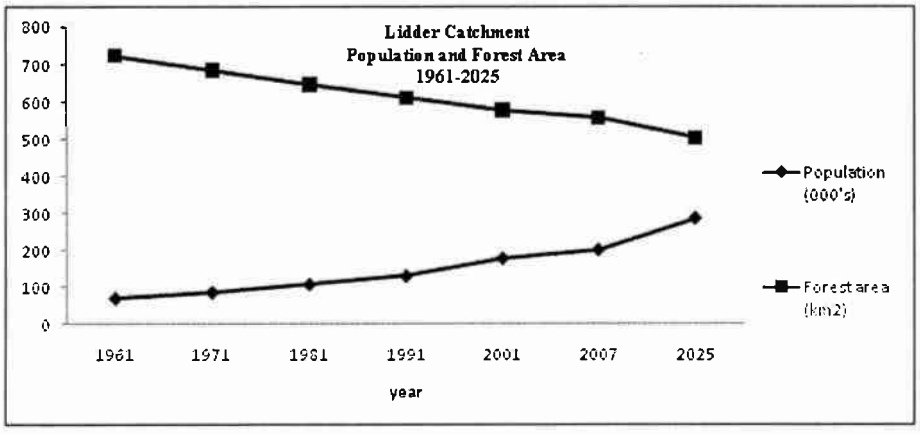


Table1: Trends in forest area and anthropogenic variables.

Year	Population (persons)	Population density (persons/ km²)	Physiological density (persons/km² of net sown area).	Tourist flow (persons)	Tourist Fuel wood consumption (metric tons)	Domestic Fuel wood consumption (metric tons)	Forest area (km²)
1961	69299	59.77	514.71	28002	112.008	41440.80	723.43
1971	85024	73.33	627.43	50149	200.596	50844.35	683.32
1981	106339	91.72	726.90	172620	690.480	63590.72	645.44
1991	129626	111.80	886.08	5230	20.92	77516.34	609.66
2001	177361	152.97	1212.06	341791	1367.16	106061.87	575.86
2007	199737	172.27	1364.97	497001	1988.00	119442.72	556.49
2025*	285274	246.05	1949.52	1531014	5674.45	170593.85	502.19

Source: Computed from SOI toposheets (1:50000 scale) 1961, satellite image 2007, Census of India (1961-2001) and Primary survey (2007). *Projected figures.

Material and methods

The values for simulation were determined through the following equation

$$Fv = Fi\,(1+r/1oo)^{n}.$$

Where,

Fv = value of the required year;

Fi = value of the base year;

n = time between current and base year and r = rate of growth and is given by

$$(r = n\sqrt{c/b} - 1)\,100.$$

Where,

c = value of current year;

b = value of base year and

n = time between current and base year.

Forest change in Himalayas

Himalayan forests have been under continual threat of deforestation for centuries posing a serious ecological crisis in these inherently fragile ecosystems (Ives and Messerli, 1989) leaving some of the hilly areas of north-western India as last remnants of the glorious past. It has been estimated (Pandit *et al.*, 2006) that the current level of deforestation will confine the dense forest cover (>40 per cent canopy cover) to only about 10 per cent of the land area of the Indian Himalaya by 2100 AD.

The national forest policy laid down that in the hills and mountains 60 per cent of the area should be under forests (Kashyap, 1985). The forest cover in Lidder catchment does not confirm to the minimum threshold limit of forest cover laid by the national forest policy, as the present forest cover of the catchment accounts only for 47.99 per cent (2007) which was 62.39 per cent in 1961. The causes of forest depletion in the Himalayan region are complex and they vary from one local setting to another, as the result of long historical trends (Tucker,

1987). Thus forest cover has declined as a result of the land use change (Houghton, 1994) under the combined presence of shifting cultivation, uncontrolled herds of goats, sheep and cattle and wood gathering for home consumption or sale.

Results and Discussion

Impact of population

The Himalayan region has experienced unparalleled land use changes driven by rapid human population growth and intensifying human activities over the past few decades (Pandit *et al.*, 2006). There is no doubt that the natural environment of the Western Himalaya has been reshaped by human impact since Neolithic times dating back to 5000-4500 B.P. (Lone *et al.*, 1993) but until the nineteenth century they were thinly populated (Schickhoff, 1995). The extraction of the forest products do not cause considerable disturbance when the population is sparse and the product is used for domestic use. But as the population pressure becomes greater and the motive of extraction is profit, the disturbance become serious and creates environmental problems. Population growth is a significant driver of deforestation which triggers various other forms of environmental change or degradation. Countries with slow population growth are characterized by forest expansion, though of modest proportions, while those with faster growth are associated with substantial forest contraction (Mather and Needle, 2000). In other words there is a positive correlation between population growth and deforestation (Brown and Pearce, 1994). Harrison (1992) suggested that population growth was responsible for 79 per cent of global deforestation between 1973 and 1988. Growth in population is accompanied by growth in demand for food. This in turn may mean growth in demand for arable land, and hence forest clearance (Mather and Needle, 2000) as the primary reason for forest destruction has always been the creation of new land in order to grow food (Williams, 1997).

The Lidder catchment is inhabited by 124 rural settlements and one urban centre (Pahalgam) belonging to three tehsils of Anantnag, Pahalgam and Bijbiara of Anantnag district (Jammu and Kashmir, India). The total population of the catchment is 1.78 lack persons with a density of 153 persons per km^2 (Table 1.1). This population is spread over 25315 households with an average household size of 7 persons (Census

Fig. 4: Growth in Arithmetic and Physiological density, Lidder Catchment.

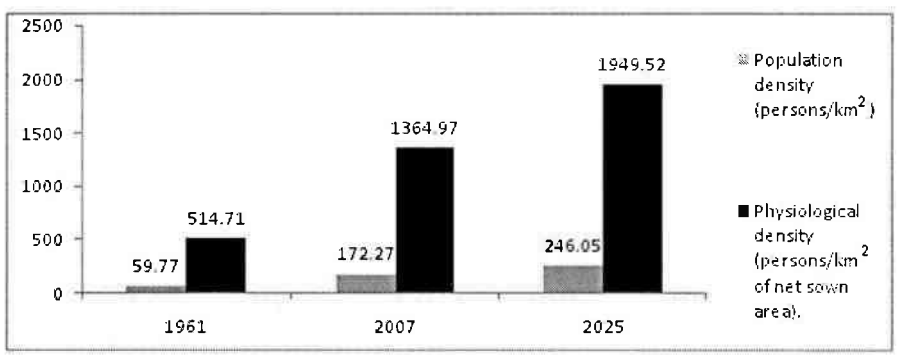


Table 2: Forest change detection - Lidder Catchment, 1961-2007.

Land use/ land cover category	Area (km^2)		Net change (area km^2)	Rate of change (annual)
	1961	2007		
Dense forests	348.43 (30.05)	250.04 (21.56)	-98.39 (-28.24)	-2.14 (-0.61)
Sparse forests	375.00 (32.34)	306.45 (26.43)	-68.55 (-18.28)	-1.50 (-0.40)
Total forests	723.43 (62.39)	556.49 (47.99)	-166.94 (-23.07)	-3.63 (-0.50)

Source: Computed from SOI toposheets (1:50000 scale) 1961and satellite image 2007.

Note: Figures in parenthesis indicate percentage change.

of India, 2001). The population of Lidder catchment has increased 2.5 fold from 1961 to 2001 with the growth rate of 2.38 per cent per annum. The density of population has increased by 155.93 per cent from 59.77 persons per km^2 in 1961 to 152.97 persons per km^2 in 2001 which is much higher than the state average of 99 persons per km^2 (Census of India, 2001). The population of the catchment is projected to be 1.28 million persons in 2025 AD with the population density of 246.05 persons per km^2 which will limit the forest cover to only 502.19 km^2 (Fig. 3). The physiological density has also increased more than two fold from 514.71 persons per km^2 of net sown area in 1961 to 1212.06 persons per km^2 of net sown area in 2007 (Fig. 4) and is estimated to reach 1949.52 persons per km^2 of net sown area in AD 2025. This phenomenal growth in physiological density could be attributed to high population growth on the one hand and the constant net sown area available on the other because more than 60 per cent of the catchment area falls in the slope category of steep to very steep which is not suitable for agricultural practices.

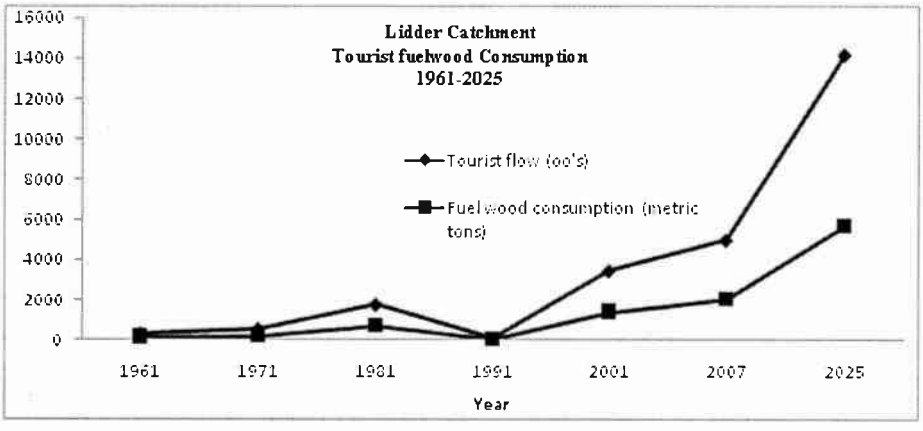
Degradation of vegetation and landscape is found to be a long term complex process that is strongly influenced by changes in the socioeconomic environment (Schickhoff, 1995). The introduction of modern economic systems and the pressure of rural subsistence and population migrations have caused the forest depletion in the Himalayan region (Tucker, 1987). The foremost reason for the forest decline in Kashmir valley is the effects of opening virtually almost all forest regions for the tapping of resin and commercial exploitation of timber and domestic fuel wood consumption (Gupta, 1978) as firewood is the only source of energy for many people living in the mountains. The valley of Kashmir faces shortage of fire wood as the willow trees (traditional fuel wood) are used to prepare the cases for shipping apple and also a significant proportion of the yield is used in sporting-goods industry. The leading factors responsible for the deforestation in the Lidder catchment are the increasing expansion of agricultural land (0.47 km^2/ year), fuel wood consumption (13.12 kg/day/household and 62 kg/day/ hotel) and overgrazing (9.02 livestock units/ household). In summer animal migrations

from the villages to the temperate forests and the alpine meadows eliminate rich flora. Local herdsmen (*gujjars*) need wood for fuel, thus they seriously damage shrubs and trees of the alpine forest zone (Polunin and Stainton, 1984).

Impact of Tourism

Tourism avoids central places and makes much use of peripheral regions and is most suitable choice for any mountainous region to develop its economic base at low cost input. Concern over the ecological effects of tourism started to mount during the 1960's and 1970's (Pearce, 1985) through the realization that the industry has the capacity of either moderately altering or completely transforming destination regions in adverse ways. Many of world's finest resorts have become ugly due to excessive tourist flow. Over the last half century, mountaineering, trekking and mass tourism have developed dramatically in the Himalayan region (Ivas, 2004). Lidder valley is one of the prime tourist destinations of India receiving more than 50 per cent of the total tourists visiting Kashmir valley. The study area has registered the tourist growth rate of 6.45 per cent per annum from 1961-2007 and is estimated to receive more than 1.5 million tourists by 2025 AD (Fig. 5). The mass tourist influx in the catchment is one of the leading contributory factors involved in the process of deforestation (Bhat *et al.*, 2007). The uncontrolled cutting of trees to meet demand of trekkers and tourists has left many highland communities without essential firewood or building material. Fuel wood consumption in hotels is imposing major stress on environment in Lidder catchment especially at Pahalgam. The average fuel wood consumption was calculated about 62 kg/day/hotel which amounts to the total fuel wood consumption of 1964.16 metric tons/year (eight months tourist season). This huge quantity of fuel wood consumption by the hotels is resulting in a heavy pressure on the available forest stock which may result in large scale deforestation and degradation of forests in the catchment. Besides the direct impact due to hotels and construction of roads, there has been indirect impact on the forests which includes forest extinction made by the immigrant population especially shopkeepers, tour operators, Pony owners

Fig. 5: Fuel wood consumption by tourists.



etc. However, it is pertinent to mention here that the dependency on forest stock for energy consumption has decreased from 133 kg/day/hotel (Bhat, 1992) to 62 kg/day/hotel in 2007. This means that the present average fuel wood consumption is less than half of that in 1992. Such as reduction in the average consumption of fuel wood has been possible mainly due to the replacement of fuel wood by Liquefied Petroleum Gas (LPG) for cooking and heating. The average consumption of LPG has been estimated about 196 lt/hotel/month.

The amount and disposal of waste products is another environmental problem emerging at Pahalgam. The average solid waste generated at Pahalgam has been estimated about 25 kg/day/hotel. Regarding its disposal, dustbins were used by all the hotels. The liquid waste was estimated to be 198 lt/day/hotel which amounts to the total liquid waste of 9.53 million lt/year. So far as the liquid waste is concerned, 60 per cent of the hotels drain away their liquid waste directly in Lidder river while 40 per cent hotels use underground soakage pits for its disposal.

Forest change detection

The forest cover in the study area (Fig. 6, see page #) has registering a decline of 23.07 per cent with an average annual loss of 0.50 per cent (3.63 km^2/year). The area under dense forests has recorded a decrease of 28.24 per cent (98.39 km^2) with the average annual decrease of 0.61 per cent while the area under sparse forests has registered a decrease of 18.28 per cent (68.55 km^2) which accounts for the average annual decline of 0.40 per cent (Table 2). Thus the forest cover in the catchment has been reduced to 47.99 per cent in 2007 compared to the total forest cover of 60.10 per cent for western Himalaya as a whole (Pandit *et al.*, 2006). The per capita forest area in the catchment is 0.31 hectares with no forests remaining below 2000 meters. The growth and expansion in agriculture, tourist activities and settlements at the expense of forest cover in the Lidder flood plain has extended to the mountainous areas, similar to the trend as identified for north India as a whole where agriculture replaced forests first in the Gangetic plains and then in mountains.

Conclusions

The study area is experiencing an increasing anthropogenic interference as a result of mass tourist inflow which has changed the demographic and economic scenario of the catchment. This situation has stressed the already weak economic base of the area which is characterized by heavy reliance on agricultural sector and other natural resources especially the forests. The energy and food requirements of the native and floating tourist population are being met through local resource base which have mainly encroached the forest resource of the area. Besides this the weak tourist infrastructure base, biased and unplanned economic activities of the local dwellers and non existence of government tourism policy, have resulted in a continuous and fast change in the land use/land cover of the catchment from forest to non-forest uses and the consequent degradation of the various available resource potentialities of the catchment. The simulations for the year 2025 have shown alarming rates of different demographic variables and tourist inflow and the resultant pressure on the forest resource of the catchment. If the present scenario of

increased anthropogenic interference and the resultant deforestation continues unchecked the forest cover of the catchment would be reduced to only 43.3 per cent (502.19 km^2) by AD 2025. Which in its turn may damage the overall resource potentialities/ carrying capacity of the watershed beyond repair; the catchment might become very fragile and face an ecological disaster. Therefore the resource potentialities of the catchment need to be evaluated objectively to identify the potential sectors of development and their carrying capacity which would help in the integrated development of the catchment and its stakeholders in an eco-friendly and sustainable manner.

Acknowledgement

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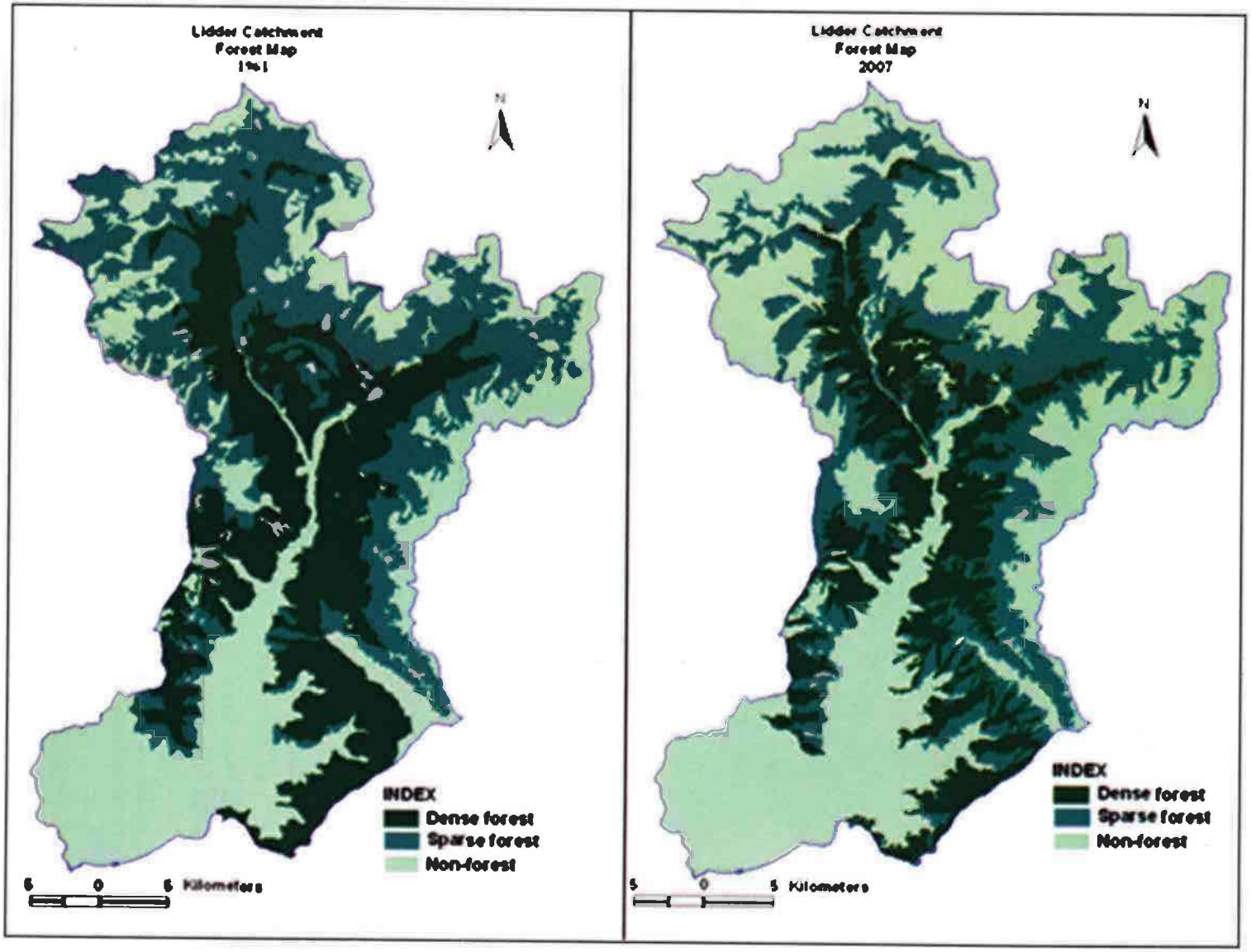
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Forest Map
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Dense forest
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