CHAPTER 1

INTRODUCTION

1.1 CONCEPT AND DEFINITION

Knowledge about land use and land cover has become increasingly important as the nation plans to overcome the problems of haphazard, uncontrolled development, deteriorating environmental quality, loss of prime agricultural lands, destruction of important wetlands and loss of fish and wildlife habitat. Land use data are needed in the analysis of environmental processes and problems that must be understood if living conditions and standards are to be improved or maintained at current levels. The research goal is to promote awareness and use of spatially explicit and graphic information on natural resource trends among national and regional decision-makers, and engage them in modeling future scenarios that will help them formulate sound and sustainable policy responses leading to better natural resource management, conservation, food security and human well being in the town planning. The results of the research will be shared with Uttarakhand and Indians political leaders, environmental decision-makers, urban planners and the broader scientific community in countries throughout the region. A modern nation, as a modern business, must have adequate information on many complex interrelated aspects of its activities in order to make decisions. There are many geographers and planners who have given their concept and definition of land use/land cover as discussed briefly in the following paragraphs.

1.1.1 Land Use/Land Cover

Land use is a product of interactions between a society's cultural background, state and its physical needs on the one hand and the natural potential of land on the other
(Ram and Kolarkar, 1993). Land use is the intended employment of land management strategy placed on the land cover by human agents or land managers to exploit the land cover and reflects human activities such as industrial zones, residential zones, agricultural fields, grazing, logging and mining among many others (Zubair, 2006). Land use change is defined to be any physical, biological or chemical change attributable to management, which may include conversion of grazing to cropping, change in fertilizer use, drainage improvements, installation and use of irrigation, plantations, building farm dams, pollution and land degradation, vegetation removal, changed fire regime, spread of weeds and exotic species and conversion to non-agricultural uses (Quentin et al., 2006). Land cover is defined by the attributes of the earth’s land surface captured in the distribution of vegetation, water, desert and ice and the immediate subsurface, including biota, soil, topography, surface and groundwater. It also includes those structures created solely by human activities such as mine exposures and settlement (Lambin et al., 2003; Chrysoulakis et al., 2004; Baulies and Szejwach, 1998). Land use refers to man's activities which are directly related to the land (Clawson and Stewart, 1965). Land use involves the management and modification of natural environment or wilderness into built environment such as fields, pastures, and settlements.

1.1.2 Land Use/Land Cover Change

Land use/land cover change has become a central and important component in current strategies for managing natural resources and monitoring environmental changes. Land use/land cover change is a dynamic process taking place on the bio-physical surfaces that have taken place over a period of time and space is of enormous importance in natural resource studies. Land use/land cover change dynamics are
important elements for monitoring, evaluating, protecting and planning for earth resources. Land use/land cover changes are the major issues and challenges for the eco-friendly and sustainable development for the economic growth of any area. With the population explosion, human activities such as deforestation, soil erosion, global warming and pollution etc, are very harmful for the environment. This causes land use/land cover changes with the demand and supply of land in different activities. Land use/land cover change has become a central component in current strategies in managing natural resources and monitoring environmental changes. Land use/land cover change, as one of the main driving forces of environmental change, is central to the sustainable development debate. It has impacts on a wide range of environment and landscape. The change in land cover occurs even in the absence of human activities through natural processes where as land use change is the manipulation of land cover by human being for multiple purposes-foods, fuel wood, timber, fodder, leaf, litter, medicine, raw materials and recreation. Many socio-economic and environmental factors are involved for the change in land use/land cover. Land use/land cover change has been reviewed from different perspectives in order to identify the drivers of land use/land cover change, their process and consequences. Change detection in land use and land cover can be performed on a temporal scale such as a decade to assess landscape change caused due to anthropogenic activities on the land (Gibson, 2000). Land use/land cover change is influenced by various natural and human activity processes. Spatial details play important role in this process (White et al., 1997). In order to improve the economic condition of the area without further deteriorating the bio-environment, every bit of the available land has to be used in the most rational way. This requires the present and the past land use/land
cover data of the area (Chaurasia et al., 1996). Land use/land cover dynamics are widespread, accelerating and significant processes driven by human actions but also producing changes that impact humans (Agarwal et al., 2002). Prakasam (2010) studied the land use and land cover change in the Kodaikanal region of Western Ghats in Tamil Nadu State of India to observe changes during a span of 40 years from 1969 to 2008. Some recent studies (Samant and Subramanyan, 1998; Jaiswal et al., 1999; Minakshi et al., 1999) have shown the use of remote sensing and GIS in land use change detection. Micro watershed study helps in identifying the areas causing problems and ultimately becomes a step towards planning to mitigate the problems (Jensen, 1996). The land use/land cover pattern of a region is an outcome of natural and socio-economic factors and their utilization by man in time and space. Information on land use/land cover is important to support urban management and planning, sustainable management of natural resources and socio-economic development (Kontes et al., 2000) Land cover is a fundamental parameter describing the Earth’s surface. This parameter is a considerable variable that impacts on and links many parts of the human and physical environments (Foody, 2002).

1.1.3 Urban Land use/land cover

Urbanization is the process of converting a rural area into the urban area. It thus, refers to placing infrastructure (buildings, transport) in an area, hereby improving trade and increasing the livelihood of people. This improvement occurs, partially because of easier transport (better road system) and partially because of a higher population density. Higher population density reduces travel distance, allowing more walking and cycling, and provides a larger customer base for public transport. Most of the developing countries are passing through the face of population explosion and
urbanization. Without proper urban planning and management, it will be impossible and enormous challenges for the government to provide shelter and residence to millions of homeless and poor in the urban areas and it will create hopscotch condition in future. This has also posed great concern among urban planners. Urban growth due to immigration has led to increase in population density among the cities. There is an increase in slum and squatter settlements in cities and urban area due to shortage of facilities and increasing demand of urban land for residential purposes. Housing overcrowding, loss of privacy, lack of housing contributes directly to crime, stress and family breakdown shortage of livable housing leading to growth of slums human beings have a right to lead a life of dignity. The migration of rural people to urban areas hoping for better job opportunities and better standard of living. The amount of land have been used in different purpose in a town like residential, industrial, commercial, institutional, constructional, public administrative sites and transportation facilities, viz., road, railway station, airport and yard, cemeteries, golf courses, sanitary landfills, water control structures, sewage plants, small parks within the town area are considered as urban land use. The urban land use/land cover change of a region is an outcome of natural and socio-economic factors and their utilization by man in different time and space. Land use/land cover change has become an important component in current strategies to manage and monitoring in natural resources and environmental changes.

1.1.4 GIS and Remote Sensing in Land Use/Land Cover Study

With the invent of remote sensing and GIS techniques, land use/land cover mapping has given a useful and detailed way to improve the selection of areas designed to agricultural, urban or industrial areas of a region (Selcuk et al., 2003). Application of
remotely sensed data made possible to study the changes in land cover in less time, at low cost and with better accuracy (Kachhhwaha, 1985) in association with Geographical Information System (GIS) that provide suitable platform for data analysis, update and retrieval (Chilar, 2000). The advent of high spatial resolution satellite imagery and more advanced image processing and GIS technologies, have resulted in a switch to more routine and consistent monitoring and modeling of land use/land cover patterns. Remote-sensing has been widely used in updating land use/land cover maps so, land use/land cover mapping has become one of the most important applications of remote sensing (Lo and Choi, 2004). The mapping of land use/land cover can be performed in a cost-effective manner using earth observation remote-sensing technologies in conjunction with geographical information systems (Weng, 2002) and GI Science (Wilson and Fortheringham, 2008). Digital change detection techniques based on multi-temporal and multi- spectral remotely sensed data have demonstrated a great potential as a means to understanding landscape dynamics-detect, identify, map, and monitor differences in land use/land cover patterns over time, irrespective of the causal factors.

1.2 STATEMENT OF PROBLEM

In Indian cities the problems are manifold and the solution lies only in the present frame work of our urban society, administration and technological availability of resources. The local planning body aims at limited improvement of physical landscape, construction of better drains, roads, water towers and safety latrines. It also aims at better utilization of the available human resources along with the housing improvement and creation of jobs and may be attempted on self-help basis to solve the urban problems. Some of the most important universal urban problems are ever
increasing population, core and the periphency differentials, problems of land reserves and land use management, slum area, housing and living problem, problems of inadequate transport, waste and sewage disposal, environmental problem, provision of infrastructural facilities, problem of rural suburb and problem of migrants etc. A brief amount of these problems are discussed below.

1.2.1 Ever Increasing Population

According to 1991 census, about 25 per cent population of India lives in urban cities. But in comparison with western world the population is about 21 crores which covers about three-fourth of the United States of America. The basic problem is that, in India the facilities in urban areas are very poor in comparison with situations available in the western world. The exodus of rural population from nearby the city of Nainital district are the issues which has hampered the provision of adequate water supply, sufficiency of transport and favors rush in schools, colleges, hospitals, bus traffic, trains and even in the market centers and residential houses. The existing large and small sized towns have already grown beyond their capacity and even the present rate of growth is likely to be unmanageable. Out of total population of Uttarakhand, 30.55% people live in urban regions. The urban population in the last 10 years has increased by 41.86 percent. Acceleration of growth means the infusion of more employment and worsening the living conditions of people of urban area.

1.2.2 Core and the Periphency Differentials

The recognition of the city core and its related areas differentiation is of course a key objective in any urban plan. In core areas, the worsening of traffic problem increases the quantity and complexity of functions to serve a much larger and far-flung
population and workers besides increasing the congestion along with mix of small scale industries even in residential areas. On the other hand, in the fringe area of the city, the dump of heaps of garbage, residential quarter of low income group people, low sitting conditions and less development of transport linkage are some of the basic problems of urban development (Bekinsale and Howston, 1968). Nainital district is famous for tourist place because it’s natural beauty and favorable climatic condition. Some time, it creates unbearable traffic problem because the lane in hilly area is single and low space. Year by year, the number of new vehicles are increasing which also creating the critical traffic problem.

1.2.3 Problems of Land Reserves and Land Use Management

In urban areas the presence of land reserve is essential for effective planning. Planning will take a long period, not less than 10 to 25 years. Unless free land is available in fairly well determined quantities and at favorable locations for specific future uses, obviously there would be no plan except casual development efforts. With the 4 per cent of annual increase in urban population the demand of land for housing colonies has gone up drastically (Wise, 1964). The Haldwani and Ramnagar towns expended on a foothill region (locally called Bhabhar) made-up of quaternary deposits, i.e., coarse alluvium where the mountain rivers debauch and re-emerge in the adjacent Indo- Gangetic plain. Due to very high fertile soil this area is famous for vegetation and agricultural production. There is huge migration of population to this area from the mountainous parts of the Kumaun region. Sometime it create problem for sustainable land use management. In the other side, Nainital, Bhimtal and Bhowali towns are situated on the Lesser Himalayan mountain region. These areas are mainly surrounded by steep and high hills with very less amount of agricultural land. But all
these cities are increasing with high population density. Due to hilly terrain these
towns are also prone for landslides. These all factors suggest that there is need of
proper land use/land cover planning and management in these town areas.

1.2.4  Slum Area

Slum is highly congested low income part of the city where a considerable diversity in
occupations, caste and religion is found. This is the area of shortage of houses, insanitary
condition, retched and muddy lanes besides the utter lack of drinking water supply. Slum
clearance is a vast and complex issue. The slum is an extreme illustration of housing
shortage, illiteracy, heterogeneity of caste and functions of people older slums are
concerned extensive redevelopment necessary for abolishing them. Equally important is
the problem of preventing the emergence of new slums (Mandal, 2000). Most of the
towns of Nainital district has influenced with slum problem.

1.2.5  Housing and Living Problems

The housing problem is due to increase in industrialization, profit motive and increase in
gap between population and construction of houses. About a quarter of population of the
city lead a life of single person without their family female counter part and they form
more than half of the households. Most of them are male and living alone as married
migrant. Many of them are illiterate, unskilled workers and their per capita income is very
low. The majority of this large group live in about the worst living condition in the city.
Such a miserable condition is going to be happening in Haldwani and Ramnagar towns,
therefore, there is an urgent need of proper land use/land cover management.

1.2.6  Problems of Inadequate Transport and Traffic

Besides shortage of residential houses there is an utter lack of sanitation, water supply
and repair of roads in the towns of Uttarakhand State. Only the patchwork repair of
large potholes on roads will solve the problem either by the municipalities or by the Government with sustainable land use/land cover. The most important transport problems are often related to urban areas and take place when transport systems, for a variety of reasons, cannot satisfy the numerous requirements of urban mobility. Urban productivity is highly dependent on the efficiency of its transport system to move labor, consumers and freight between multiple origins and destinations. Additionally, important transport terminals such as ports, airports, and rail yards are located within urban areas, contributing to a specific array of problems. There are many problems related to traffic in the study area as described below:

1.2.6.1 Traffic Congestion and Parking Difficulties
Congestion is one of the most prevalent transport problems in most of the towns in the hilly region of Uttarakhand because this state is a tourist hub and the roads are mainly single and narrow in width, it create traffic problem. Because of shortage of parking places people park their own vehicle on the road side which creates traffic problem in town areas.

1.2.6.2 Public Transport Inadequacy
Because of low space hilly area and low ridership makes many services financially unsustainable, particularly in suburban areas. It creates crowds at the office hours.

1.2.6.3 Environmental Impacts and Energy Consumption
Pollution, including noise, generated by traffic circulation has become a serious impediment to the quality of life and even the health of urban populations. Not only that, it also harm and destroy the natural environment in the tourist places and towns.

1.2.6.4 Difficulties for Non-Motorized Transport
Sometimes tourist and the local people create intense traffic, where the mobility of pedestrians in the hilly area becomes very difficult because of high slopes.
1.2.6.5 Accidents and Safety

The growth of traffic in urban areas is linked with a growing number of accidents and fatalities, especially in hilly areas. As traffic flow increases, people feel less safe to use the streets and in the hilly area.

1.2.6.6 Loss of Public Space

Most of the roads are publicly owned and free of access. Public activities are adversely responsible for increase of traffic flows which crowded the streets such as markets, parades processions, games and community interactions. Traffic flows influence the daily life and interactions of residents. More traffic impedes social interactions and street activities.

1.2.7 Waste and Sewage Disposal

Another important question is of waste and sewage disposal. These should be studied by the local bodies. Some ideas are expensive, but there are others which are low-cost methods and these should be implemented whenever feasible. Effort should be made on the use of waste by recycling it for proper town management. Some of it may be used for manure. Other things such as paper, rags and so on can be recycled. There are other things which are used as sources of energy and similarly there is metal scrap and so on. All these things are treated as rubbish today, are valuable substances.

1.2.8 Environmental Problems

The problems of environmental pollution exist in almost all urban centers. It is found that the public transport, the private buses, the power stations and other factories generate a lot of pollutants. In the cities having far less industries than the industrialized countries have a far greater rate of pollution because they have not
taken steps to check and clean up their cities. So we must insist from now that any new services, any new industry that comes up, must have those safeguards. Now a days, with the overwhelming increase of population, the burden of the available residential houses, cultivable land, roads, railways, water taps and industries located in urban areas have surpassed all previous levels in terms of harnessing the resources and creating environmental hazards.

1.2.9 Provision of Infrastructural Facilities

The first necessity is to provide the infrastructure, i.e., adequate water supply, drainage, electricity, roads and means of transport. There is also problem of the slum and the pavement dwellers. We have to remove slums, but we cannot remove the people who live in slums; they have to provide proper livelihood and it requires systematic land use/land cover in these cities.

1.2.10 Problems of Unemployment

Many urban dwellers in cities are without employment. Many more are becoming houseless year by year. In migration in the cities and natural increase of population are the causes of housing shortage. In urban areas the mal-distribution of population would jeopardize the whole planning endeavor.

1.2.11 Problems of Migrants

Those who come from urban centre demands greater facilities whereas migrants come from rural areas have low demand for housing and social amenities. The people living in urban areas are mostly migrants and in some cities they constitute 70 to 80 per cent of the total urban population.
1.3 STUDY AREA

The study area, viz. district of Nainital (Fig. 1) lies in the Kumaun division of the Uttarakhand State in India. The Almora district is in the northern part of Nainital district, Udham Singh Nagar in south, Champawat in east and Pauri Garhwal district is in the west to the Nainital district. On the northern part of the Nainital district are Himalayan ranges while on the southern part is plain surface. The highest peak (2556 m) of the district is Baudhansthali near Binayak adjoining Nainital town. In the hilly region of the district, there are large and small lakes i.e., Bhimtal, Sattal, Naukuchiatal, Khurpatal, Nainital, Malwatal, Harishtal and Lokhamtal etc.

Gaula and Kosi are the main river of the district Kosi river arising out of Koshimool near Kausani flows on the western side of the district. There are number of other smaller rivers like Bhakra, Dabka, Baur etc. Most of these have been dammed for irrigation purposes. The district is one of the best hill stations in the world with its salubrious climate and scenic beauty, and the Jim Corbet National Park with its favorable physiographic conditions makes this area a tourist hub. There are five blocks in the hilly part of the Nainital district namely Bhimtal, Ramgarh, Betalghat, Dhari and Okhalkanda. Most of the hilly part is not favorable for agriculture but in the southern Bhabhar region like Haldwani, Ramgarh and Kotabagh have very fertile land and are famous for agricultural production. The district consists 450 Gram Sabhas and 4 Municipal Boards and one Cantonment Board.

1.3.1 Location

The study area viz., the Nainital District extends between 28°57'40"N to 29°36'07"N latitudes and 78°51'53"E to 79°57'57"E longitudes and encompasses an area of 4143.38 km² (Fig. 1). About three fourth part of the district is hilly while remaining one fourth parts is plain locally known as Bhabhar.
Fig. 1.1: Location map of the District Nainital.
1.3.2  Relief and Climate
The average height of the district stands at 809 m above mean sea level which varies between 123 m in the extreme south to 2556 m at the extreme northern part. Climatically, the district enjoys sub-tropical conditions in the southern Bhabhar zone while entire the hilly region of the district has cool to cold temperate climatic conditions. Nainital district receives about 2530 mm annual rainfall.

1.3.3  Soil and Vegetation
Broadly speaking the district is made up of two types of soils. These are mountainous soils in the hilly region and alluvial soils in the entire Bhabhar region. The hilly region of Nainital district is covered with Pine, Oak, Buruns, Kaphal and other temperate trees while the bhabhar zone and valleys are covered by Sal and Shisham of sub-tropical trees.

1.3.4  History
History of Nainital District states that it has several significant mythological references as Nainital is one of the 51 Shakti Peethas in India (http://www.indianetzone.com/49/nainital_district.htm). British government occupied Kumaon and Garhwal in 1815. Nainital became a popular hill resort since 1887. On 3rd of October 1850, Nainital Municipal Board was formally constituted. In 1862, it became the summer seat of the North Western Provinces. After it was made the summer capital, a remarkable expansion of the town occurred with the growth of magnificent bungalows all around and construction of facilities such as marketing areas, rest houses, recreation centre’s, clubs etc., together with the secretariat and other administrative units. It also became an important centre of education.
1.3.5 Education

There is a proper government educational setup in Nainital district besides having several prestigious public schools. At present there are around 1260 Junior Basic Schools, 356 Senior Basic Schools, 198 Secondary Schools, 4 Degree Colleges and one University, viz., the Kumaun University. Nearly 90 percent of Junior Basic Schools are located in the rural areas while about 85 percent and 65 percent of Senior Basic and Secondary Schools respectively are located in urban areas. For technical education, Nainital Polytechnic provides 3 years diploma courses in various streams like civil, mechanical, electronics and 2 years diploma courses in pharmacy, computer applications, and short hand-secretarial work. Various private institutions affiliated to Kumaon University are also providing MCA, B.Ed and MBA courses. (http://www.indianetzone.com/49/nainital_district.htm).

1.3.6 Culture

Nainital District is rich in cultural traditions and heritage. The main towns of the district like Haldwani, Nainital, Ramnagar, Bhimtal and Bhowali have cosmopolitan nature and their people are associated with various religions and faith. The major part of population follows indigenous Kumauni traditions. In societies, marriages are mostly arranged by the parents. The tradition of colorful ornamentation on Aanchal cloths is a unique Kumauni tradition, rooted deep in its long history. The style of painting is locally known as Aipan. Several fairs and festivals are organised in the district. After harvesting season people mostly relax, rejoice, dance and sing and thus a festival is celebrated Vasant Panchami, Shivaratri, Holi, Ramnavami, Dussehra, Raksha Bandhan, Janmashtami, Diwali, etc. are some of the auspicious occasions.
which are celebrated in the district. Fairs are also organised on these occasions on certain places such as Haldwani, Nainital, Ramnagar, Bhimtal and Bhowali.

**1.3.7 Tourism**

Nainital is blessed with scenic natural splendour and varied natural resources. Dotted with lakes, Nainital has earned the epithet of ‘Lake District’ of India. The most prominent of the lakes is Naini Lake ringed by hills. Nainital has a varied topography. Some of the important places in the district are Nainital, Haldwani, Kaladhungi, Ramnagar, Bhowali, Ramgarh, Mukteshwar, Bhimtal, Sattal and Naukuchiatatal. Nainital’s unending scenic beauty is nothing short of a romance with awe-inspiring and pristine nature. Nainital District offers several scopes for trekking for the adventure lovers. Nainital is well connected with the rest part of the country through different modes of transport. Nainital has achieved a special status in industrial development. HMT watch Factory, Ranibag, Century Pulp and Paper Lalkuan, IOC bottling plant, Mota Haldu are the main industries of the district.

**1.3.8 Demography**

As per Census 2011 (Table-1.1), Nainital district has a population of 955128 out of which male and female are 494115 and 461013, respectively. The Census data reveal that the population growth rate in district Nainital has dropped down in 2011 in 25.20% in compression to the population growth rate of 2001, i.e., 32.72%. The population density of the district stands at 225 persons per km$^2$ and have a literacy of 84.85%. If things are looked out at gender wise, male and female literacy is 91.09% and 78.21%, respectively. In the district, there are total 122199 children under age of 0-6 which constitutes about 12.79% of the total population of the district. The details
of urban and rural population of the study area are described in the following paragraphs.

1.3.8.1 Urban Population 2011

The total urban population of the Nainital district stands at 371891 which accounts for 38.94% of the total population of the district (Table-1.2). Sex Ratio in urban population is 911 female per thousand male. Child sex ratio in the Nainital district is 881 female per 1000 male. Child population (0-6) in urban region is 44037 out of which males and females are 23410 and 20627, respectively. Average literacy rate in the urban areas in the district at present is 86.13 % and in male and female the literacy rate stand at 89.67 % and 82.27 %, respectively. Total number of literate people in urban region of district Nainital stands at 282398.

1.3.8.2 Rural Population 2011

Table 1.2 contains a comparative account of rural and urban population characteristics of district Nainital. It reveals that as per 2011 census, 61.06 % population of Nainital district lives in rural areas while remaining 38.94% lives in urban areas. The total district population living in rural areas is 583237 out of which males and females are 299542 and 283695, respectively. In rural areas of Nainital district, sex ratio is 947 females per 1000 males. If child sex ratio data of the district is considered, figure is 896 girls per 1000 boys. Child population in the age 0-6 is 78162 in rural areas out of which males are 41216 and females are 36946. The child population comprises of 13.76% of the total rural population of Nainital district. Literacy rate in rural areas of the district is 84.02%. Gender wise, male and female literacy stand at 92.04% and
75.63%, respectively. In total, 424357 people in the rural area of the district are literate out of which males and females are 237751 and 186606, respectively.

**Table 1.1:** Demography of the district Nainital in 2001 and 2011 (*Based on Census Handbook 2001 and 2011*).

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<tr>
<th>S.No.</th>
<th>Description</th>
<th>Year</th>
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<tbody>
<tr>
<td></td>
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<td>2011</td>
</tr>
<tr>
<td>1</td>
<td>Actual Population</td>
<td>955,128</td>
</tr>
<tr>
<td>2</td>
<td>Male</td>
<td>494,115</td>
</tr>
<tr>
<td>3</td>
<td>Female</td>
<td>461,013</td>
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<tr>
<td>4</td>
<td>Population Growth</td>
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<tr>
<td>5</td>
<td>Area Km²</td>
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<tr>
<td>6</td>
<td>Density person/km²</td>
<td>225</td>
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<td>7</td>
<td>Proportion to Uttarakhand Population</td>
<td>9.44%</td>
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<tr>
<td>8</td>
<td>Sex Ratio (Per 1000)</td>
<td>933</td>
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<tr>
<td>9</td>
<td>Child Sex Ratio (0-6 Age)</td>
<td>891</td>
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<tr>
<td>10</td>
<td>Average Literacy</td>
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<td>11</td>
<td>Male Literacy</td>
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<td>12</td>
<td>Female Literacy</td>
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<tr>
<td>13</td>
<td>Total Child Population (0-6 Age)</td>
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<td>14</td>
<td>Male Population (0-6 Age)</td>
<td>64,626</td>
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<td>15</td>
<td>Female Population (0-6 Age)</td>
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<tr>
<td>16</td>
<td>Literates</td>
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<td>Male Literates</td>
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<td>18</td>
<td>Female Literates</td>
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<td>19</td>
<td>Child Proportion (0-6 Age)</td>
<td>12.79%</td>
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<td>20</td>
<td>Boys Proportion (0-6 Age)</td>
<td>13.08%</td>
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<td>21</td>
<td>Girls Proportion (0-6 Age)</td>
<td>12.49%</td>
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<tr>
<td>22</td>
<td>Sex Ratio (Per 1000)</td>
<td>933</td>
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Table 1.2: Urban and Rural Demography of district Nainital in 2011 (Based on Census Handbook 2011).

<table>
<thead>
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<th>S.No.</th>
<th>Description</th>
<th>Rural</th>
<th>Urban</th>
</tr>
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<td>1</td>
<td>Population (%)</td>
<td>61.06%</td>
<td>38.94%</td>
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<td>2</td>
<td>Total Population</td>
<td>583,237</td>
<td>371,891</td>
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<tr>
<td>3</td>
<td>Male Population</td>
<td>299,542</td>
<td>194,573</td>
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<td>4</td>
<td>Female Population</td>
<td>283,695</td>
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<td>5</td>
<td>Sex Ratio</td>
<td>947</td>
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<td>6</td>
<td>Child Sex Ratio (0-6)</td>
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<td>881</td>
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<td>Child Population (0-6)</td>
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<td>8</td>
<td>Male Child (0-6)</td>
<td>41,216</td>
<td>23,410</td>
</tr>
<tr>
<td>9</td>
<td>Female Child (0-6)</td>
<td>36,946</td>
<td>20,627</td>
</tr>
<tr>
<td>10</td>
<td>Child (0-6)</td>
<td>13.40%</td>
<td>11.84%</td>
</tr>
<tr>
<td>11</td>
<td>Male Child</td>
<td>13.76%</td>
<td>12.03%</td>
</tr>
<tr>
<td>12</td>
<td>Female Child</td>
<td>13.02%</td>
<td>11.63%</td>
</tr>
<tr>
<td>13</td>
<td>Literates</td>
<td>424,357</td>
<td>282,393</td>
</tr>
<tr>
<td>14</td>
<td>Male Literates</td>
<td>237,751</td>
<td>153,483</td>
</tr>
<tr>
<td>15</td>
<td>Female Literates</td>
<td>186,606</td>
<td>128,910</td>
</tr>
<tr>
<td>16</td>
<td>Average Literacy</td>
<td>84.02%</td>
<td>86.13%</td>
</tr>
<tr>
<td>17</td>
<td>Male Literacy</td>
<td>92.04%</td>
<td>89.67%</td>
</tr>
<tr>
<td>18</td>
<td>Female Literacy</td>
<td>75.63%</td>
<td>82.27%</td>
</tr>
</tbody>
</table>

### 1.4 LITERATURE REVIEW

The major objective of the present research is to conduct studies on change pattern in urban land use/land cover pattern using remote sensing and GIS technologies. The fundamental objective of this section is to review the literature on urban land use/land cover and change detection studies. This literature review has done in the different level, i.e., review at international level and national level. A detailed account of international and national review of literature is presented in the following paragraphs.
1.4.1 International Level Review

Various works on urban land use/land cover have been done by many scholars. Some of the scholars who have done major contributions specially on land use/land cover change detection are Anderson et al. (1976); Friedman et al. (1979); Toll et al. (1980); Welch (1982); Khorram et al. (1987); Singh (1989); Michalak (1993); Meyer (1995); Macleod and Congalton (1998); Adeniyi and Omojola (1999); Daniel et al. (2002); Tian et al. (2005); Xiao et al. (2005); Lu et al. (2007); Dewan and Yamaguchi (2009); Shahraki et al. (2011); and Noor and Rosni (2013). A brief account of above scholarly works is given in the following paragraphs.

Anderson et al. (1976) developed a hierarchical land use/land cover classification system for utilization with remote sensing data which has been adopted by the U.S. Geological Survey for 1:250,000 and 1:100,000 scale land use and land cover mapping of the United States of America. The Anderson classification system and or Anderson derived land use and land cover classifications have been adopted in most contemporary land use and land cover research utilizing remotely sensed satellite data.

Friedman et al. (1979) developed two methodologies for detecting and mapping land cover changes in and around growing urban regions at Jet Propulsion Laboratory. Both approaches, primarily based on digital image processing techniques, have been developed to supplement data stored in an Image Based Information System (IBIS). The structure of this information system enables the depiction of land cover changes in image format concurrently with statistical reports in tabular form. To date the expansion of two urban areas, Houston, Texas and Orlando, Florida, has been monitored.
Toll et al. (1980) explained that Landsat digital enhancements and classification maps are useful for updating the urban expansion of standard metropolitan statistical areas on a macro scale. Automated procedures for detecting non-urban to urban land coverage change using multi-temporal Landsat data are investigated for five metropolitan areas, showing an overall delineation similar to that obtained from large scale aerial photography. The evaluated change detection procedures include image differencing, principal component transformation prior to differencing and post classification comparison. Results showed that image differencing techniques in MSS band 5 provided the most accurate land cover change detections.

Welch (1982) observed that remote sensor data with spatial resolutions corresponding to 0-5-10m Instantaneous Field of View (IFOV) are required to define adequately the high frequency detail in which characterizes the urban scene. Consequently, it is unlikely that satellite image data expected for the 1980s will replaced aerial photographs as a primary source of information about urban areas.

Khorram et al. (1987) have conducted supervised classification of digital Landsat Multi-spectral Scanner (MSS) data for the Raleigh, North Carolina, metropolitan area in 1982. A stratified classification based upon principal components analysis was applied to the Digital Landsat Thematic Mapper (TM) 1985 data, classifying the data into the 10 land-use/land cover categories used in the analysis of the MSS data. TM data provided significantly higher classification accuracies than can be obtained from MSS data. It is not clear that the information extracted from the TM data regarding the urban environment will be of much more use to city planners than that obtained from MSS data.
Singh (1989) described that change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times. Change detection is an important process in monitoring and managing natural resources and urban development because it provides quantitative analysis of the spatial distribution of the population of interest.

Singh (1989) and Coppin and Bauer (1996) have summarized eleven different change detection algorithms that were found to be documented in the literature by 1995. These include:

a) Mono-temporal change delineation;
b) Delta or post classification comparisons;
c) Multi-dimensional temporal feature space analysis;
d) Composite analysis;
e) Image differencing;
f) Multi-temporal linear data transformation;
g) Change vector analysis;
h) Image regression;
i) Multi-temporal biomass index;
j) Background subtraction; and
k) Image rationing.

Michalak (1993) highlighted the application of GIS in land use change analysis. A number of existing applications and solutions are reviewed. In particular, the problem of integrating remotely sensed data with other data models in GIS for planning purposes is explored. He supposed that remotely sensed images are
ideally suited to consistent, accurate, and up-to-date land use change evaluations. Unfortunately, the current techniques and commercially available systems are not entirely satisfactory. The study therefore, examined the existing approaches and suggests possible solutions and a further research agenda for improving the integration and analysis process.

According to Meyer, 1995 every parcel of land on the Earth’s surface is unique in the cover it possesses. Land use and land cover are distinct yet closely linked characteristics of the Earth’s surface. Land could be used for grazing, agriculture, urban development, logging and mining among many others. While land cover categories could be cropland, forest, wetland, pasture, roads and urban areas among others. The term land cover originally referred to the kind and state of vegetation, such as forest or grass cover but it has broadened in subsequent usage to include other things such as human structures, soil type, biodiversity, surface and ground water.

Macleod and Congation (1998) have listed four aspects of change detection which are important when monitoring natural resources: These are detecting the changes that have occurred, identifying the nature of the change, measuring the area extent of the change, and assessing the spatial pattern of change. The basis of using remote sensing data for change detection is that changes in land cover result in changes in radiance values which can be remotely sensed. Techniques to perform change detection with satellite imagery have become numerous as a result of increasing versatility in manipulating digital data and increasing computer power.

and GIS techniques, using aerial photographs, Landsat MSS, SPOT XS/Panchromatic Image Transparency and Topographic sheets to study changes in the two dams (Sokoto and Guronyo) between 1962 and 1986. Their work revealed that land use land cover of both areas was unchanged before the construction while settlement alone covered most part of the area.

Daniel et al. (2002) compared 5 methods of land use/land cover change detection, v.z., traditional post-classification cross tabulation, cross correlation analysis, neural networks, knowledge-based expert systems and image segmentation and object-oriented classification. A combination of direct T1 and T2 change detection as well as post classification analysis was employed. Nine land use/land cover classes were selected for analysis by Daniel et al. observed that there are merits to each of the five methods examined at the point of their research; no single approach can solve the land use change detection problem.

Tian et al. (2005) analyzed spatio-temporal characteristics of urban expansion in China using satellite images and regionalization methods. Landsat TM images at three time periods, 1990/1991, 1995/1996, and 1999/2000, are interpreted to get 1:100000 vector land use datasets. Their study calculated the urban land percentage and urban land expansion index of every 1km² cell throughout China. They also concluded that, land use dynamic changes reflect the strong impacts of economic growth environments and macro-urban development policies.

Xiao et al. (2005) explored the temporal and spatial characteristics of urban expansion from 1934 to 2001 and land use/land cover change from 1987 to 2001. The remotely detected land use/land cover change from 1987 to 2001 shows that the land
use/land cover was largely changed. Finally, the major factors influencing urban expansion and land use/land cover change are also discussed. In general, the population, traffic conditions, industrialization, and policy are the major factors that influenced the urban expansion.

Lu et al. (2007) explored the techniques to improve land-cover classification accuracy through a comparative analysis of different combinations of spectral signatures and textures from Landsat Enhanced Thematic Mapper Plus (ETM+) and Radarsat data. A wavelet-merging technique was used to integrate Landsat ETM+ multispectral and panchromatic data or Radarsat data. They suggested that, data fusion and textures increases classification accuracy by approximately 5.8–6.9% compared to Landsat ETM+ data, but data fusion of Landsat ETM+ multi-spectral and panchromatic data or Radarsat data cannot effectively improve land-cover classification accuracies.

Dewan and Yamaguchi (2009) discussed the land use/land cover change in Dhaka Metropolitan of Bangladesh for 45 years using topographic maps and multi-temporal remotely sensed data from 1960 to 2005. They validated their maps of land use/land cover by using high resolution images such as SPOT, IRS, IKONOS and field data. The overall accuracy of land cover change maps, generated from Landsat and IRS-1D data, ranged from 85% to 90%. The maps showed that between 1960 and 2005 built-up areas increased approximately 15,924 ha, while agricultural land decreased 7,614 ha, vegetation decreased 2,336 ha, wetland/lowland decreased 6,385 ha, and water bodies decreased about 864 ha. The amount of urban land increased from 11% (in 1960) to 34.4% in 2005. Their study quantified the patterns of
land use/land cover change forms valuable resources for urban planners and decision makers to devise sustainable land use and environmental planning.

Shahraki et al. (2011) described urban growth in the city of Yazd, Iran. Urban growth and other land uses were calculated through treated satellite images for four periods: 1975, 1987, 2000 and 2009. Their results revealed that from 1975 to 2009, the urbanized area increased from 1843 ha to 13,802 ha. The Yazd case is interesting for several reasons: first, it is a case of very fast urban growth even for a developing country; second, it illustrates how the fastest rates of urban sprawl may correspond to middle size cities rather than large centers. Third, it portrays a land substitution process in which agricultural land is not the primary provider of urban land which is relatively rare in urban contexts, and fourth, it also illustrates how sprawl may also hide important internal land uses such as the presence of agricultural plots within urban boundaries.

Noor and Rosni (2013) attempted to study the measurement of defining sprawl by using spatial factors indexes through remote sensing and GIS approach. The IKONOS pan-sharpened and SPOT-5 with 1 and 2.5 meters resolution were used and combined with GIS database to analyze the geospatial indicators using spatial factors namely highway strips, leapfrog development and land use segregation. Kuantan city was selected due to the high growth rate of its population and the rapid establishment of new town area. The findings showed that characterization of these spatial factors have resulted in identifying Kuantan as non-sprawl city.

1.4.2 National Level Review

In India various works on urban land use and land cover have been done by many scholars. Some of the scholars who have done major contributions on urban land use and
land cover are Nagamani and Ramachandran (2003); Sudhira et al. (2004); Sarma and Kushwaha (2005); Pandy and Nathawat (2006); Jata et al. (2008); Bhatta et al. (2010); Kaul and Sopan (2012); Mallupattu et al. (2013); Rawat et al. (2013) and many others. A brief account of their research work is given in the following paragraphs.

Nagamani and Ramachandran (2003) evaluated the effectiveness of high resolution satellite data and computer aided GIS techniques in assessing land use/land cover change detection for the period 1990 to 2002 for Pondicherry, India. They evaluated that coastal areas are highly dynamic and undergoing rapid change. They have suggested that the knowledge of land use/land cover changes is very important in understanding natural resources, their utilization, conservation and management. They have concluded that, in recent years remote sensing and Geographical Information System have gained importance as vital tools in the analysis of temporal data at the district and city level.

Sudhira et al. (2004) explained that urban sprawl is the extended form of urbanization, which is a global phenomenon mainly driven by population growth and large scale migration. They have suggested that GIS and remote sensing data along with collateral data help in analysing the growth, pattern and extent of sprawl. With the spatial and temporal analyses along with modelling it was possible to identify the pattern of sprawl and subsequently predict the nature of future sprawl. Their results brings out the extent of sprawl taking place over a period of nearly three decades using GIS and Remote Sensing. Their study also attempted to describe some of the landscape metrics required for quantifying sprawl. For understanding and modelling this dynamic phenomenon, prominent causative factors are considered.
Sarma and Kushwaha (2005) have worked on coal mining impact on land use/land cover in Jaintia hills district of Meghalaya, India using remote sensing and GIS technique. They used LANDSAT data of 1975, 1987, 1999 and 2007 and conclude that there was four fold increases in mining area from 1975 to 2007 accompanied by three fold decreases in forest area. Visual interpretation technique was used by them for land use/land cover mapping for the different data of four years.

Pandy and Nathawat (2006) carried out a study on land use/land cover mapping of Panchkula, Ambala and Yamunanger districts, Haryana State in India. They observed that the heterogeneous climate and physiographic conditions in these districts has resulted in the development of different land use/land cover. An evaluation by digital analysis of satellite data indicates that majority of areas in these districts are used for agricultural purpose. The hilly regions exhibit fair development of reserved forests. It is inferred that land use/land cover pattern in the area are generally controlled by agro-climatic conditions, ground water potential and a host of other factors.

Jata et al. (2008) studied urban sprawl of the Ajmer city at a mid scale level, over a period of 25 years (1977–2002), to extract the information related to sprawl, area of impervious surfaces and their spatial and temporal variability. They used statistical classification approaches for the classification of the remotely sensed images obtained from various sensors, viz., Landsat MSS, TM, ETM+ and IRS LISS-III. In their study, urban sprawl and its spatial and temporal characteristics have been derived from the classified satellite images. The Shannon’s entropy and landscape metrics (patchiness and map density) have been also computed in terms of spatial phenomenon, in order to quantify the urban form (impervious area). Results revealed
that land development (16.08%) in Ajmer is more than three times the population growth (50.1%). Shannon’s entropy and landscape metrics have also revealed the spatial distribution of the urban sprawl over a period of the last 25 years.

Bhatta et al. (2010) analysed urban growth by using the historical and present data is an essentially performed operation in the urban geographic studies and for future planning. Urban growth can be mapped, measured and modeled by using remote sensing data and GIS techniques along with several statistical measures. In this study three temporal satellite images of 15 years interval (1975, 1990 and 2005) have been classified to determine the urban extent and growth of Kolkata-Howrah (West Bengal, India) in eight different directions within a circular region. Pearson’s chi-square test and Shannon’s entropy method have been applied to calculate the degree-of-freedom and degree-of-sprawl towards the analysis of urban growth. A new measure, degree-of-goodness, has also been proposed for the analysis of urban growth. The result showed that the city of Kolkata-Howrah has a high degree-of-freedom, high sprawl, and a negative goodness in urban growth. Apart from the derived results, this study also showed the potentials of remote sensing data and effectiveness of demonstrated/proposed models in urban geographic studies.

According to Kaul and Sopan (2012), land use and land cover change has become a central component in current strategies for managing natural resources and monitoring environmental changes. To maintain the present natural resources and to understand the causes and consequences of over exploitation of soil and water resources the land use and land cover mapping and monitoring was done in the study area, viz., Jalgaon District. For this purpose satellite images for March and November 2007 were used for obtaining land
use and land cover Supervised classification. Seven land use and land cover classes were decided. For Accuracy Assessment Classification error matrix and Kappa analysis was done.

Mallupattu et al. (2013) have determined land use/land cover changes in an urban area, viz., Tirupati, from 1976 to 2003 by using GIS and remote sensing technology. The study was conducted by using the Survey of India topographic map 57O/6 and the remote sensing data of LISS III and PAN of IRS ID of 2003. The comparison of land use/land cover in 1976 and 2003 derived from toposheet and satellite imagery interpretation indicated that there is a significant increase in built-up area, open forest, plantation, and other lands. It is also noted that substantial amount of agriculture land, water spread area and dense forest area vanished during the period of study which may be due to rapid urbanization of the study area.

According to Singh and Singh (2014), land use /land cover change of Delhi. The change analysis was performed by post classification comparison method, comparing the data of two different sensors (Lands at TM and LISSIII IRS P-6), at different time periods (years 1992 and 2004). The results showed that the residential area of Delhi was 39507 hectare in 1992 increased 57928 hectares in 2004. The total area increased 18421 hectare in twelve years (1992-2004) and growth rate is 46.6 % during the study period. There has been rapid conversion of agricultural areas to non agricultural uses. The total agriculture land was 65214 hectare in 1992 decreases 54152.6 hectare in 2004. The share of agriculture land was 45% of land in 1992 which decreases 37% of the total land in 2004.Urban expansion of city has destroyed 11062 hectare of fertile agricultural land between 1992 and 2004, there was rapid
change in land cover/land use. It was found that there was a phenomenal change in the
built-up area in watersheds, loss of forest cover and change in agriculture land.

1.5 OBJECTIVES

The fundamental objectives of the present study are as follows:

- To develop a land use/land cover classification scheme.
- To prepare the land use/land cover map of different time periods and
determine the nature, rate, trend and magnitude of land use/land cover
changes.
- To prepare the land use/land cover matrix and maps of land encroachment of
each land category.
- To develop the different methods of environment conservation and tourism
development.
- To evaluate the socio-economic implications of land use change.

The study incorporates the followings studies of the urban areas of district Nainital
related with the above mentioned objectives:

1. Land use/land cover studies
2. Land use/land cover dynamics
3. Land use/land cover matrix
4. Land use change in urban built-up area
5. Spatial pattern of urban settlement
6. Trend of urban spatial growth
7. Directional change in urban built-up area
8. Study about environment conservation and tourism development.
REFERENCES CITED


URL-http://nainital.nic.in/ 22/01/2013.