CHAPTER I:
INTRODUCTION
1.1 EPILOGUE:

Haridwar district located at the foothills of Siwalik Himalaya is the part of the Upper Ganga Basin, represents polycyclic landscape. The present work has been concerned mainly with the study of the Environmental hazards and their impact on land use of Haridwar district, Uttarakhand. That is why due weightage has been given in studying different major environmental hazards of the study area which is a part of the upper Ganga basin. Haridwar district is marked by the occurrence of distinct environmental hazards like flood, water logging, riverbank erosion, landslide, excessive soil and gully erosion, deforestation, water pollution etc. and these have a great impact on the development of varied land use pattern as well as the economic activities including agriculture, industry,
tourism in the area under study. The geo-lithological structure of Siwalik Himalaya and active fluvial and tectonic processes also have an important role in the evolution of physical and cultural landscapes in the study area. Being rich in various important natural resources, the entire area has enough potentiality of development.

1.2 INTRODUCTION:

The present research work is concerned with the study of the environmental hazards and their impact on land use of Haridwar district, Uttarakhand. Haridwar is one of the holiest places of pilgrimage for the Hindus. It is located at the foothill of the Himalayas, representing the point where the Ganga reaches the plains. Though there are so many hazards and environmental problems in the study area but the researcher has given the special emphasis on study of some major environmental hazards and their impact on land use characteristics of the study area. The researcher has broadly categorized the major environmental hazards into natural hazard, quasi-natural and human induced hazards. The special emphasis has been given on flood, river bank erosion, shifting and avulsion of channel, soil and gully erosion, landslides and rockfall, forestfire, poaching, death of wild animals in train accidents, wild animal attack, pollution of surface and ground water, etc. The impact of the hazards on land use is very prominent which is reflected through the shifting and damaging of settlement areas, roads and agricultural land and various constructional works etc. The study area is characterized with varied landforms like fluvial landforms (breaks and knicks of slope, waterfalls, river terrace, rill, gully, micro valley in valley.) and tectonic landforms (fault scarp, structural valley etc). Beside various exogenetic (fluvial) and endogenetic(tectonic) processes. The entire study area is a representative of polycyclic landscape characterized with four distinct erosional surfaces with the expression of major breaks and knicks of slope. Structure has a dominant controlling factor for the development of various landforms which influence variety of land use pattern like settlement, roads, railway, agriculture, aquaculture, pasturing, barrage, forest, tourist places etc. The state of Uttarakhand was formed on November 9, 2000. The most significant resource of the state is its natural resources and resources that are closely linked to ecological wealth. The area has a long and rich cultural history where natural beauty and ecological features have played a central role.
Fig. No. 1.1 Location Map of the Study Area

Source: Atlas of Uttarakhand, Natmo, 2003, & Toposheet 53K/1, K/2, K/5, etc, S.O.I
Fig. No. 1.2 Satellite Image (LISS III, Nov, 2005) of the Study Area
Fig. 1.3: Major Road Network of the study area
CHAPTER 1 INTRODUCTION

1.3 AREA AND LOCATION:

The study area is situated in upper Ganga basin. Northern portion of the area includes young folded Tertiary Himalayan mountain and southern part falls under Ganga-Yamuna Doab. The study area falls under three tahesils namely i) Haridwar ii) Roorkee iii) Laksar including six blocks namely 1) Bhagwanpur, 2) Roorkee, and 3) Narsan, 4) Bahadrabad, 5) Laksar, and 6) Khanpur. The study area extends (Fig-1.1) from 29°35'37"N to 30°13'29"N latitude and 77° 52' 52"E to 78° 21' 57"E longitude covering an area of 1883 sq.km. Haridwar was the part of district Saharanpur before 1989 and in the south of it, the district is Muzafarnagar.

1.4 HISTORICAL BACKGROUND OF THE AREA:

The Archaeological survey has proved that the evidence of different cultures is available in this area. The excavations were carried out in different parts of the district, i.e., Ambakheri, Bargaon, Hulas, Bhadarabad and Naseerpur etc. A number of things are found during these excavations, on the basis of which, it is established that in Saharanpur district, the earliest habitants were found as early as 2000 B.C.

Traces of Indus Valley Civilization and even earlier are available and now it can be definitely established that this region is connected with Indus valley civilization. Ambakheri, Bargaon, Naseerpur and Hulas were the centers of Harappa culture, because many things similar to Harappan civilization were found in these areas. From the days of the Aryans, the history of this region is traceable in a logical manner but it is difficult at present to trace out history and administration of the local kings without further exploration and excavations.

Muhammad Tughlaq reached northern doab to crush the rebellion of Siwalik Kings in 1340. There he came to know about the presence of a Sufi saint "Shah Harun Chisti" on the banks of 'Paondhoi' river. He went to see him there and henceforth the place is known as 'Shah-Harunpur' or " Saharanpur" by the name of Saint.
Akbar was the first Mughal ruler who established civic administration in Saharanpur and made it 'Saharanpur -Sarkar' under Delhi province and appointed a Governor. The Jagir of Saharanpur was honoured to Raja Sah Ranveer Singh who founded the city of Saharanpur. At that time Saharanpur was a small village and served as army cantt area. The nearest settlements at that time were Shekhpura and Malhipur. Most of the part of Saharanpur was covered by forests and 'Paondhoi' 'Dhamola' and 'Ganda Nala' were swampy/marshy. The city which Sah Ranveer Singh founded was surrounded by 'Nakhasa' 'Rani Bajar' Shah Bahlol' and ' Laki Gate' along the 'Paondhoi' River. Saharanpur was a walled city and had four gates - Sarai gate, Mali gate, Buria gate, Lakhi gate.

In the Vanaparva of the Mahabharat, where sage Dhaumya tells Yudhisthira about the Tirthas of India, Gangadwar, i.e., Haridwar and Kankhal, have been referred. Haridwar came under the rule of the Maurya Empire and later under the Kushan Empire. Archaeological findings have proved that Terra Cotta culture dating between 1700 BCE and 1200 BCE existed in this region. First modern era written evidence of Haridwar is found in the accounts of a Chinese traveller, Huan Tsang, who visited India in 629 AD. during the reign of King Harshavardhan (590-647) records Haridwar as 'Mo-yu-lo', the remains of which still exist at Mayapur, a little to the south of the modern town. Among the ruins are a fort and three temples, decorated with broken stone sculptures, he also mentions the presence of a temple, north of Mo-yu-lo called 'Gangadwara', Gateway of the Ganga.

Ain-e-Akbari written by Abul Fazal, in 16th century during the reign of Mughal Emperor Akbar refers to it, as Mayapur. During the Mughal period, there was mint for Akbar's copper coinage at Haridwar. It is said that Raja Man Singh of Amber, laid that foundation of the present day city of Haridwar and also renovated the ghats at Har-ki-pauri. After his death, his ashes are also said to have been immersed at Brahma Kund by Mughal emperor Akbar himself.

Thomas Coryat, an English traveller, who visited the city in the reign of Emperor Jahangir (1596-1627) mentions it as 'Haridwara',

The city was also invaded by Timur Lang (1336-1405), a Turkish invader on January 13, 1399. During his visit to Haridwar, first Sikh Guru, Guru Nanak (1469-1539) bathed at 'Kushwan Ghat'. He later also visited Kankhal enroute to Kotdwara in Garhwal.
Being one of the oldest living cities, Haridwar finds its mention in the ancient Hindu scriptures as it weaves through the life and time stretching from the period of the Buddha, to the more recent British advent. Haridwar has a rich and ancient religious and cultural heritage. It still has many old buildings and mansions bearing exquisite murals and intricate stonework. One of the two major dams on the river Ganga, the ‘Bhimgoda Dam’, is situated here. Built in 1840s, to divert the waters of Ganga, to the ‘Upper Ganges Canal’ which irrigated the surrounding lands. The headworks of the Ganga Canal system is located in Haridwar. The Upper Ganga Canal was opened in 1854 after the work began in April 1842, prompted by the famine of 1837-38. The unique feature of the canal is the half-kilometre-long aqueduct over Solani river at Roorkee, which raises the canal 25 metres above the original river.

‘Haridwar Union Municipality’ was constituted in 1868, which included the villages of Mayapur and Kankhal. Haridwar was first connected with railways, via Laksar, through branch line in 1886, when the Awadh and Rohilakhand Railway line was extended through Roorkee to Saharanpur, this was later extended to Dehradun in 1900.

1.5 PROBLEMS OF THE AREA:

The landscape of the study area is characterized with fluvial and tectonic processes, which is have now developed various alarming environmental problems. The major environmental problems of the study area can be classified into three classes i.e., natural hazards, quasi natural and man made hazards or anthropogenic hazards.

Flood and flash flood: The main natural environmental hazard of the area is flood. At the southern part of the area seasonal flood is found. During excessive rainfall in the non-perennial streams flash floods occur. Sometimes overflow through Upper Ganga Canal (UGC) causes water logging situation in Haridwar city also.

Riverbank erosion: River bank erosion is a serious natural hazard of the study area. River bank erosion is the single most common problem which is noticed in almost every river. The erosion causes a lot of damages of agricultural land and settlement areas.
Soil and gully erosion: Soil erosion and gully erosion are other natural hazards of the study area. Mainly at the base of Siwalik hill, excessive rill, gully and soil erosion are found. Excessive gully erosion causes rapid deforestation in the forest areas. Soil erosion in Haridwar district is also observed in agricultural field and settlement area with extreme surface run-off in the villages like; Shyampur, Kangri, Pilli etc.

Shifting and avulsion of channel: The study area is facing major natural hazards like shifting and avulsion of channel. In the southern part of the study area, shifting and avulsion of channel (Plate-1.4) in Ganga and Solani river are a major problem. Almost in every river it is found. Due to shifting and avulsion of channels, many of settlements have been rejected by the villagers.

Landslide and rockfall: Landslides and rockfall in Siwalik hill are considered as quasi-natural hazards which mainly hamper transport system of the area. During monsoon period in Chandi temple and Mansa temple landslide and rockfall are observed along the roads.

Degradation of forest resources: In Rajaji National Park (Plate:1.5), a large number of accidental, human-caused forest fire incidents are reported from forest areas. Such forest fires threat to the ecosystem. These forest fires cause rapid destruction of forest resources. Due to over utilization of forest resources, illegal poaching and trapping of wild animals, many species of birds and animals are considered as highly endangered species.

Contamination of surface and ground water: Contamination of surface and ground water is another human induced hazard of the study area. Pollution of the Ganga river water is a serious problem not only for Haridwar but also for the people of the Ganga basin. The depletion and contamination in groundwater resource is taking place mainly due to increasing water demand by growing population and expanding agricultural and industrial sectors.

Unscientific tourism:
Unscientific tourism is another problem of the study area. Sometimes the channel bars of Ganga river are utilized for temporary residence of the tourists. Especially during Kumbh mela numerous tourists and pilgrims directly contaminate the environmental quality of the area. Construction of hotels, ashrams in vulnerable riverbank areas, wastage removed by the tourists here and there make garbage pollution in the city area. Many ashrams, hotel and temples have been constructed on the riverbank. These ashrams, temples, and other religious establishments/buildings are crowded places and are highly illuminated during the night with a chanting of hymns. These factors have further added problems to movements and dispersal of wild animals. That is why, the animals are compelled to move across the rail line passing through the narrow Chilla-Motichur corridor between place Motichur and Raiwala. Hence, the occurrence of death of wild animals by the rail accidents is increasing day by day.

1.6 OBJECTIVE OF THE STUDY:

The main objectives of the Ph.D. thesis are—

To identify the various types of major environmental hazards and land use patterns of the study area.

To classify the environmental hazards based on their genesis, such as Natural hazard, Quasi-natural hazards, and human-induced or anthropogenic hazards.

To explain the causes and mechanism of the environmental hazards.

To study the various landforms development under various geomorphic processes and their role in creation of natural hazards in the study area.

To assess the changing nature of land use pattern of the study area and impact the hazards on land use characteristics.
CHAPTER- I INTRODUCTION

To suggest suitable strategies for the management of the hazards and sustainable development of the area under study.

1.7 METHODOLOGY:

To fulfil the research work, the researcher has adopted three methods, i.e., 1) Pre Field 2) Field and 3) Post Field.

Pre Field: The study area related maps were collected from different Govt. organization like; topographical sheets (53 K/1, 53 K/2, 53 K/5, 53 J/4, 53 G/13, 53 G/14, ), district planning map from Survey of India, District resource map of Saharanpur from Geological Survey of India, Kolkata, Satellite Imagery (Fig-1.2) mainly LISS-III(1997,2005),LISS-IV(2005) from National Remote Sensing Centre(NRSC) and other maps (water resource map, rainfall map etc.) from National Atlas and Thematic Mapping Organization (NATMO), Kolkata. The researcher has also collected maps and secondary data from different books and journals.

Field: The researcher has completed his field work in ten stages; April 2006, June 2007, October 2007, May 2008, October 2008, May 2009, February 2010, October 2010, October 2011, November 2011. Field study involves the ground truth verification, collection of soil samples from different soil horizons of different sites, water samples (ground and surface) and primary data about slope, river velocity, terrace study, cross sectional study of river Ganga, Ranipur rao, Rawali rao, Betan rao, land use survey and household survey etc. with help of the instruments like Global Positioning System (GPS), Clinometer, Abney Level, Dumpy Level and Prismatic Compass etc. and secondary data were collected from various offices and Institutes like Wadia Institute of Himalayan Geology, Forest Research Institute, Dehradun, Collectorate House, Haridwar. A detailed land use map of Tatwala village and Kangri Mouza of Bahaderabad block, Haridwar has been prepared with intensive field survey. Measurement of river bank erosion at different sites of Ganga river, Ranipur rao, Betan rao has been done with the help of Global Position System(GPS). Measurement of the rate of the gully erosion from 2006 to 2010 has completed by the present researcher.
Post Field: In the Post field study, processing of raw data, tabulation and preparation of diagrams and finalization of maps like physiographic zonation, Geological map, Drainage map, Geomorphological map, land use map, Digital Elevation Model (DEM), TIN (Triangulated Irregular Network) etc. have been prepared. The researcher himself has prepared the maps with the help of advanced GIS and Remote Sensing softwares like Geometica V-10, Map Info V-9, ERDAS Imagine 8.4, Surfer, Arc view etc. and other softwares like MS Excel, Origin 6.0 have also been used to process the data. Soil samples were analyzed in the laboratory of National Bureau of Soil Survey and Land use Planning and water samples were analyzed from National Institute of Hydrology (NIH), Roorkee, Haridwar.

1.8 IMPORTANCE OF THE STUDY AREA:

1) Geomorphological importance: The area has a great geomorphological significance. Physiographically the study area is a part of Upper Ganga Basin with four major erosional surfaces. The Northern portion of the area includes young folded Tertiary Himalayan mountain and southern part falls under Ganga-Yamuna Doab. Hence the area is characterized with tectonic landforms, fluvial erosional landforms in north and fluvial depositional landforms in south. According to the Geological Survey of India, from the foothill of the Siwalik Himalaya to the extreme south of the study area is a part of an alluvial fan.

2) Spiritual importance: The area has a great spiritual importance (Plate:1.2). Haridwar, also referred to as 'the Gateway to the God, is considered as the gateway to the four pilgrimages in Uttarakhand area; Badrinath, Kedarnath, Gangotri and Yamunotri. Haridwar, the famous holy pilgrimage center is a beautiful landscaped city and lies at the base of the Siwalik hills. In the age of Puranas, it was named as Mayapuri. A paradise for nature-lovers, Haridwar presents kaleidoscope of Indian culture and civilization. Haridwar also is known as Mayapuri, Kapila, and Gangadwar. The followers of Lord Shiva (Har) and followers of
Lord Vishnu (Hari) pronounce this place ‘Harihar’ and Haridwar respectively as told by some.

Legendary king Bhagirath is said to have brought the river Ganga from heaven to earth in order to provide salvation to his ancestors. The King, Bhagirath, the great-grandson of the Suryavanshi King Sagar (an ancestor of Rama), is said to have brought the river Ganga down from heaven, through years of penance in Satya Yuga, for the salvation of 60,000 of his ancestors from the curse of the saint Kapila a tradition continued by thousands of devout Hindus, who bring the ashes of their departed family members, in hope of their salvation. Lord Vishnu is said to have left his footprint on the stone that is set in the upper wall of Har-Ki-Pauri, where the Holy Ganga touches it all times.

It is also said that Haridwar has been sanctified by the presence of three Gods; Brahma, Vishnu and Mahesh. Lord Vishnu is said to have his footprint on the stone that is set in the upper wall of Har-Ki-Pauri where the Holy Ganga touches it all the times. Devout believers feel that they can go to heaven by getting their salvation after a dip in the sacred Ganga at Haridwar. According to Hindu mythology, Haridwar is one of the seven holiest places of pilgrimage for the Hindus. Millions of Hindu pilgrims from all parts of India come to the banks of the Ganga in Haridwar every year to have a holy bath.

Haridwar is also one of the four places; where Kumbh Mela occurs after rotation of every twelve years and Ardh Kumbh after every six years. It is said that drops of Amrit (Elixir) fell in to the Brahmkund of Har-Ki-Pauri, therefore considered that a dip in the Brahmakund on this particular day which is very auspicious and when Jupiter (Brahaspati) comes to the sign Aquarius (Kumbh) once in every twelve years the Maha Kumbh fair is celebrated at Haridwar.

3) Ecological importance: The Rajaji National Park has a great role to maintain ecological balances of the surrounding areas. The park areas sustain rich biodiversity which controls bio-geo-chemical cycle and energy flow among various tropic levels. It has a role to control temperature and moisture of the area. The entire forest area is a good recharge zone of ground water. That is why an enriched ground water resource is available in
Haridwar district. So to maintain the hydrological balance of the area, the park has an important role.

3) **High population density:** Haridwar is the most densely populated district of Uttarakhand. Total population of the district is 1447187, Census 2001. Haridwar is one of the holiest places of pilgrimage for the Hindus, where about 27 per cent population of Uttarakhand live here. Being located at the foothill of Siwalik Himalaya, the people of the district are suffering from different types of environmental hazards.

4) **Economic importance:** The area has a great economic value for its agricultural, tourism and its industrial activities. It is located at the foothill of the Himalayas, representing the point where the Ganga reaches the plains.

**Agriculture:** As the southern part of the area is under Ganga-Yamuna Doab, that is why the area contains very fertile soil and plenty of riverine water resources are available which have developed agricultural production. About 53.3 percent areas are under agricultural lands. The region is very enriched in agricultural resources due to fertile soil and enough supply of ground and surface water. Rice, Wheat, Sugarcane are the main agricultural crops of the study area.

**Industry:** The district Haridwar is not the main center from industrial point of view. However, sugar mill is situated at Iqbalpur while B.H.E.L. at Ranipur is the famous factory in India. The city Haridwar has an abundance of the ayurvedic and small-scale industries such as; Kraisher, Steel, Agro and Food processing etc. units are also found in the district. The Siwalik range provides the raw material for the industry. Woodwork is exported to countries like Germany, U.K., USA, Canada, Sweden, Singapore and many others.

**Tourism:** The area has a great importance in tourism. Every year a large number of tourists come here to enjoy the natural beauties as well as for the holy bath. Every year Indian and foreign tourists come here, specially during Kumbh years number of tourists and pilgrims enhance. With the growth of tourist population, which has already recorded as 7.5 million (2005), the tertiary sector continues to grow up, particularly the activities like transport and communication; trade, hotel and restaurant.
1.9. PREVIOUS LITERATURE:

Studies on the geomorphological problems of the Upper Ganga Basin area have been carried out by some eminent earth scientists and environmentalists since the thirties (Auden1934, 1937, Nakata 1986, Dhoundial 1989, etc). They have highlighted mainly of the geological aspects without analysing the development of landforms and the land use of the area under study. D. N. Wadia was one among the great geologists in the Geological Survey of India who laid the foundation of the geological investigations in India by their pioneering work. D.N. Wadia did some Benchmark works on Western Himalayan geology. Wadia made very significant contributions on the geological setting and economic minerals of limestones occurring as isolated masses of older rocks amidst younger sedimentary rocks in the Sub-Himalayan Tertiary belt of Jammu. He had a great contribution on Palaeontological study which has helped to understand the standard rock formation of the Upper Siwalik. His book ‘Geology of India’ written in 1919 and published by MacMillan, became the source book for learners for a long period of time. Previous workers, Valdiya (2003), Mukhopadhyay (2003), Husain (1993), Jha (1993) Israil (2006, 2007), Singhal (2006,2007), Gupta (2007), Sharma (2007), and others contemporary authors have carried on a geomorphic investigation in the course of their general geological studies of the evolution of Western Himalayan Foothills area, Uttarakhand terrain. Former workers Singh(2001) ,Sharma (2001), Joshi(2010) and others researchers studied on wildlife related aspects of Rajaji National Park area. National Remote Sensing Center (2010) has worked on hazard zonation map of Uttakhand. National Institute Of Hydrology (NIH),Roorkee is engaged in the study of water resource related issues. National Association of Thematic Mapping Organization (2005) has prepared Atlas of Uttaranchal which is also very useful tools to the researchers.

The present researcher has endeavored to carry out a comprehensive study on environmental hazards including Geologic hazard (earthquake, landslides), Hydrologic hazard (river flood, waterlogging), Geomorphic hazard (Riverbank erosion, Shifting and avulsion of channel, soil and gully erosion),Anthropogenic hazard (wildfires, deforestation, poaching,surface and ground water pollution ) and their impact on land use with an integrated approach.
The researcher has tried to establish the relationship between environmental hazards and land use change in the part of the upper Ganga basin. The author put his earnest efforts to identify the major hazards, such as; flood, landslide, river bank erosion, soil erosion, channel shifting, forest fire, wild animal attack, water pollution etc. and their causes and mechanism. The present researcher has classified the environmental hazards based on their genesis, such as natural hazard, quasi-natural hazards, and human-induced hazards. The author also has assessed the changing nature of land use pattern of the study area and impact of hazards on land use characteristics. The researcher also has suggested suitable strategies for the management of the hazards. The researcher has tried to do the land potential classification with the calculation of Land Capability Index (Mondal, 1990) of the study area.