Chapter I

INTRODUCTION

1.1: The Statement of the Problem

Degradation of environment is one of the most serious challenges before the mankind in today’s world. Mankind has been facing a wide range of problems arising out of the degradation of environment. Not only the areas under human inhabitation, but the areas of the planet without human population have also been suffering from these problems. The number of problems arising out of environmental degradation has been increasing and the intensity of these problems has, at the same time, been aggravating with time.

Land cover change takes place due to multiplicity of a number of natural as well as anthropogenic factors. All of them together bring about a change in the general environment of an area. Manifestations of the natural forces like forest fire, volcanic eruption, earthquake, tornado, tsunami, flood, meteor-fall, cloud burst etc. which occur from time to time, cause serious damage to the environment. Human activities can generate severe negative impact on earth systems resulting in environmental degradation. The truth is that the present man-induced or anthropogenic factors are causing many times more damages to the environment than their natural counterpart.

Looking back into the past we find that the use of fire by the pre-historic people is the initiation of man-induced environmental degradation. Production of foodgrain through agriculture, which came little later and initiated permanent settlement replacing the nomadic life style of the pre-historic people is another important factor to cause man-induced environmental degradation at a much faster manner. During that period these were not felt as problems. The dimension of these
problems started to grow with human population and associated diversification of the economic activities. The spread of industry following the industrial revolution has made these problems more and more acute and eventually, the people started to suffer. Industrialization, reckless and wide spread deforestation and population explosion have been considered as the major causes of a wide range of environmental problems all over the world.

The list of necessary commodities of our everyday life has been growing longer and longer as a consequence of population growth and the prevalence of the concept of consumerism in the society. As such, there has been a continuous process of manufacturing of goods through the utilization of the natural resources. Like a double-edged sword, this very process is causing degradation of environment in two ways – environmental pollution through industrialization and damage to natural environment and habitat of various life forms through the exploitation of natural resources.

Land cover and land use changes are among the most important drivers of the earth’s environmental change, and significantly affect the key aspects of earth system functioning. Land cover is the biophysical attributes of the earth surface and land use is the human purpose applied to these attributes (Melendez-Pastor et al, 2010). In fact, land-use and land-cover changes have been identified as the factor with the largest effect on terrestrial ecosystems than any other driver of global environmental change. Land-cover change is treated as one of the most important direct drivers of terrestrial ecosystem change. Land cover change involves changes in the human management of ecosystems. It also drives biodiversity loss through habitat fragmentation and destruction. Land-cover change includes the outright conversion of an area from one land use to another, as well as declines in the biological or economic
productivity and complexity of the land as a result of land use (Reyers et al, 2009). Use of land in different ways for various purposes is the interplay of various physical, socio-economic and historical factors as a result of which a particular pattern evolves in a particular region (Das and Das, 1989). Environmental degradation caused by unsuitable land use is a worldwide problem that has raised the question of sustainability.

Unplanned changes of land use and land cover have become a major problem in many parts of the world. Most of these changes occur without clear and logical planning, paying no attention to their environmental impacts. Floods, pollution in large cities, deforestation, urban growth, soil erosion, desertification etc. are consequences of mismanaged planning without considering environmental impacts. North-East India is now turning into a potential danger zone because of growing environmental changes due to depletion of forests, occurrence of floods, landslides and soil erosion, unscientific mining, improper resource utilization and loss of biodiversity (Chetry and Borah, 1999). The depletion of forests in the hilly parts of the region has taken the momentum after the loss of the forests in the plains.

With regards to the study area, it is observed that there has been a continuing process of land cover change in the belt of foothills of Assam-Nagaland border. The belt of foothills referred to here is a transition zone between two important physiographic units of the north-eastern part of India. The belt separates the hills and mountains of Nagaland from Assam with its major part in the plains of Brahmaputra.

The people of Nagaland are basically hill dwellers and their life style is shaped and structured by the hilly environment. Traditionally, they have been practising shifting agriculture, locally called jhum cultivation since time immemorial. The practitioners of jhum cultivation follow certain customary rules and regulations
with regard to preservation of forest in the areas they cultivate and live in. In this regard, the Naga people (people of Nagaland) are also of no exception. But, in a modified environmental set-up, more particularly in the study area, they have lost some of their traditional practices. Increase in the Naga population and certain other factors have forced many of the Naga families to migrate from the interior of the state (Nagaland) to the foothills of Assam-Nagaland border. Recently, the jhum cycle of most of the hill states of North-East India has shrunk from 7-10 years to 3-5 years. The foothills of the border had a thick vegetation cover with a rich biodiversity and a large variety of economically valuable trees. Of the 22 different varieties of bamboo species in Assam (Borah, 2003), nearly all are found to occur in this belt of foothills.

In their natural state these hills are covered with dense evergreen forest. Most of the low and gentle slopes up to the height of 5000 feet (1500 m) have, however, at one time or another been cleared for cultivation. Where this has been done they are covered for the most part with scrub, bamboo and grass, and the larger forest trees have disappeared (Sharma and Sharma, 2005, p. 9). There are several large reserved forests along this belt of foothills. The forest products including bee-wax, several dyes, a variety of cinnamon, few kinds of fiber locally called as labhe, nettle and a sort of creeper are collected by the Naga and Mikir (Karbi) people of the area as means of subsistence. The occurrence of coal, chalk and limestone (Sharma and Sharma, 2005, p. 4), which are being exploited, is another major concern with regard to the land cover change in the area.

Anthropogenic factors are largely responsible for the land cover change in the area. Mention can be made about the taungya system. Under this system, peasant farmers from areas within or surrounding the forest and sometimes the forest plantation workers are given the right to cultivate food crops within the forest during
the early stages of forest plantation establishment. In addition to growing of food crops they are required to plant and tend the tree seedlings on the same piece of land for 3 to 5 years when canopy closure makes further growing of food crops impossible (Chamshama et al, 1992). The setting up of ‘forest villages’ inside forest land by the Assam Forest Department following the introduction of taungya system is a sort of self-slaughtering activity on the part of the government. These forest villages are different from the common villages (revenue villages) in that the villagers do not pay land revenue to the State Revenue Department. Instead, the forest villagers have to extend their physical labour to the Department for certain days every year. The purpose of the taungya system was, undoubtedly good and it is proven to be fruitful in certain parts of the world including Tanzania (Chamshama et al, 1992). In the context of Assam, the forest villagers played a negative role as care takers and conservators of the forest resources. They started to play a destructive role.

Subsequently, few villages were setup inside the forest lands by the state government in order to rehabilitate a section of flood victims of river Brahmaputra. After the introduction of these forest villages, many unauthorized villages started to grow inside the reserved forest areas. These have later been described as ‘encroached villages’. All the villagers cleared up the jungle in order to reclaim land for cultivation. A section of these people started to engage themselves in the illegal trade of timber and other forest resources. Poaching and hunting of the wild animals is still continuing. The belt of foothills also became a shelter place for certain anti-social elements, criminals and extremist outfits taking the advantage of almost non vigilance with regard to law and order as the area lies in the margins of both the state administrations. This is, perhaps because of the fact that the boundary line separating the two states has not yet been marked.
There exists an inter-state border conflict between Assam and Nagaland, which has been continuing for decades. A much tensed situation has been prevailing all along the Assam-Nagaland boundary during the last few years. The physical absence of the political boundary separating the two states has played a catalytic role leading to reckless encroachment and consequent deforestation thereby aggravating the environmental problem in the area. Many attempts have been made to resolve the boundary problem between the states through several interim agreements between the governments of Assam and Nagaland as well as maintenance of peace and tranquillity at different sectors along the border. Such an agreement was signed between the Chief Secretaries of both the state governments on 31st March, 1972. This was the ‘Interim Agreement between the Government of Assam and Nagaland Regarding Maintenance of Peace and Tranquillity in the Geleki Reserved Forest and Construction of a Portion of Amguri-Tuli road’. A second agreement was signed by them on the same day regarding the boundary between Assam and Nagaland from Gorajan stream to Kakadonga river. An interim agreement between the governments of Assam and Nagaland regarding the boundary from Disoi river to Gorajan stream and from Kakadonga river to Doyang river was signed by the Chief Secretaries of both the state governments on 2nd May, 1972 (Sharma and Sharma, 2005). These all indicate a long continuing boundary problem between the two states. Information often comes from Assam Police and from various print and electronic media indicating frequent tensed situation prevailing all along the Assam-Nagaland inter-state boundary.

It is already stated that the belt of foothills, where resentment has been prevailing, is a transitional zone between the plains of Assam and the hills of Nagaland. Any change that takes place in a transitional area shows its impact in much distinctive way. Deforestation, encroachment, agricultural and other economic
activities as well as associated activities in the transitional foothills have changed the land cover of the area. The foothills environment has a highly fragile ecological setup. The land cover change in the area has brought about concomitant change in the ecosystem putting the flora and fauna of the area under considerable stress and strain.

Developmental activities including construction of roads, schools, churches, setting up of police stations, government offices, check gates, petrol pumps, guest houses, brick kilns, tea gardens, rice and saw mills, business enterprises, supply of electric power and the like are taking momentum in this belt of foothills with a fragile ecological setup. Merapani, Uriamghat, Halowating, Bihubar-Naginimara and so on are some areas along the foothills belt, which have an urban look but they are not declared towns. Drilling activities for extraction of crude oil from areas like Khoraghat, Gholapani, Athkhel and Geleki, which are located within this belt or very close to it are also causing disturbance to the environment. Such injudicious developmental activities cause environmental degradation and ecological disturbance leading to imbalance between the environment and the socio-economic development of the society (Bora, 1998). These also cause geo-environmental changes and affect the natural processes that are operating in the area.

One type of environmental damage leads to another damage and the cumulative effect is enhanced further. It is an established fact that overexploitation of forests and grasslands leads to soil erosion, which in turn is responsible for floods, rising of river beds and loss of plant nutrients and even climatic change. The foothills of Assam-Nagaland border are feeding a good number of large and small rivers and streams which flow down the plains of Assam to meet river Brahmaputra. Most of these rivers and streams either have their sources in these foothills or they flow through this belt of foothills to arrive at the Brahmaputra. The land cover change in
this area has led to soil erosion at an accelerated rate. Study reveals that nearly half of
the Himalayan region is now degraded with soil erosion rates ranging from 20 tons / ha / year to 40 tons / ha / year (Sharma, 2004). Similar soil erosion has been taking
place in the study area and the publications and documents of National Bureau of Soil
Survey and Land Use Planning (NBSS&LUP, 1993) confirm it.

The eroded materials are carried away by the rivers and streams to the plains
of Assam and are deposited on the bed and banks of the rivers causing siltation in the
beds of the rivers. This is a matter of serious concern to the plains of Assam as it
damages the fertile agricultural lands and causes floods. Such situations obviously
necessitate the erection of earthen embankments on the banks of the rivers and
streams. During the recent years, the rising water of the rivers has started to wash
away these earthen embankments causing unthinkable damage to life and properties in
the plains of Assam. Frequency of such breach of embankments is increasing over the
years.

These rivers and streams assume great significance as the agricultural and
many other economic and social activities in the plains of Assam are directly
associated with their flows. Since agriculture is the main occupation of the people,
engaging 77 per cent of the total working population in it and its allied activities, these
rivers play a significant role in the primary sector of economy. Agricultural
production in the plains has started to behave keeping pace with the changing nature
and characteristics of these rivers and streams.

Within the geographical territory of the study area comprising the Golaghat,
Jorhat and Sibsagar districts of Assam there are as many as twenty notified forest
areas including reserved forests, wild life sanctuaries and national parks. All these
belong to Assam Forest Department. Of these notified forest areas, nine reserved
forests are forming an almost continuous belt of forests which merges with the belt of foothills along Assam-Nagaland border. These reserved forests are Nambar (south), Doyang, Rengma, Diphu, Disoi valley, Disoi, Tiru hills, Geleki and Abhayapur reserved forests. The famous Kaziranga National Park, Nambar-Doigurung wildlife sanctuary, Gibbon wildlife sanctuary and Pani-Dihing wildlife sanctuary of Assam are located very close to this foothills zone. The part of the foothills within the territory of Nagaland also has an almost continuous cover of forest with Intangki National Park, Rangapahar wildlife sanctuary and Singphan reserved forest along the inter-state border. It thus indicates that the area under study has a rich plant and animal biodiversity. The ongoing land cover change in the area has obviously caused habitat destruction and consequent decline in biodiversity.

Under human intervention the larger part of the forests of the area has been wiped out. Growth of settlements in the forest areas and associated reclamation of land for agricultural purpose have been identified as the major factor for the land cover change in the study area. Area under production of food crops, tea gardens and other horticultural crops in this belt of foothills is expanding day by day. Tea cultivation has become very popular among the encroachers of the area as it gives more return for a longer period of time. Frequent disputes are being reported which take place between the people of Assam and Nagaland living along the interstate border. It is learnt that most of these disputes have been taking place with regard to possession of land in order to open up tea gardens in the foothills belt. These disputes have been fueling the bilateral issue of boundary conflict between Assam and Nagaland. With regards to the above mentioned observations, it can be added that the belt of foothills is under the process of rapid transformation.
In view of the above, the following geo-environmental problems have been identified in the study area.

(a) Loss of biodiversity and habitat loss particularly in the foothills zone.
(b) Decline in the area under forest.
(c) Conversion of the Reserved Forest areas into built up area and agricultural area.
(d) Soil erosion at an accelerated rate and deposition of these materials in the plains.
(e) Siltation in the river beds.
(f) Changes in the fluvio-geomorphic behaviours of the rivers.
(g) Expansion of area under inundation in the plains.
(h) Increase in flooding intensity.
(i) Increased sedimentation and damage to the crop fields and soil quality in the plains.
(j) Increase in the dimension of the issues on border problem between the states.
(k) Probability of low rainfall and high atmospheric temperature in the area in the future.

1.2: The Study Area

As indicated in the Survey of India topographical sheets (bearing No. 83F, 83G, 83J, 83K, 83N and 83O), Assam and Nagaland share a length of 387 km common boundary between them. As many as five districts of Assam are located along this inter-state boundary. From west to east, these districts are North Cachar (recently renamed as Dima Hasao), Karbi Anglong, Golaghat, Jorhat and Sibsagar. The first two districts (North Cachar and Karbi Anglong) have hilly topographic condition and are excluded from the purview of the present study. The three eastern districts (Golaghat, Jorhat and Sibsagar) are located in the plains of Assam and the
southern margins of these three districts share a common belt of foothills with the state of Nagaland. Nagaland is, basically a hilly state formed by the Naga-Patkai range. Assam with most of its territory is under the plains of Brahmaputra.

The Assam-Nagaland inter-state boundary is not merely a political boundary separating the two states. It is, rather a geographical boundary separating the two important physiographic units of the north eastern part of the Indian sub-continent, i.e., the alluvial plains of the Brahmaputra valley on the north and the Tertiary hills and mountains of the Naga-Patkai range on the south. These foothills form an elongated belt along the southern margin of the study area. This belt of foothills has a length of nearly 200 km.

A good number of large and small rivers and streams come down from the foothills to the plains of Assam and they finally meet the Brahmaputra. The Major rivers of the study area which come down from the foothills are Dikhow, Janji, Bhogdoi, Kakadonga and Dhansiri. In addition to these, many small rivers and streams dissect the area. Most of these streams are seasonal in character while some others maintain their flow all round the year.

Except the tract of foothills of the study area, the rest is a leveled plain formed by the fluvial activities of the Brahmaputra river system. The three districts which form the study area have a total geographical area of 8731.77 sq km (ARSAC Report, 1990). It covers 3358.80 sq km of Golaghat district, 2730.47 sq km of Jorhat district and 2642.50 sq km of Sibsagar district. The Brahmaputra and its tributaries cover 72 percent of the total geographical area of Assam (Bora, 2001, p. 19). Based on this, the present study area covers 15.50 per cent of the Brahmaputra valley within the state of Assam. The year 1971 has been considered as the base year for the present study and during that year all the three districts (Golaghat, Jorhat and Sibsagar) were under the
same district administration with the name as Sibsagar district. The present three districts were the sub-divisions of then undivided Sibsagar district of 1971.

1.3: The Objectives of the Study

The study is planned to be conducted with the following objectives.

(1) To assess the nature and dimension of land cover changes in the study area.

(2) To find out and analyse the factors responsible for the land cover changes in the study area.

(3) To assess the impact of the land cover changes in the foothills upon the plains of Assam.

(4) To examine the land cover changes in the foothills with respect to deforestation.

(5) To establish the role of the anthropogenic factors in land cover changes as well as in the geo-environmental processes.

(6) To apprehend what environmental impact would be experienced by the study area in near and far future as a result of such changes.

1.4: The Hypotheses

In view of the above objectives the following hypotheses are framed.

(1) The land cover change in the foothills assumes greater dimension in terms of forest cover change.

(2) Among the factors responsible for land cover change, human encroachment plays the major role.

(3) Increasing pressure of population and associated infrastructure developments have accentuated the depletion of forests in the foothills.
The forest cover change in the foothills of Assam-Nagaland border has a direct bearing on the fluvio-geomorphic behaviours of the rivers in the plains of Assam.

1.5: The Organization of the Study

The thesis is designed in ten chapters. The first chapter gives an introduction to the problem under study. Next to the statement of the problem, a brief geographical description has been given about the study area. This description is expected to ensure a better understanding of the problem in the geographical setup of the study area. This is followed by the objectives of the study and the hypotheses that guide the course of the research. The first chapter is concluded with the organization of the study. The organization gives details of the contents of each of the chapters of the thesis.

The second chapter deals with the various sources of data and the methods of study that have been used in the study. It describes the temporal and the spatial data and attempts to justify the selection of the different points of time for temporal analysis and also the spatial units for spatial analysis. With regard to the methods of study, the pre-field procedures for the purpose of understanding the problem, the data collection techniques, the field techniques and the post field techniques used in the study have been discussed in this chapter. Finally, a description is given as to how these data have been processed, presented and analyzed.

The third chapter deals the review of literatures relevant to the research theme. Research works undertaken by scholars in related fields in different parts of the world give guidance and clues to any investigation. These works have been critically studied and categorized under several sub-themes of the present study, such as land cover change and climate, land cover change and hydrology, land cover change and habitat management and so on.
The fourth chapter gives a detailed geographic description about the area under study. The chapter starts with a brief description about the study area in Indian context which is followed by a detailed geographical account of the study area in terms of its location and extension, geology, physiography, land use, settlement, population, transport and communication and other developmental activities of the study area.

The fifth chapter gives the recent status of land cover in the study area. It starts with the meaning of land cover and shows how it differs from land use. Next, it introduces the land cover categories used in the study and the basis of categorization. At the end the chapter gives an account of the latest land use / land cover pattern in each of the spatial units spanning over three districts of Assam in the study area.

The sixth chapter carries assessment on spatio-temporal changes of the land cover in the foothills of the study area. At the beginning, the spatial pattern of the land cover change in the foothills belt is discussed in historical perspective and it describes the forest cover of the foothills belt of each of the spatial units. It also describes how the reserved forests are distributed along the Assam-Nagaland inter-state border. The temporal pattern of land cover changes has also been discussed taking three points of time. The increase and decrease of the area under the land cover categories are analysed for these three points of time. Special emphasis has been given on the agricultural land uses, especially the land use under plantation crops. Discussion is also made on human settlements as well as encroachment problems in the reserved forests of the foothills belt. The chapter also deals with the identification of the causes responsible for the forest cover changes.

Assessment of the geo-environmental impacts on land cover changes in the plains of the study area has been made in the seventh chapter. Impacts of the land
cover change in terms of meteorological aspects of the study area have been described in the beginning. In the subsequent part, the impacts on the river regimes and also on the socio-cultural aspects of the study area are analysed.

In order to study the nature and dimension of the impact of land cover changes in the river regimes, a case study on the Bhogdoi river basin has been undertaken and presented in chapter VIII. As the river has undergone significant changes due to anthropogenic and natural factors during the last two centuries, a historical account of the river course has been given at the beginning. In the later part, the basin has been studied at temporal scale with regard to aspects like its hydrological parameters, hypsometry and hypsography, flood frequency, suspended sediment load and the depositional characteristics.

The chapter IX deals with the management of the geo-environmental impacts arising out of land cover changes. The chapter presents some strategies to be undertaken for the minimization and mitigation of the adverse environmental impacts of the land cover changes in the plains. Discussion is also made regarding formulation of plans for the mitigation of the geo-environmental impacts that have been experienced in the plains of the study area.

The tenth chapter is the concluding chapter. It presents a summary of what has been done in the research works. This chapter also carries conclusions with the major findings. Some suggestions are also mentioned in this chapter. Besides these ten chapters, the thesis contains the list of references and appendices at the end.