

Chapter 1

Introduction

1.1 Statement of the problem

The main components of a river basin are soil, water and vegetation. Water in a river basin is available as a result of hydrologic cycle. The rainfall produced by hydrological cycle falls on basin, erodes the soil surface and goes to the river channel as runoff. This runoff takes the form of flood during heavy rainfall causing erosion of the river banks and spills over the bank creating flood havoc in the river basin. Based on the topography of a river basin, a part of the eroded soil sediments carried by runoff gets deposited on the river bed and the other part goes to the reservoir or the river delta. Thus the eroded soil creates a lot of problems to the reservoir, river and cropland of the basin. Useful life of reservoir goes on decreasing; river bed level increases and thus it loses its flood carrying capacity. Therefore knowledge of soil erosion pattern and spatial extent of flooding in a river basin and their different measures of control are very important to develop watershed management programme (Das, 2013).

The river Brahmaputra is the lifeline of Assam since ages. It flows in a highly braided channel characterized by the presence of numerous mid-channel and lateral sandbars. The course of the Brahmaputra River is 2880 km in length flowing through Tibet, India and Bangladesh. The river basin is a monsoon rainfall dominant regime marked with a unique physiographic setting, fragile geological base and active seismo-tectonic instability. It receives 33 major tributaries in India and most of them are from the North Eastern Region of which 20 come from the north and 13 from the south (Goswami, 2008).

The River Dhansiri is one of the major south bank tributaries of the river Brahmaputra. The river along with its tributaries drains the Dhansiri (South) River basin of North East India covering an area of approximately 12,240 sq.km lying partly in the state of Assam and partly in Nagaland. The Dhansiri (S) River originates in the south-west corner of the Laishong Peak of the Barail Range in Nagaland. It is the main river of Golaghat district of Assam and Dimapur of Nagaland. In addition the watershed also spreads over the districts of Karbi Anglong and Dima Hasao of Assam, Kohima, Wokha, Mokokchung, Zunheboto and Phek of Nagaland and Senapati of Manipur. Its major tributaries on the right bank are Diyung, Diphu and Gelabil and those on the left are Deopani, Nambor, Doigurung and Kaliyani. The Dhansiri(S) flows through a distance of 352km from south to north before joining the Brahmaputra on its south bank at Dhansirimukh. The watershed can be divided broadly into two portions (1) the hilly region and (2) the plain region. The hilly catchment lies in the districts of Kohima, Wokha, Mokokchung, Zunheboto, Phek in Nagaland, Karbi Anglong and Dima Hasao in Assam and Senapati in Manipur, while the plain region falls in the district of Golaghat, part of Karbi Anglong in Assam and part of Kohima in Nagaland. The plains catchment is about 2790 sq.km which is about 27% of the total catchment area of the sub-basin. It has a unique geo-environmental setting and possesses very rich biodiversity due to its strategic location.

The river Dhansiri acquires a meandering course during its flow through the plains of the basin. This results in frequent shifting of the bankline of the river. This contributes to severe river bank erosion associated with loss of land and sediment deposition along the river channel (Barman, 2015). The river basin is thus considered as one of the most erodible river basins in India. After the earthquake of 1950 the course of

the river is said to have undergone significant change which resulted in the existing severe and intense bank erosion problem throughout the Brahmaputra valley of Assam (Sarma, 1993).

Since a major part of the catchment lies in the hilly region, land use systems practiced in upstream area has a direct implication on the downstream areas. Land use is the human use of land which involves the management and modification of natural environment or wilderness into built environment such as fields, pastures and settlements. It has been defined under FAO, 1997a; FAO/UNEP, 1999 as “the arrangements, activities and inputs people undertake in a certain landcover type to produce, change or maintain it”. Land use/land cover and human/natural modifications have largely resulted in habitat destruction of many wild-lives thus causing biodiversity loss, heavy loss of soil due to soil erosion leading to desertification, global warming and increase of natural disaster-flooding.

Shifting cultivation is a primitive form and major agricultural practice in the hilly terrains of North East India (Lallianthanga et.al.1999). The process involves slashing and burning of the forests and cropping for a year or two and then leaving the land for forest regeneration. After some years the same site is revisited and the same process is repeated. By the process of shifting cultivation both primary and secondary forests are destroyed every year. This practice is the major cause of deforestation in the region which has led to the habitat destruction of many wild-life and heavy loss of soil due to soil erosion and also floods. Forested uplands are hydrologically stable. Deforestation destabilizes the health of a watershed. Forest plays an important role in maintaining the health of a watershed hydrology. It has been well established that forests effectively intercept rain water, reduce the energy of raindrops falling in the soil

and the soil dispersion thereby preventing the soil erosion and run off. The root systems of perennial vegetation bind the soil particles tightly and thereby prevent soil erosion. Forest litter, too, reduces the runoff speed and thereby minimizes sheet erosion. But many forests have been replaced today with cropping systems and other land use practices that has been detrimental to the flow and quality of water and soil erosion problems to downstream areas.

The removal of soil at a greater rate than its replacement by natural agencies like water, wind etc is known as soil erosion (Husain, 2007). It is the loosening/detachment of soil particles and its transportation from one place to another. It can be divided into two very general categories: Geological erosion and Accelerated erosion. Geological erosion occurs where soil is in its natural environment surrounded by its natural vegetation. This has been taking place naturally for millions of years and has helped create balance in uncultivated soil that enables plant growth. A classic example of the results of geological erosion is the Grand Canyon. Accelerated erosion can be caused by man's activities, such as agriculture, deforestation, construction etc which alter the natural state of the environment.

Three types of erosion are: 1) Sheet erosion, 2) Rill erosion 3) Gully erosion.

Sheet erosion is defined as the uniform removal of soil in thin layers from sloping land. This, of course, is nearly impossible; in reality the loose soil merely runs off with the rain.

Rill erosion is the most common form of erosion. Although its effects can be easily removed by tillage, it is the most often overlooked. It occurs when soil is removed by water from little streamlets that run through land with poor surface draining. Rills can often be found in between crop rows.

Gullies are larger than rills and cannot be fixed by tillage. Gully erosion is an advanced stage of rill erosion, just as rills are often the result of sheet erosion.

A flood is a high stage in a river at which it overflows its banks and inundates the adjoining areas (Subramanya, 2005). Based on its characteristics, four basic types of floods have been classified viz. flash flood, standing flood, coastal flood due to storm surges and riverine flood. Amongst these, riverine flood is the one which is most difficult to control (Cuny, 1991). The impact of flood is determined by its magnitude, frequency and duration. These characteristics are again dependent on the hydro-geomorphic properties of a river basin (Kale, 2004).

The Dhansiri(S) watershed is under the grip of problems of deforestation and land degradation. One of the major causes of land degradation and deforestation is the shifting cultivation practiced by the hill tribes of this region. Shifting cultivation results in soil erosion in the hill slopes and accentuates flood problems on the lower reaches of the basin. The problem of flood in the lower reach of the basin is a recurrent phenomenon. This causes heavy loss of agricultural production, livestock and human lives (Barman, 2015).

Some of the important biodiversity rich areas through which the Dhansiri (S) River flows include the Dayang Reserve Forest, Garampani Wildlife Sanctuary, Nambor Reserve Forest and finally the Kaziranga National Park close to its confluence point with the Brahmaputra River at Dhansirimukh in Golaghat district of Assam. The Dhansiri River flowing through Golaghat district carries effluents from the Numaligarh Refinery (NRL). The effluents discharged by the NRL pollute the river water thereby degrading its quality.

The cumulative impacts of all these anthropogenic activities are threatening the ecological, economic and aesthetic integrity of the Dhansiri watershed. For the present study the part of the river basin flowing through Assam is considered. The western and southern parts of the basin lying in Assam are hilly and have dense vegetation. The northern and eastern part of the basin comprise of alluvial plains. The basin has three major reserve forest, namely, the Nambor Reserve Forest, and parts of Dayang and Rengma Reserve Forests. Thus a large part of the basin is endowed with thick forest cover. Forest and agriculture provide the main means of livelihood to the people of the catchment. Therefore information on landuse/landcover of the area would help to bridge the gap in better understanding of relationship between cropland, forestland, settlement, wetlands etc. with the river meandering through the area. The growing pressure of population coupled with increasing demands made on land resources has brought extra pressure on the available land (Rao et al. 1996). Information on the rate and kind of changes in the use of land resources is essential for proper planning, management and to regularize the use of such resources.

The strategies to mitigate these impacts have explicit spatial dimensions. The optimal utilisation of these natural resources on a sustainable basis and management of natural hazards of the basin necessitate the need for making better use of analytical tools which address spatial and temporal variability. Geospatial technology is best suited for these purposes.

Geospatial technology refers to technology used for visualization, measurement and analysis of features or phenomena that occur on earth. Geospatial technology includes three technologies that are related to mapping features on the surface of earth integrated with information technology. These three technology systems are

- Remote Sensing
- Geographical Information System
- Global Positioning System

The space borne remotely sensed data provide spatial and temporal data at various spectral and spatial resolutions, geographical information system facilitates integration of different spatial and non-spatial data to arrive at alternate scenarios of development.

Remote sensing is a science where the information about an object, area, or phenomenon is acquired from a distance by a device i.e sensor that is not in contact with that object, area, or phenomenon. The principle of remote sensing technology is the formation of images by recording the radiated and/or reflected electromagnetic radiation from a remote object, area, or phenomenon at a particular wavelength of the electromagnetic spectrum. Spatial information is extracted of the object, area or phenomenon from analysis of those images. This information is stored, compiled and merged with other form of analysis and application in GIS (Lillesand et al., 2008). GIS is a computer based integrated database management system that stores a large volume of spatial data along with its attribute or non-spatial data which are captured, stored, retrieved, processed and analyzed to provide answers to queries of a geographical nature as and when required.

The fundamental key of GIS is that, the association of Geographic features present on earth's surface, which can be the geo-referenced with a database related to it. The term "Geo-referencing" refers to providing accurate location of a point or area in the space in terms of true earth co-ordinate system and "Database" is simply a collection of raw facts which are stored in a structural manner having relationship with each other.

In a nutshell, Spatial data can be described as “where things are” and attribute data are “what things are”.

GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and the geographic analysis benefits offered by maps. These abilities distinguish GIS from other information systems and make it valuable to a wide range of public and private enterprises for explaining events, predicting outcomes and planning strategies.

Analysis of satellite data in conjunction with drainage, lithology, and land use/land cover collateral data facilitates effective evaluation of geomorphological conditions and status of degraded landforms. This data set is the core of the Geographic Information System (GIS) that provides an excellent means of spatial data analysis and interpretation. It also provides a powerful mechanism, not only to monitor degraded lands and environmental changes, but also permits analysis of information of other environmental variables.

The Global Positioning System (GPS) is a satellite-based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defense. GPS was originally intended for military applications, but in the 1980s, the government made the system available for civilian use. GPS works in any weather conditions, anywhere in the world, 24 hours a day. The system’s positioning and timing data are used for a variety of applications, including air, land and sea navigation, vehicle and vessel tracking, surveying and mapping for ground truthing and asset and natural resource management.

Thus, these combined technologies have brought revolution in inventorying, monitoring modeling and managing earth resources and help us understand the global

ecosystem. They provided a powerful tool to the decision makers. Different researchers worldwide today extensively use these technologies to monitor landuse/landcover change, shifting of river bankline, river bank erosion, extent of flooding in an area and many more aspects by using multi-temporal satellite images. Geospatial Technology provides the solution in cost and time effective manner.

1.2 Review of Literature

Geo-environmental studies on river geomorphology, landuse/landcover, soil erosion, flood, using remote sensing and GIS technology have been adopted worldwide today.

1.2.1 Research works done abroad

James F. Daniel (1971) had carried out a study on the Channel Movement of Meandering Indiana Streams. In his study he found that the process of channel movement in a meander system involves rotation and translation of meander loops and an increasing path length. The amount of path length increase is directly proportional to the impulse supplied by discharge and is inversely proportional to the silt clay percentage of the materials composing the channel perimeter.

A statistical analysis of bank erosion and channel migration in western Canada was carried out by Nanson and Hickin in 1986. In their study they found the mean lateral-migration rates for 18 meandering river channels in western Canada. They explained the results statistically in terms of hydraulic and sediment related variables. The volume of sediment eroded from the outer bank of a meander bend is shown to be largely a function of river size and grain size of sediment at the base of the outer bank. These

variables explain almost 70% of the volumetric migration rate for these relatively large, sand- and gravel-bed streams. It would appear that bank erosion and channel migration are essentially problems of sediment entrainment which is dependent on total stream power and sediment size. Vegetation on the other hand is seen to have less significant effect in controlling channel migration.

Viet et al. (2002) used remotely sensed images and described the process of quantification of riverbank erosion. Time series satellite images of different sources composed of optic and radar imagery were used by them to detect the changes of riverbanks at Tien and Hau branches of the Mekong River. The movement of the banklines were analyzed in pairs and compared through superimposition of all vector layers. Erosion of Mekong riverbanks was calculated to be 4 to 10 km in length, 100 to 1000 meters in width at Tien and 2.5 to 4.5 km in length, 100 to 1000 meters in width at Hau from 1966 to 1999.

A study on planform geometry and channel migration of confined meandering rivers on the Canadian prairies was done by Nicol and Hickin in 2010. Their attempts to seek correlations between migration rate and channel flow and morphometry data was modestly successful.

M. Nasiri (2013) carried out a study on GIS modeling for locating the risk zone of soil erosion in a deciduous forest of Iran. He prepared the maps of altitude, geology, vegetation cover and land use. These maps were then classified as the main criteria to locate soil and water conservation programs and by using Analytical Hierarchy Process (AHP) the relative priorities of these criteria by pairwise comparison were determined. The thematic maps were then integrated using the overlay process in Geographical

Information System (GIS) and the final map of soil erosion risk was produced. Results indicated that vegetation cover was given the highest weight (0.494). The geology was assigned the second highest weight (0.313), as the main cause of initiation of the erosion of erodible lands. Land-use change has a local influence on soil erosion, so it was assigned the third weight (0.151). Altitude is a low-impact variable for predicting the water and soil conservation areas.

Bathrellos G. and Skilodimou H (2007) has done a study using the Analytic Hierarchy process to create an erosion risk map in the Malaksiotiko stream, Trikala Prefecture. The study aimed at using a Geographic Information System (GIS) for the evaluation of the erosion risk at the drainage basin of Malakasiotiko stream in Trikala prefecture. Six factors that influence erosion were identified as slope, lithology, drainage density, tectonic features, density, land use and rainfall and a database had been created which was inserted into GIS. These factors were grouped into various classes and then using Analytic Hierarchy Process (AHP) the individual classes of each factor were rated and weightage was given on the impact of one factor against the other in order to determine their importance to erosion process. The results of the AHP application in combination with GIS techniques were used to create the erosion risk map. The study area was thus divided into three zones of erosion risk. High erosion risk zones are mostly located on the northwest, west and south parts of the drainage basin of Malakasiotiko stream. The erosion risk map of the study area can be a useful geologic and geomorphologic criterion for the landuse planning.

1.2.2 Research works done in India

In India an Integrated Mission for Sustainable Development (IMSD) study was initially conceived in the year 1987 by the Department of Space (DOS), Government of India. The study was initiated for pilot demonstration in 21 districts of thirteen (13) States in India. After its success the study has been extended to 174 districts distributed in all 25 States of India (ARSAC, 1997).

A study on application of Remote Sensing and GIS in integrated watershed development planning in Dhandhuka and Viramgam taluks of Ahmedabad district was carried under the IMSD project (Singh et. al., 1996). The objective of the study was to arrive at plans for sustainable development and optimal utilization of land and water resources for achieving optimum production without endangering the environment by integrating information generated through space technology and other conventional sources. Similarly a watershed management plan for Jamuna Sagar Waterhshed in Kalahandi district, Orissa was prepared under the IMSD project (Behera et.al., 1996)

The Central Soil and Water Conservation Research and Training Institute, Dehradun and its Regional Centres have been playing a pioneering role in popularizing this watershed approach, through research, demonstration and training over the last 25 years or so (Narayana et.al., 1997). The institute had undertaken three operational research project watersheds at Fakot (Tehri-Garhwal district, Uttar Pradesh), Sukhomajri/Nada (Chandigarh) and G.R. Halli (Chitradurga district, Karnataka). In each case, a complete watershed of 300-400 ha were covered by watershed development. The actual work involved fuel-fodder plantations in the denuded catchments, construction of erosion control structures like check dams, graded bunds,

construction of small water-storage reservoirs, adoption of appropriate cropping systems, cultural methods and water management practices. These case studies have shown that the integrated watershed development approach is economically beneficial, especially in places where dependable water resource is developed in such a programme. Based on these successes the institute is now implementing watershed development in other locations all over the country.

Mithun Deb et.al (2012) has done a study on the evaluation of meandering characteristics using RS and GIS of Manu river.

1.2.3 Research works done in North Eastern Region of India

In Assam, Puthimari Watershed, covering parts of Kamrup and Darrang District was selected for the study under the IMSD project DOS, Govt.of India. The study involved space based technology for generating various thematic maps and integrating those with various conventional resource data. The study was entrusted to Assam Remote Sensing Application Centre, A.S.T.E. Council, Guwahati during the period 1992-93. During the study action plan packages were formulated for permanent solutions to problem areas in various resources and developmental sectors (ARSAC, 1997).

Dulal C. Goswami (1985) carried out a study on physiography, basin denudation and channel aggradation of the Brahmaputra River, Assam, India. In his study he had highlighted that the Brahmaputra River in Assam is characterized by high seasonal variability in flow, sediment transport and channel configuration and experienced a secular period of aggradation from 1971 to 1979.

A study on the Fluvial Regime and Flood Hydrology of the Brahmaputra River, Assam was also done by Dr. D.C. Goswami. In his study he examined some of the important features of flow regime of the Brahmaputra River in general and the flood regime in particular, through analysis of flow data covering the last 40 years in general and the 1971-80 decade in particular. The focus of the study was on the several aspects of the basin environment that have considerable bearing on the flow regime of the river.

U. M. Hazarika (1998) carried out a study on landuse planning and land management of Nanoi Watershed, Nagaon district (Assam). In his study he has examined critically the existing landuse and land management models of both USA and India and assessed their applicability in respect of Nanoi watershed of Nagaon district, Assam.

A study on management of Baladi Watershed in North Kamrup was undertaken by Ajay Kumar Sarma (1988). The study attempted to understand the hydrological parameters using photo interpretation techniques and essentially finding ways and means to obtain a reasonable value for the run-off factor at different periods of the year.

Bora et. al. (1990) carried out a study on application of satellite remote sensing in the study of basin and sub-basin characteristics of the Jia Bharali River, N.E. India. The study was based on the interpretation of Landsat imageries. In their study they divided the basin into 12 sub-basins and measured and quantified the morphological and network characteristic of the basin. These parameters were then examined against the background of geology and physiography of the region to bring out the underlying geomorphic significances.

Santanu Sarma (2006) carried out a study on the Kulsi watershed of Kamrup district using geospatial technology. In his study he suggested an integrated approach to the management of natural resources and hazards of this interstate basin.

Narayan Chetry (2006) had undertaken an integrated management approach and planning for sustainable development of diverse natural resources and infrastructure using GIS based spatial model in the Kathiatoli Development Block of Assam.

The Water Resources Department (WRD) of the state government of Assam, India engaged consultants to undertake an environmental impact assessment (EIA) of a multitranche financing facility (MFF) for the Assam Integrated Flood and Riverbank Erosion Risk Management Investment Program. The Program aims to enhance the effectiveness and reliability of flood and riverbank erosion risk management (FRERM) systems in three existing flood embankment systems (or subprojects) protecting urban, suburban, and other strategic areas of Assam: (i) Palasbari reach (74 kilometers [km]) in Kamrup (south) district; (ii) Kaziranga reach (29 km) in Golaghat district, adjacent to the Kaziranga National Park (KNP); and (iv) Dibrugarh reach (25 km) in Dibrugarh district. The Program also aims to strengthen the policy, planning, and institutional bases to support better FRERM operations. Comprehensive and adaptive structural and nonstructural FRERM measures will be provided in the three subproject areas. These are provided in two tranches during the 7-year implementation period, based on the local priorities.

P Phukan et.al (2013) had done a study to analyse the land use land cover changes in Golaghat district of Assam by using multi temporal remote sensing data (LANDSAT ETM 1989, and IRS LISS III 2009). In his research he examined the nature

and extent of land use land cover changes in Golaghat district of Assam in the past 20 years. He found that the major changes in the landuse/landcover pattern had occurred in cropland and scrubland. He concluded that the cause behind the changing pattern is that the area under scrubland is converted into agricultural or crop zone.

N Mili and Shukla Acharjee (2014) had conducted a study on the importance of geomorphology in understanding natural hazards with special reference to hazards of the Dhansiri River Basin in the Golaghat district of Assam. In their study they found that a knowledge on geomorphology of the area helps in mitigating various hazards or reducing its impact to a large extent. During their study they observed that bank erosion, shifting of channel and loss of human habitats, agricultural lands are common phenomenon associated with the river Dhansiri. They concluded in their study that the earthquake of 1950 may be a threshold point after which the bank erosion problem has become more severe and intense throughout the Brahmaputra valley of Assam

J.N.Sarma et.al (2007) carried out a study on the change of river channel and bank erosion of the Burhi Dihing river (Assam) using remote sensing data and GIS. They studied the bankline shift due to bank erosion for the periods 1934-1972, 1972-2001, 2001-2004 and 1934-2004. During the study of the entire period (1934-2004), they found that the overall erosion on the both the banks was more compared to sediment deposition

A GIS based study on bank erosion by the river Brahmaputra around Kaziranga National Park, Assam, India using multi date satellite data was carried out by J.N.Sarma and S. Acharjee in 2012. The study led to the identification of areas experiencing bank erosion and gain in land due to bank retreat of the Brahmaputra River along Kaziranga National Park during the period 1912 to 2008. The results showed that the reach of the

Brahmaputra along the Kaziranga reach had widened substantially from 8.36km in 1912 to 11.96 km in 1972 due to the effect of the earthquake. The maximum width of the river in the Kaziranga reach in 1998 and 2008 was 10.28 km and 11.01 km, respectively. The result confirms that the widening process had slowed down considerably in recent times and indicated that in future, deposition is likely to be more in eastern part of Kaziranga and erosion in middle part of Kaziranga National Park area.

P. Kotoky et.al (2012) carried out a study on the evaluation of changes in landuse/landcover along the Dhansiri channel using remote sensing and GIS techniques. In his study he used IRS P6 LISS III satellite imagery of 2008 and SOI Topographic sheets of 1975 under GIS domain to evaluate the changes in landuse/landcover along the Dhansiri River Channel. He found that cropland has reduced significantly during the span of thirty years.

A study on the Mechanisms and Spatio-temporal Variations of Meandering and Erosion-Deposition Statistics of the Dhansiri River, Assam was done by P. Kotoky and M.K Dutta (2015). A stretch of the Dhansiri River channel from Dhansirimukh to Nowakota Kachari spanning the period 1914–2000, was studied with an objective to understand the erosion-deposition activities operating within the channel. The study has revealed a total average annual erosion and deposition covering the entire period were 1.32 and 1.27 km²/year respectively. The average rates of erosion and deposition per kilometer length of the river were 0.006375 and 0.00625 km²/km respectively. Increasing rate of erosion since the year 1914, comparatively higher erosion along the west bank than the right bank, has also been observed. The areas around Butalikhowa, Golaghat and Kuruabahi have undergone severe erosion posing a threat to the population in the vicinity.

A.J Desai, S.D Naik, and R.D Shah (2012) conducted a study on the Study on the channel migration pattern of Jia-Bhareli, Puthimari and Pagladiya tributaries of the Brahmaputra River using remote sensing Technology.

Roy (1975), Mazumder et al. (2001), Luirei and Bhakuni (2008), and Sarma and Acharjee (2012) have carried out important studies on neotectonics of the eastern part of Assam. In these neotectonic studies attempts were made to correlate subsurface active structure with drainage patterns, drainage anomalies and bank erosion.

The nature of bank erosion of the Kaziranga area was studied by Naik et al. (1999) using multitemporal satellite data

Sarma, 2002; Sarma and Phukan, 2004, 2006; Sarma et al., 2007, 2011 carried out studies on bank erosion of the river Brahmaputra and many of its tributaries using topographic maps and satellite data.

1.3 Significance

The present study would help in better understanding of the baseline condition and potentialities of the Dhansiri (south) River basin, Assam. The study would help recognize the linkages between highland-lowland interactive processes. It would also directly focus on the nature of biotic pressures and resources to be protected in the watershed under study. It would facilitate development of sustainable management solutions to current land and water degradation problem. The study will be greatly beneficial in understanding the flood and erosion hazard in the Dhansiri (south) River basin and adjoining areas including Kaziranga National Park close to the Dhansiri-Brahmaputra confluence. Recommendations for conservation and management of the river basin may be passed on to decision and policy makers.

1.4 Structural set up of the Study

Chapter 1: This chapter presents an introduction to the problem pertaining to the river basin under study, its management, review of the past literatures on relevant works carried out in the line and significance of the research work.

Chapter 2: This chapter deals with the objectives, database and methodology to be used while carrying out the research work.

Chapter 3: In this chapter the geo-environmental setting of the study area is described.

Chapter 4: This chapter presents the various thematic maps prepared during the study and their interpretation.

Chapter 5: This chapter deals with the pattern of change in landuse/landcover in the study area.

Chapter 6: This chapter presents nature of channel change during the period from 1999 to 2008 and estimated bank erosion in the study area. It also presents the results of investigation of geotechnical properties of soil samples collected along the bank of the river and their classification according to Indian Soil Classification System (ISC).

Chapter 7: In this chapter the methodology applied for mapping of soil erosion risk zones of the study area is described and various erosion prone areas is identified.

Chapter 8: This chapter deals with the problem of flood and inundation mapping and identification of flood prone areas in the study area.

Chapter 9: This chapter presents an integrated river basin management plan for the study area with special emphasis on minimizing the impacts caused as a result of deforestation, soil erosion and flooding in the area.

Chapter 10: This chapter contains the summary and conclusion of the study