GEOMORPHIC STUDY OF LOWER SUBANSIRI BASIN, ASSAM

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INTRODUCTION

Geomorphology is the study of landforms, their description and interpretation. The science of geomorphology is important not only as an academic discipline but also in its practical applications in the field of the soil science, economic, geology, geohydrology, military geology, engineering geology and rural and urban planning.

According to Brown (1970) Geomorphology is the science which describes the shape of the earth. The science of Geomorphology, which is primarily concerned with the form of the earth, is more than one hundred-years old. Traditionally the study of geomorphology was essentially that of orgin and evolution of landforms.

According to Wooldrige (1958) Geomorphology is a fundamental science that is primarily concerned with the interpretation of the form and the study of the processes. However, today Geomorphology is the science which studies landforms and land forming processes.

On the other hand geomorphologists like Leopold, Wolman and Miller (1969) while observing that much of geomorphology is stratigraphic geology, have made the

study of contemporary processes, part of their methodological approach to the subject. But now geomorphology tells about the shapes of hills and valleys, the degree and frequency of slopes, the development of drainage patterns and nature of the material exposed in all available sections. Study of geomorphology is not limited to the academic sphere only. There has been a phenomenal development in the field of geomorphological studies in the twentieth century with several schools of thought. C.A.M. King (1966) in her book explains that there are three major groups. The first arises out of the work of Walter Penck and may be called the mobilistic view, the second one gives priority to the effects of climate in studying the characteristics of the landscape, and the third one is based essentially on an idea of correlation by altitudes.

The modern trend in geomorphological study is towards the increasing importance of the quantitative as well as of the qualitative methods. R.E. Horton (1945) described that the drainage and channel networks are purely quantitative science, providing the hydrologists with numerical data of practical value. A.N. Strahler (1942, 1954, 1956, 1964) and his associate Schumm (1956) Melton (1957) and Morisawa (1957) further developed Horton's ideas. It has also been noted that

the applications of modern geomorphology are based on the dynamic approach, systematic and mathematical approach for a better understanding of geomorphology. The works of the W.M.Davis, J. Playfair, G.K. Gilbert, L.C. King, W.D. Thornbury and B.W. Spark are outstanding contributions in the field of geomorphology.

Since 1960s a phase of intensification and concentration has emerged in the study of geomorphology in correct perspective. This has been facilitated through by increasing use of systematic approach, helped by model building and design, and more sophisticated techniecques and methods of analysis. The significance of man as an agent of geomorphologcal processes is also increasingly emphasised. The study of the impacts of man directly or indirectly upon both surface processes and forms is included in the study of geomorphology.

Conceptual Framework

The science of geomorphology is concerned with the geomorphic characteristics of the earth's surface and processes, which are responsible for its development and evolution. In fact, the study of landscape processes responsible for the type of landform and rates of formation constitutes the science of geomorphology.

The term, geomorphology was first introduced in mid 1880's as the study of land formation. This was originally derived from the Greek words, 'geo' (earth) 'morpho', shape and 'Logos' (reasons); hence the study of earth's shape or a discourse on earth forms (Thornbury, 1988, p-1).

The aim of geomorphological research is to identify the landforms' types and the nature of their changes and also to find out the processes resulting in the development of landforms, the rate at which they work and the matter in which the landorms, change with the passage of time. Thus, the geomorphologist establishes the relationship between the forms and process and finally develops theories/models to explain the real world situation, in such a manner, so that it can be applied in a generalized form for the purpose of land evaluation. Geomorphologists generally consider the landscape on a spatiotemporal basis and the spectrum of approaches in geomorphic studies is based on the following perspectives.

(i) Historical studies attempting to deduce the erosion and deposition of the ladscape and trace the sequence of historical event through which it has passed and

(ii) Functional studies of contemporary processes and the behaviour of the earth material, which can be directly observed. It helps the geomorphologists to understand the change of landforms (Chorley et.al, 1984,P-1).

River basin as a Geomorphic Unit

The need for the precise description of the geometry of landforms, particularly those of dominantly fluvial erosion, has been a recurring theme for geomorphologists. One of the most important aspects has been the search for the basic areal unit within which such data could be collected. (Chorley, 1969,P-3). Drainage basin may be defined as the system of river and its tributaries, which drains an area. A mjor river and its tributaries reveal a hierarchy of channels which can be enumerated and studied quantitatively.

The drainage basin is considered as the most satisfactory geomorphic unit. In fact, the drainage basin is viewed as a geographical study of varied aspects such as (i) their existence in physical landscape and significance for producing fluvial landforms, (ii) their importance indirectly in relation to many other geomorphic processes in fluvial landforms and (iii) their significance for human use (Gregory and

Walling 1973, P-3). It forms a convenient unit for the consideration of the processes determining the formation of specific landscpe in various regions of the earth (Leopold, Woolman and Miller, 1964, P-131).

It was Davis (1899) and his contemporaries who studied river valleys and examined evolution of progresses over a period of time(Thornbury, 1899, P-122) and postulated the concept of "The geographical Cycle" of landscape evolution. Other satisfactory units were also adopted by the workers like Playfair (1802) Wooldrige (1932) Savigear(1965) and U.S. engineers etc. The drainage basin is viewed as a topographic and hydrological unit which creates erosional and depositional landscape elements. It clearly defines topographic character and is considered as an open system in terms of input and output.

The drainge basins are evaluated in their dimensional form of properties, which include the evolution of linear, areal and relief properties of the drainage basin using morphometric techniques.

In a country like India, application of geomorphology in the field of land utilization particularly for agriculture, horticulture, forest development, selection of dam sites, transport and communication and human habitation is of great relevance to further development. But very little research works have been undertaken in the field of geomorphology in the Northeast India. This may be due to the lack of detail geological and topographical information, maps and related data.

In Assam limited research has been done in the field of geomorphology. Goswami (1988) studied "Suspended sediment transport, valley degradation and basin denudation, Brahmaputra River", Sarma (1989) studied "Geomorpholoogical studies on the Dhansiri river Basin" (1989) wrote his doctoral thesis on "Jia-Bharali river basin," Saikia (1994) based his study on "Geomorphology of Kapili river basin". The aforesaid researches in this field have provided valuable informations regarding various geomorphic features and hydrological characteristics of the study area.

Statement of the Problem

The present study intends to examine the morphological characteristics, fluvial processes and flood problem in the Lower part of Subansiri basin, Assam.

Morphometric analysis has been used for illustrations and descriptions of the landforms, i.e. relief, slope, drainage network analysis etc. in reltion to the geomorphology and fluvial geomorphology. The diverse topographical features of Subansiri basin have made a geomorphic study of the basin absolutely essential to acquire a detailed geomorphic information for the development of the basin.

Objectives of the Study

The following objectives have been taken into consideration for the investigation:

(i) to study the structural and tectonic history of the basin area

(ii) to find out the drainage network and evolution of the basin

(iii) to study the fluvial action of streams and network system

(iv) to study the nature of slope, drainage density pattern and their characteristic feature

(v) to find out the flood prone areas and its impact on the agricultural land

Location and extent

The Lower Subansiri basin is located between 26°40' N to 27°45'N latitudes and 93°15'E to 94°35'E. longitudes and covers an area of 9636 sq.kms. The

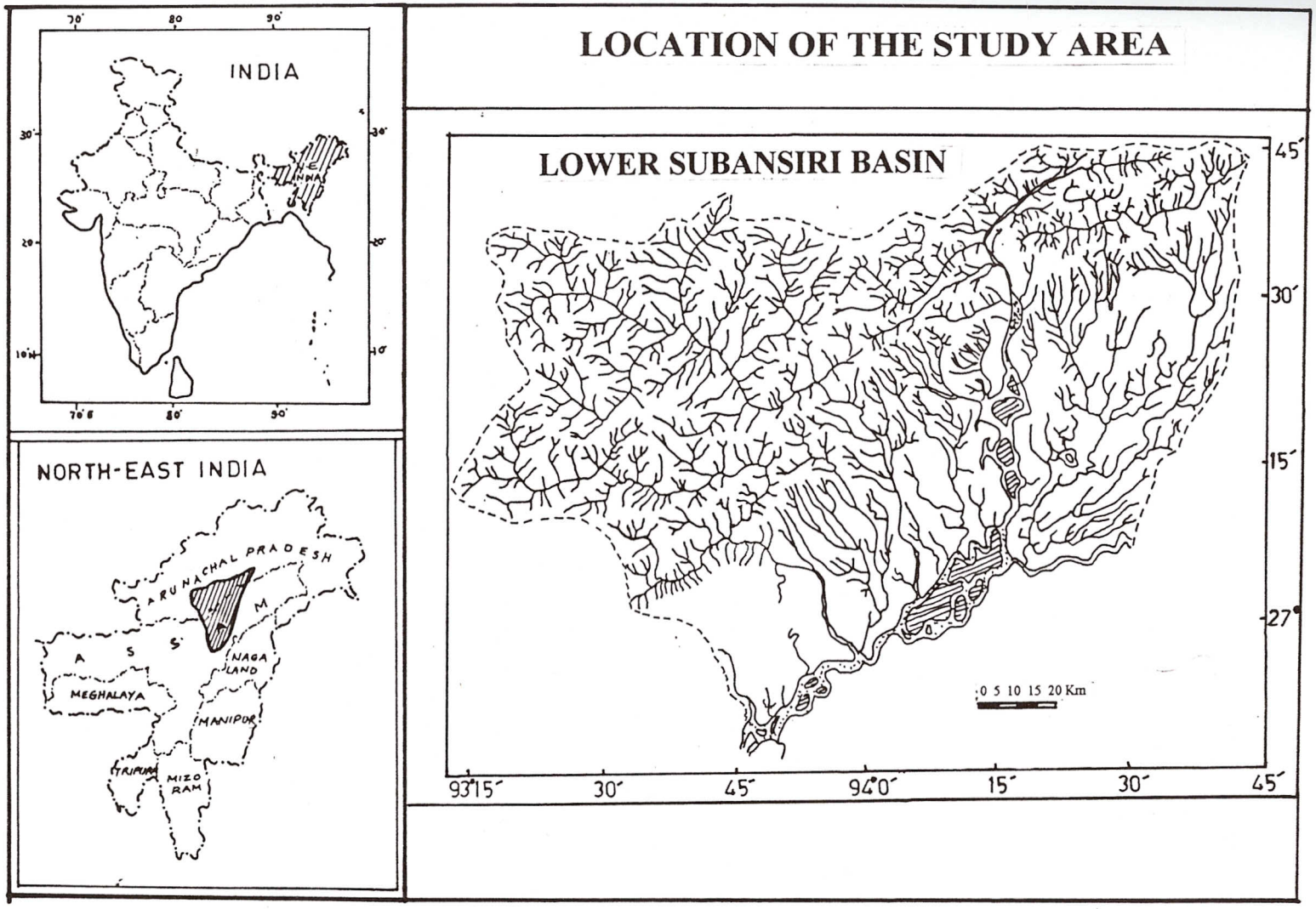
LOCATION OF THE STUDY AREA
INDIA
NORTH-EAST INDIA
ARUNACHAL PRADESH
NAGA LAND
MEGHALAYA
MANIPUR
TRIPURA
MIZO RAM
LOWER SUBANSIRI BASIN
0 5 10 15 20 Km
93°15´
30´
45´
94°0´
15´
30´
45´
45´
30´
15´
27°

Fig. 1.1

Subansiri River is a main tributary of the mighty Brahmaputra River. It originates in Tibet Himalaya and flows through Arunachal Pradesh. For the convenience of research the lower Subansiri basin has been considered for the present study. (Fig.1.1).

River System of the Basin area

The Subansiri river is a major tributary of the mighty Brahmaputra. It originates in the great Himalayan range in the Tibet, which is the source of many rivers at an altitude of about 5000m above the m.s.l. The principal streams belong to Chu group in the Nye Chu, which may also be considered as the main source of the river. It originates in the snow-clad peaks of Kareng, Shobota, Baru and meta. another river Larochu near the Chyal and these join the Nye Chu by taking the name of Chayal Chu. The another stream Char Chu rising from snow clad peaks in the north joins the main river and crosses the international boundary to enter the Indian territory.

The river, as it approaches the Miri hills in the Arunachal Pradesh after crossing the internationl boundry runs in to the valley. The important sub tributary called Kamala rising in the southern part of Himalaya joins the Subansiri on the right

bank at a distance of about 95 kms. from the point of confluence of the Yume Chu and Tsari Chu. The river runs another 30 kms. through steep gorge to emerge from the hills through a short canyon to Subansiri river. The entire course of the Kamala is combined to a narrow gorge.

The main course of the Subansiri after entering the Miri hills in Arunachal Pradesh runs between Dafala and Abor hills. Debauching from the hills near Dolongmukh the course of the river lies in the fertile plain of North Lakhimpur district of Assam. In the broad and flat valley, the river flows in lazy and sinus curves. In fact during monsoon, it is a mass of water heavily charged with silt and in winter it becomes quiet and flows smoothly. After flowing for about 70 km. from the hills, the river falls in to Kherkutiasuti.

Subansiri is a composite basin with two major sub basins viz. the Ranganadi sub basin and Dikrong sub basin. Both these rivers originate in the Lesser Himalayan zone and flow through the hilly terrain and the plains of Assam and finally meet the Subansiri before the latter meets the Brahmaputra.

Ranganadi Sub Basin

The Ranganadi which is known as the Panir river in the upper course rises from the Dafala hills in the Arunachal Himalyas Ranganadi is bounded by a series of peaks ranging in height from 2286m to 3658m. The important tributaries of the Ranganadi river in this zone are the Kying river, Pein river, Niorchi river, Kal river, Pangen river and Pite river.

The total length of the Ranganadi river in the hilly terrain is about 76 km and the river bed falls from about 1400 m. in the Dafala hills to about 150 m. near the Jaihing Tea garden in the plains of Assam.The total drainage area of Ranganadi is about 2500 sq.km. of which about 1900 sq.km. fall in the hilly terrain.

Dikrong Sub Basin

The other major tributary of the Subansiri is the Dikrong river which orginates in Arunachal Himalayas. The Dikrong basin is separated from the Ranganadi basin in the north by a series of peaks ranging in height from about 2280m to 2600m and the southern margin of the basin runs along the series of peaks ranging in height from 1300m to 2300m.

The total drainage area of Dikrong sub basin is about 1950 sq.km. out of which about 1000 sq.km. falls in the hilly terrain, before it debauches in to the plain near Doimukh. The river traverses a distance of about 80 km in the Arunachal Himalayas. There is a network of tributaries of the Dikrong in Arunachal Himalayas. The drainage basin of Dikrong is more or less rectangular in shape.

In the upper reaches of the basin, its tributaries are fed by the melting of snow. The Arunachal Himalayas receive an average annual rainfall of more than 500 cm. The gradient of the river in mountain terrain is very steep and the tributaries are numerous.

Climate

The climatic conditons of the lower Subansiri basin are more endurable than the uper valley of Subansiri basin. The climate is cool and humid. The rain stops in the area in the month of October and temperature begins to fall. The average maximum temperature is 30°C. during the four succeeding months, the four succeeding months, the climate becomes increasingly cooler. In the month of December and January the maximum and minimum temperature is about 21°C and 10°C respectively. The period from June to September is the unpleasant part of the year. Heavy rainfall takes place

during these months as a result it becomes saturated with moisture and the climate is humid and hot. In this area the rainfall is much heavier than the plain. At Pathalipam located near the foothill the rainfall is about 426cm. Whereas at Lakhimpur and Dhakuakhana it varies between 324 cm to 256 cm respectively. The period from May to September is the rainiest and more than 70% of the total annual precipitation is confined to this period. November and Decedmber are the driest months and seldom visited by violent and destructive storms through an interval of dry weather. Hailstorms sometimes cause damage, especially to the Tea gardens.

Methodology and Research Design

The geomorphological invetigation of river basins involves precise and correct understanding of the terrain attributes. It requires a scientific and methodological study of information colected through fieldworks and remote sensing data etc.

In the present study, special emphasis has been laid on the relief analysis as well as slope and fluvial processes. In adition, geological strucure and history, weathering, soil and mass wasting and environmental degradation have also been

analysed and interpreted. The entire work has been carried out in different phases of pre-field work, field work and post fieldwork.

The following steps are taken in compiling the present research design.

(i) Preparation of base maps by using Survey of India topographical sheets on the scale 1:250000 showing drainage netwoek and contours.

(ii)Collection of geological and lineament maps.

(iii) Cartographic representation of data in maps and diagrams.

(iv) Identification of different flood prone areas.

Data Source and Research Material

The field work hs been carried out for collection of the first hand data namelyl the identification of landforms, nature of soil, geomorphic processes active in the area, identification of flood prone areas, vegetation types and nature of environmental degradation etc.

For the present study the following materials have been used:-

1) Survey of India topographic sheets numbered 83E,83F, 83I & 83J on the scale 1:250,000.

2) The aerial photograph at the scale on 1:25000,

3) The IRS-1C satellite imageries.

4) The reference books and reports published by GSI and differnt allide departments.

Chapter Scheme:

The chapter scheme for the present research work has ben designed as follows:

The first chapter deals with general introduction that provides an insight into the present reserach framework including conceptual framework, statement of the problem, objectives of the study, methodology and reserch design, data source and reserach materials.

In the second chatper, the geology of the study area (Lower Subansiri basin of Assam and Arunachal) has been discussed. The discussion broadly includes the geological formation of lower part of the basin. Basically there are three main geological formations in this part which have been formed in geological past.

Chapter three deals with a detailed description of weathering processes and soils of the basin area. It has been found tht due to the prevailing climatic conditions in the area, physical weathering is found to be prominent. There is vast difference between the soil of the upper Subansiri basin and the lower part of the basin.

Chapter four concentrates on the analytical results of the relief and slope characteristics of the basin as evaluated on the basis of the field studies.

In the succeeding chaper (Chapter-five), the fluvial analysis that includes, the analysis of the suspended sediment load, gauge and flow discharge, identification of flood prone areas flood and drainage congestion etc. have been put forward in a tabular form acompanied by relevant diagrams.

In chapter six, environmental degradation of the area and its proper management techniques have been discussed in detail. Recommendations pertaining to the suitability and necessity in the present area have been put forward for the proper up-gradation of the basin area for all round development.

In the last chapter the general summry and conclusions of the study have been presented.

SUMMARY AND CONCLUSION

The Subansiri River is a major tributary of the mighty river Brahmaputra. It originates at an altitude of about 5000m in the Great Himalayan range in Tibet that is also the source of many mighty rivers. The principal streams of the Subansiri belong to Chu group of the Nye chu, in the upper reaches, which may be considered as the main source of the river. The major tributaries of the Subansiri river originate in the snow clad peaks of Kasreng., Shobota, Baru and Meta. Every year devastating flood take place in the river basin area in multiple waves affecting the economy of the people and often caused much loss of life and property. The erosional activity of the river, mainly of bank-eating type, resulting frequent changes in the course of the river that makes the situation worse. The present study focused on identification of some of the geomorphic features and natural hazards, which are most responsible for the adverse situation of the area.

The catchment area of the Subansiri basin has an extensive mountainous terrain of about 9636 km^2 out of the total basin area of 27,000 km^2. Physiographically Subansiri basin comprises of rugged hilly terrain, therefore, rivers gush down with high speed due to the high gradient of the slope. The fall in gradient of rivers are quite significant and on an average there is a fall of 2500 m to 150 m within a distance of 75 km to 100 km. About

4000 km^2 catchment area in the mountain region lies above the snowline therefore, in the upper reaches river Subansiri an tributaries are fed by melting of ice and snow. However, in the lower part of the basin it receives very high rainfall of an average of 400 cm per year.

The geological formations of Subansiri basin are complex one. The rock types of the area belong to highly sheared Gondwna shate, phyllite, carbonaceous shale and the tertiary rocks consisting of mainly soft sandstone which are prone to landslide. These are the exposed soft rocks in the outermost hill ranges which contribute enormous quantity of sediments to the basin area. The large plain and low lying area which covers an area of 2,700 km^2 in Assam and Arunachal Pradesh. The fall of gradient from the foot-hills to the Brahmaputra river in the south is very low.

During the monsoon period, due to heavy rain in the catchment area, some times for days together, the discharge of the Subansiri and its tributaries increase suddenly. This is accentuated by the melting of ice in the upper reaches. The heavy rain also led to the increase of landslide and rockslide which so often takes place in the outermost hill ranges. Thus the river receives large discharge with sediments and carries it through the hilly terrain. But as soon as it debauches in to the plain the gradient of the river bed falls abruptly and the sediment carrying capacity of the Subansiri river and its tributaries decline resulting

in deposition of sediments along their channels. The river starts meandering only a few kilometers away from the foothills. The increase in volume of water of the river spills out and inundate vast area. The situation becomes worst when there is also heavy rain in the plains. The remedy to this is the construction of embankments along the river banks. Sufficiently high and away from the bank so as to accommodate the increased volume of water and sediment during the flood. Regarding the bank line stability it my be stated that the large discharge and heavy sediment load cause the rivers to be extremely unstable and the channel consistently migrate laterally. But the Subansiri and its tributaries being mainly meandering rivers the changes and migration pattern are fairly predictable since the rivers cut on one bank and deposit on the opposite. It can be effectively controlled by timely construction of suitable dykes.

The river is floored with quaternary sediments ranging in size from boulder to clay which provide materials for the formation of good aquifers. Due to the absence of bore-holes and geophysical data, the exact thickness of the deposited sediments and the bed rock topography are not known. This data is essential for an accurate quantitative estimation of ground water in the area.

Ground water in the area occurs under water table condition in the shallow aquifers. The gradient slope of the water table is from north to south. The hydraulic gradient is highest in the pediment plain and decreases progressively southward. The water table become almost flat near the Brahmaputra. Though nothing is known definitely about the deeper aquifers, the impersistent nature of the aquifers indicates that they are in hydraulic continuity with the shallow. From the water level data, it indicates that water table is deepest in February - March and the shallowest in the month of July - August.

From the environmental point of view, it can be summarised that the area suffers from extensive landslides affecting the road connection. In addition to this heavy soil erosion and submergence of large area under the flood water especially during the rainy season accelerated further degradation of environment in the entire region.

RECOMMENDATIONS ON ENVIRONMENTAL MANAGEMENT

After the detailed field study of the area it is noticed that the environmental degradation has been taking place to a great extent. Some of the important recommendations are given below for the proper and timely management of the environment as a whole, so that no further ecological imbalance is created in the region.

(i) In the catchment area, to check vigorous soil erosion, large scale planned afforestation programme should be undertaken by the Forest Department, Govt. of Arunachal Pradesh.

(ii) Ban on all constructional activities along the NH - 52 should be put to prevent initiation of landslides.

(iii) Terrain characterisation should be made, based on geomorphic parameters to identify different landslide prone areas for rationalising landuse in the area.

(iv) The landslide muck should not be dumped as it enhances silting problem in the basin area. Suitable schemes may be formulated to dispose off this muck.

(v) Keeping in mind the seriousness of silting problems of the basin area the government agencies and NGOs should initiate a correct assessment of bilting taking place over year and accordingly take the remedial measures to minimise the silting and the landslide problems.