Morphometry and Its Impact on Land Use Dynamics of Gabharu River Basin, Assam using Geoinformatics Tools

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Abstract
River basin is one of the most important natural resources on which man's activities are based. Due to morphometric behaviour of a river basin the pattern of land use change and also leads to change the land cover of the basin. Because the drainage network, land, water, soil, geology and forest covers are the most effective approach in land use and land cover of a river basin area. Land use is a dynamic phenomenon. Due to increasing population growth and infrastructural activities in India people are using the lands which were earlier not suitable because of impact of the morphometric character of river basin. Geographical Information System and Remote Sensing are being increasingly used in resource evaluation to improve the quality and quantity of the land in a basin area. The present study will focus on land use dynamics of Gabharu river basin of Sonitpur district, Assam. The surface water and ground water are the main sources of water which is mainly depending on rainfall for the proper land use pattern in the basin area. The Gabharu basin gradient is extremely low in the downstream part and it is suddenly step in the foothill region of the Arunachal Himalaya. During summer particularly lower part experience severe flood and also change the land use pattern in every year. Therefore, the land use is intimately related to the mechanism of river morphometry in Gabharu river basin. The researcher tried to find out the different factors of river basin area responsible for change the land use using Geo-informatics tools and toposheet of the concerned area.

Introduction

Land use dynamics has, of late, become too complex specially in the marginal areas of high hills, because of the area's complex nature caused partly by natural phenomena and increasing population dynamics. Such areas are also influenced by drainage dynamics and have, therefore, been very important in the case of landuse study. While investigating the land use of the basin morphometric behavior of the river basin may be quite rightly dragged as the morphometric behavior of the basin length space and time get change to exercise its role on landuse its role on land use differentials. River basins have from the time immemorial been the storehouse a host of resources having their roles on creating landuse differentials in order to enhance the scope and prospects of overall sustainable development of human society in the basin. The land use has now become so complex and dynamics and data sources of such an area have become so large, that a simple traditional technique cannot cover up to yield appropriate data and information and bring rational meaning of landuse complexities in the midst of basin morphometric dynamics has led to search for an alternative technique of data acquisition, data processing, data mapping and data analysis using effective geoinformatic tools and techniques.

The Gabharu basin being a Himalayan tributary basin to the Brahmaputra has been found to have complex geomorphometric dynamics and pattern having their far reaching impact on land use. Here in this paper an attempt is made to explore some of the basin morphometric behavior and their impact on land use in the basin.

Study Area

The Gabharu river basin having its evolutionary history in the foreland (Krishnan,1982) covered by the Brahmaputra in this part has been marked by uniqueness of its geology, topography, and different kind of physical and human dynamics. The river basin covers an area of 382.36 sq km. bounded longitudinally and latitudinal extension of 92°25′E to 92° 40′E and 26°39′ N to 26°03′ N respectively. The river has its origin in the lesser Himalayan range of Arunachal Pradesh and passes through the hills and plains to meet the river Brahmaputra near Nabil in the Sonitpur district, Assam (Fig.1). This river having a length of 78 km. from the source to the mouth carries huge amount of water with an annual average 8450m3s-1 and 0.86 m3s-1 as the maximum and minimum respectively. The basin area receives an annual mean rainfall of 210cm. the master stream i.e. is the Gabharu is fed by a number of tributaries and sub tributaries which supply water to the basin mainly during summer and monsoonal season. In the upper part of the basin, the river is known as the Sonai-Rupai whereas in the plain parts the river is known as the Gabharu.

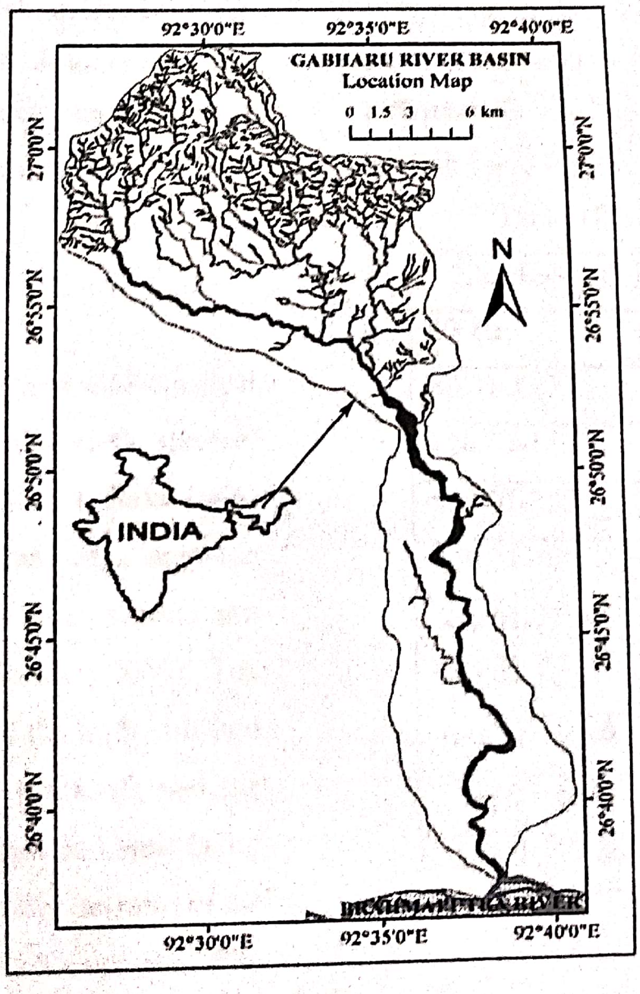

Fig.1

Objectives:

The main objectives of the study are:

1) To examine morphometric behavior of Gabharu basin
2) To know the pattern, characteristics of land use in the Gabharu river basin
3) To assess the impact of basin morphometry on changing land use pattern in the basin concerned

Methodology:

To carry out the entire study SOI toposheet 1972 were used as base map and IRS LISS-III image of 1987, 2000 and 2008 were used for delineation of changes of land use of the basin during the years. The drainage networks along with the drainage basin are digitized in order to identify morphometric behavior and land use categories. Finally all data are arranged to find out the impact of morphometry on land use in the basin area by using GIS software like ArcInfo, [illegible] etc.

[illegible]sin Morphometry:

[illegible]phometry is the measurement and mathematical [illegible]lysis of the configuration of the earth surface, [illegible]pe and dimension of its landforms (Clarke,1966) [illegible]ch can be well extended in case of a drainage [illegible] to cover up its linear, areal, relief aspects and [illegible] contribution(Nag and Chakraborty,2003). The [illegible] river basin in the midst of the high hills and [illegible] mighty river Brahmaputra in the south and the [illegible]iguous riverine plains in the east and west being [illegible]racterised by south sloping hilly terrain in its [illegible] part, the undulating plains in the upper middle part and flat plains in the lower middle and lower parts of the basin and their topography significantly distinguishable land setup. A number of [illegible] [illegible] through [illegible] [illegible] have been found to be responsible for [illegible]. The geological [illegible] of this [illegible] peculiarity of the basin is attributed to the [illegible] Himalayan part of the basin is composed of tertiary sediments. The foothills are composed of boulders, gravels, pebbles, cobbles, grit and sand, while the plain part is composed of thick layers of river borne alluvial deposits.

The basin has its elevation ranging from more than 1559 meter in the northern tip to about 80 meter in the neighborhood of the river Brahmaputra covering differentially distributed sizes of basin area as shown in table 1 and figure2.

Table1: Elevation of the Drainage

Elevation in Meter	Area in Sq.km.
80-100	87.258852
100.01-120	87.008849
120.01-150	52.778880
150.01-250	55.808477
250.01-500	55.087111
500.01-750	25.894229
750.01-1000	20.844108
1000.01-1250	7.901540
1250.01-1500	6.274852
1500.01-1559	6.104275

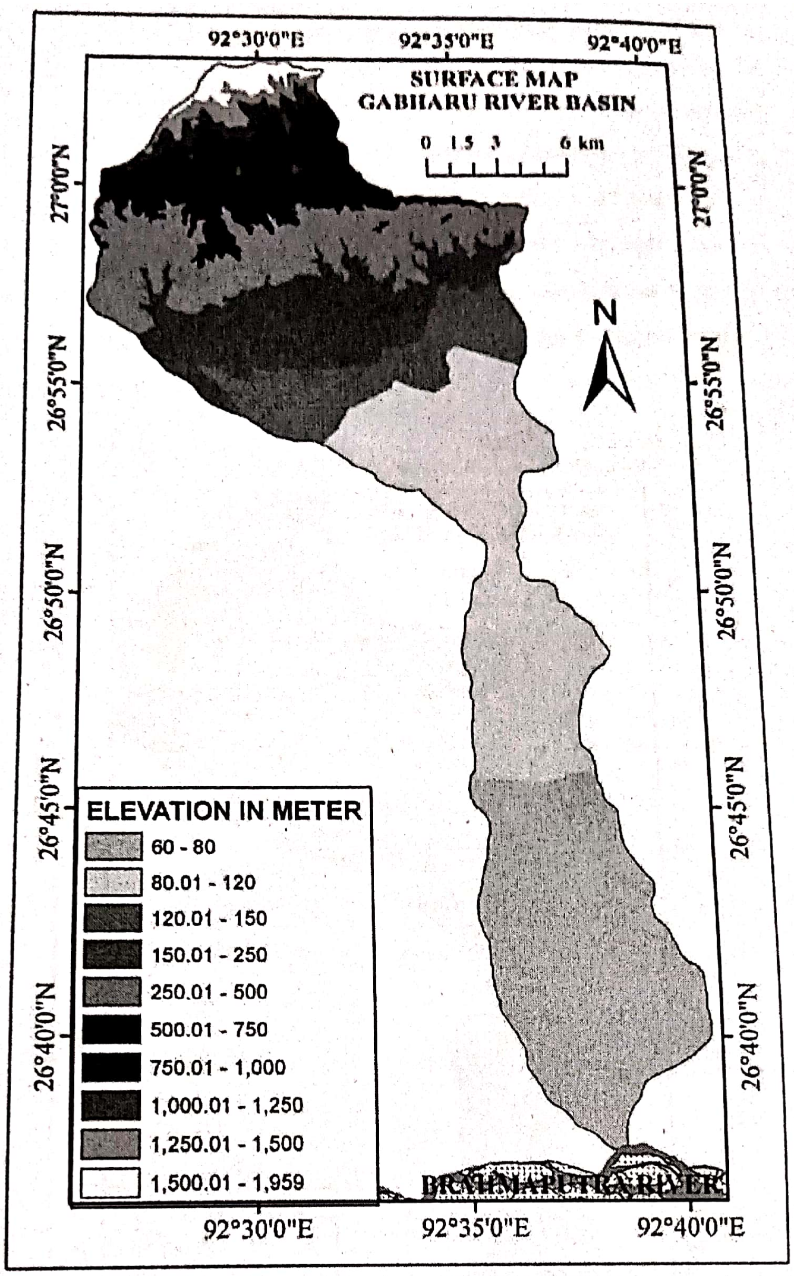

Fig.2

From the table it has been observed that as the height increases the area share decreases abruptly. Such a state of relief change can well be substantiated by the river (Fig.2) or basin profile (Fig.3) having abrupt fall with inflexion in the foothill areas and perceptibly very less relief, specially the relative relief in the built-up and floodplain areas down the foothills. As regards slope distribution, table 2 clearly indicates that the basin has GIS–based slopes ranging from less than 1^0 to about 80^0 (Table.2).

Table. 2 Slope Distribution, Gabharu river basin

Slope in Degree	Area in Km
0 - 1	245.65339
1 – 3	13.3996
3 - 5	7.4932
5 - 10	18.1108
10 - 15	21.9964
15 - 25	39.3336
25 - 35	25.0308

35 - 45	9.1852
45 - 60	1.95
60 - 80	0.2168

It is observed that the basin is not uniformly sloping nor having the equal areas within slope groups of equal interval. It is found that below the 5^0 slopes the basin covers 74.52 percentage of the total areas while 5 to 15 has the percentage share of 16.03. Beyond 15^0 slope up to about 80^0 the basin covering as large as 20.28 percent of basin area. The mean of the distributional characteristics of the slope is 38.23 while standard deviation is 73.81. Such a state of slope pattern of the basin clearly indicates that there is abruptly changing slope distribution as one goes from mountainous areas to the Gabharu river mouth in the neighborhood of the Brahmaputra.

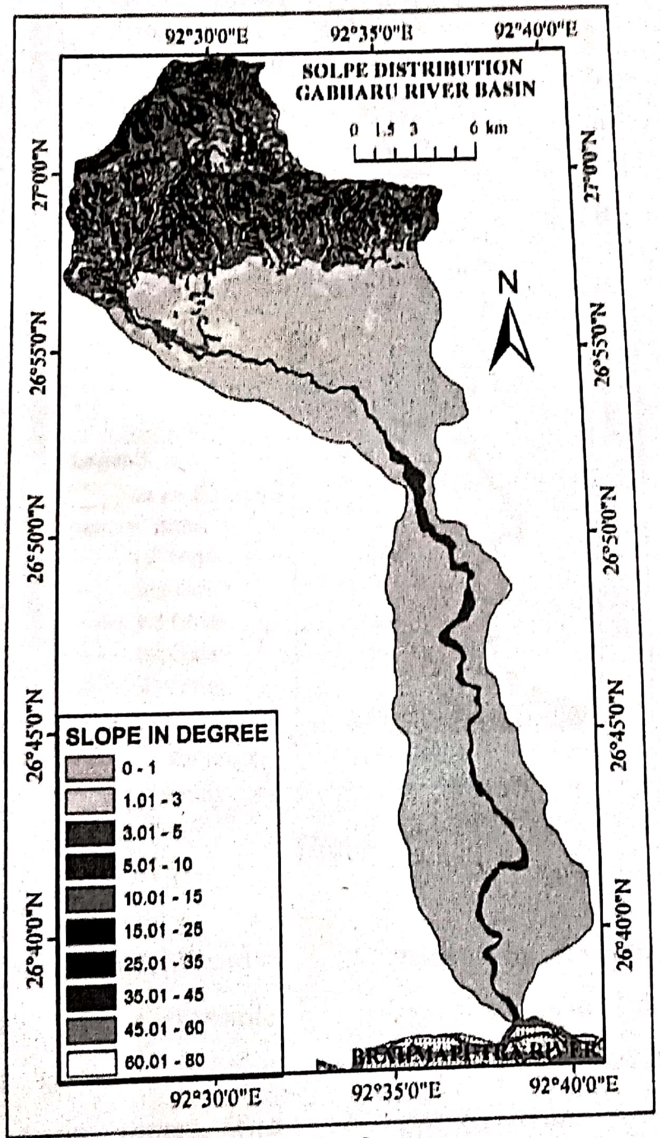

Fig.3

The basin topography or geomorphology has been highly influence by the hydrological parameters which can best be express by drainage network pattern, drainage density, drainage frequency and drainage texture in addition to drainage basin shape. The broadly set dendritic pattern of the drainage network (Fig.4)


Legend
Basin Boundary
Stream Order
1st Order
2nd Order
3rd Order
4th Order
5th Order
6th Order

Brahmaputra valley or elsewhere has a good positive relation.

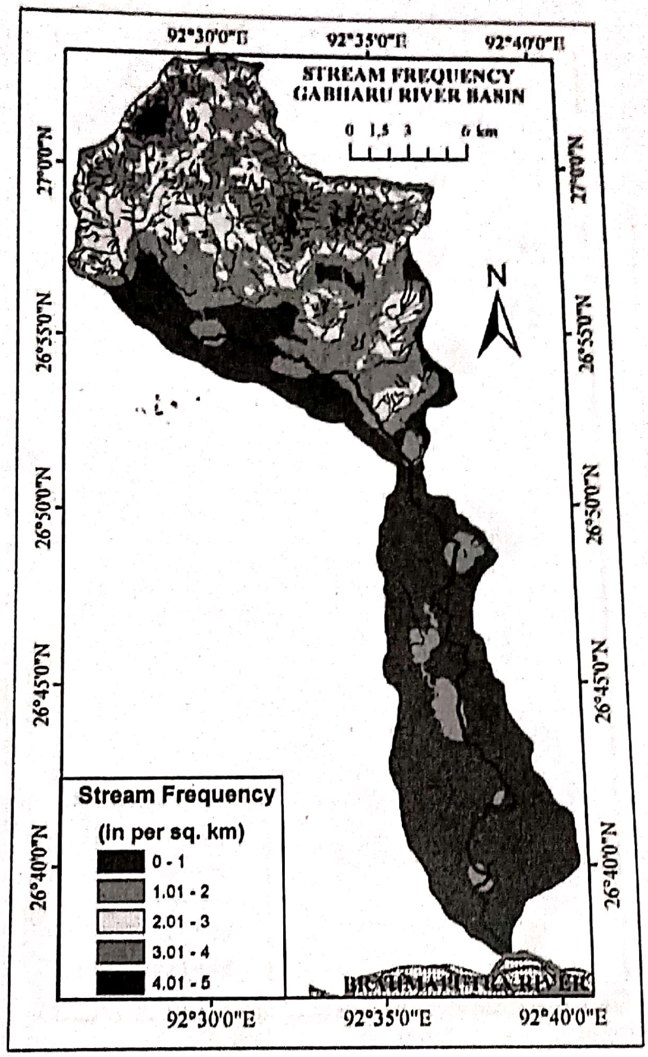

Fig.5

It is seen that the drainage density values of the Gabharu basin exhibits positive correlation with the stream frequency suggesting that there is an increase in stream population with respect to increasing drainage density. The basin has an average density of 1.54km/sq.km (Fig.6). However hill and hill slope areas it is around 12km/sq.km whereas in the built up plain and flood plain areas there around 3 and 1 respectively. The length of overland flow approximately equals to half of reciprocal of drainage density (Horton, 1945).

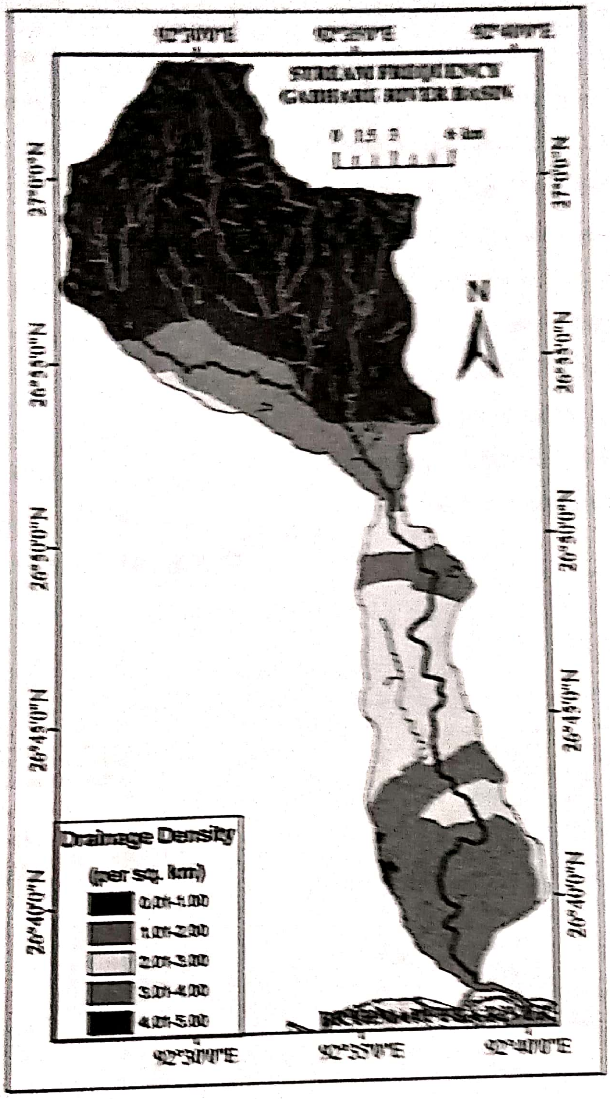

Fig.6

The Lg values of study area is 0.42 so the less of the value of Lg indicates the high relief of the basin and high value indicates the low relief of the basin. The basin bounded by the Arunachal Himalaya in the north and the Brahmaputra in the south has almost an elongated shape covering about 2/3rd of the areas of the basin above the middle part of the basin, while about 1/3rd lies in the lower part of the basin. The circularity ratio mainly concerned with the length and frequency of stream. The basin has a circularity ratio calculated by using Millers formula (Miller, 1953) is 0.48 substantiates that basin is an elongated one. It indicates that the basin is mainly controlled by the structure. Elongation ratio is the ratio between the diameter of the circle of the same area as the drainage basin and the maximum length of the basin (Schumm, 1958). The elongation ratio of the basin is found 3.18. Drainage texture is the total number of stream segments of all orders per perimeter of that area (Horton, 1945). The values of drainage texture in the study area is 7.13 indicates that the drainage texture is fine because in between 6 to 8 value indicates fine drainage texture.

The overall morphometric character of the drainage basin shows the dendraitic to semi dendraitic pattern of the river with moderate texture. The bifurcation ratio in the basin indicates normal basin category, low drainage density shows it has highly permeable soil and coarse texture. The value of form and circularity ratio indicates the basin is elongated, whereas the basin associated with moderate to high relief and flat ground slope.

Land use Dynamics in the Basin:

Landform along with naturally available supply of water in a drainage basin has a strong bearing in the pattern and classification of land use of different categories in basin. Since drainage basin is a naturally delimited area of hydrological input and output system. The Gabharu river basin having landform types from hills to flat plain signified by various capable land qualities (NATMO). The hills and hill slopes areas are different from the plain areas in case of land use categories.

The land area of the basin may be classified into as many as ten classes (table 3). It is seen that as compare to 2000 and 2008 these has been fast change in the land use and land cover areas in the basin (Fig.7 and 8).

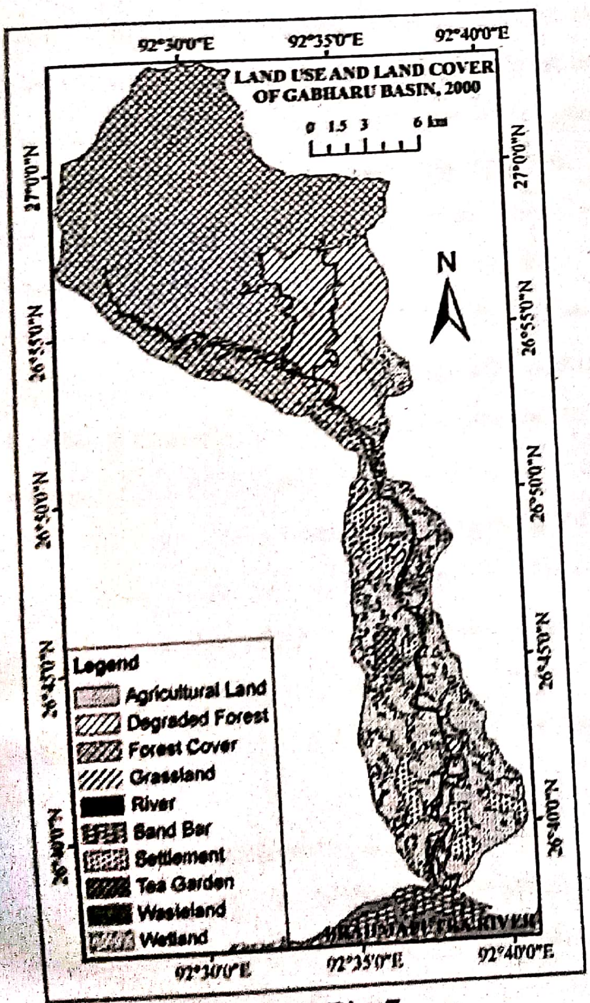

Fig.7

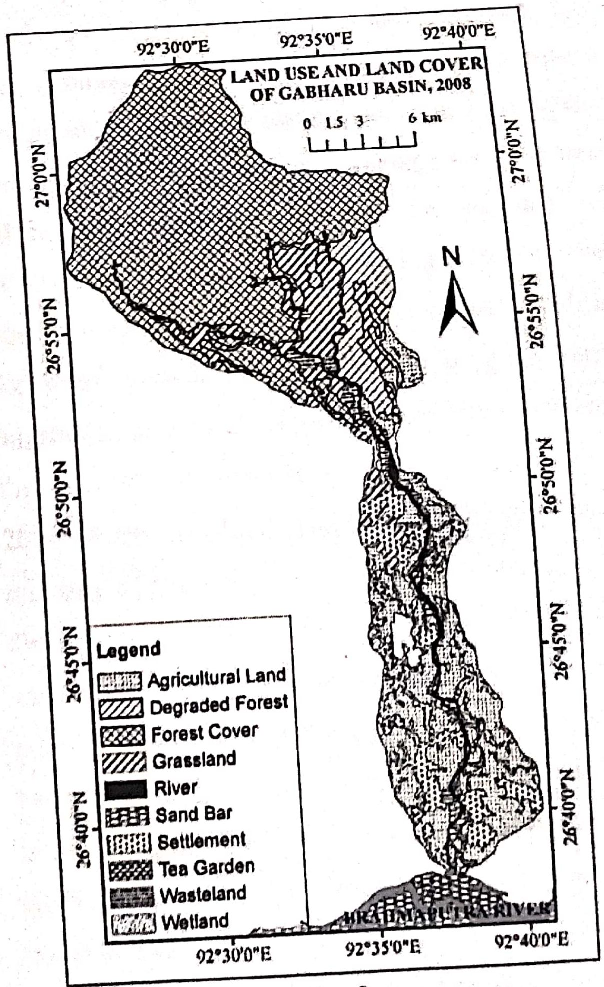

Fig.8

Table. 3. Category of land use and land cover, 2000 and 2008

Category of Land use and Cover	Area in km² 2000	Area in km² 2008
Agricultural Land	76.86	73.22
Degrader Forest	34.48	23.93
Forest Cover	187.78	182.63
Grass Land	23.94	33.93
Settlement	35.11	38.80
Sand Bar	8.52	9.82
River	6.33	8.70
Tea Garden	3.81	3.79
Wasteland	3.90	5.43
Wetland	0.28	0.17

It is does seen that agricultural area only 20.01percent in 2000 change into 19.14 percent in 2008. Similarly the degraded forest 9.1 percent as on 2000 reduce to 6.25 percent in 2008. The forest cover has a marginal loss 1.34 percent over 49.07 percent as on 2000. Similarly grassland has again of 2.25 percent during the eight years of time. There was a marginal increase of settlement areas from 9.18 percent in 2000 to 10.14 percent in 2008. The sand bar and river as the geomorphologically significant landform entities rose from 2.22 percent to 2.56 percent and 1.60 percent to 2.22 respectively during 2000 to 2008. The wetland changes from 0.07 percent in 2000 to 0.04 percent in 2008. The wasteland on the other increase from 1 percent in 2000 to 1.42 percent in 2008. The tea garden covers 0.99 percent in 2000 which remain static in 2008.

Impact of geomorphometry on land use:

It observes that the differential relief and slope characteristics stream network and distribution pattern have their exercising role on the distributional pattern of land use. The abruptly hill morphometry in the areas of elevation ranging from 250 meter to 1959 meter with rugged relief and high slope ranging from 15 to 80 degree in the northern part of the basin give mainly the forest cover of rich and degraded. The high drainage density mostly more 4 km per square km, drainage frequency more than 10 nos per square km along with efficiently set drainage network have all rendered congenial condition for retaining soil moisture in the area for luxuriant growth of forest cover. In spite of congenial natural growth condition for forest growth the area has under gone human aggression as a result of which there have changes in the quality and quantity of forest during 2000 to 2008. Even as the agriculture main stay of the majority of the population in the Brahmaputra, both the figures of 2000 and 2008 indicate the share of agricultural land in the basin is low in the tune of around 20 percent. It has experience that the Gabhoru basin is a highly flood prone basin and the land in the basin is not suitable as expected for some other basins characterize by less flood impact, less forest cover and less amount of wasteland and wetlands and less amount of grassland areas. The sand bar in the basin area showing increasing trend by 2 percent during 2000 to 2008 indicates that flash flood have their adverse impact on sound agricultural practices in the basin. Very low relief in the plain (absolute relief ranging from 60 to 250 meter) and low slope, low drainage density, low drainage frequency and reticulated pattern of drainage network have developed a condition for uncertainty in the sound growth and production of agricultural crops. Hence it is observe the strong impact of topographic or geomorphologic impact in the basin. The grasslands are of riverine origin mostly scattered along the river Gabharu and its major tributaries in basin middle and lower parts. Definitely such a pattern of land cover indicates the impact of topographic morphometry and river created soil composition on the share of grassland in the basin. The land areas cover by rivers both in 2000 and 2008 also clearly shows the impact of climogenetic supply of water flowing over the low slope plain areas of the basin.

The existence of tea gardens needs elevated of old alluvium which plays a major role in the Gabharu basin also. Even as percentage share of land used for tea garden are 0.99 percent in both 2000 and 2008, they indicate the impact of raised landform morphomerty in such a sector of commercial agriculture. As the basin is mostly flat one having a network of drainage lines wastelands and wetlands are having their significant impact on their distribution.

Conclusion:

The Ghabharu basin is a really a very complex in morphometric, hydrologic and land use and land cover pattern. Actually this basin lies almost unexplored in these areas of spatial pattern of natural and cultural development. The present study is to observe some of basin morphometry and its impact on land use. The basin needs further more investigation to examine the cause-effect relationship to cover up more scope of operation towards identification, understanding, evaluation, decision making and management of the basin parameters and resources.