International Journal of Interdisciplinary Research in Science Society and Culture(IJIRSSC)
Vol: 7, Issue:2, (December Issue), 2021
ISSN: (P) 2395-4345, (O) 2455-2909
Impact Factor: 3.635

Land-use, Land cover, Flood and its Impact on the People of the Nona-Baralia River Basin in Assam

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ABSTRACT :

River basin is a spatial unit of study in the long running history of human habitation. Drainage basin has geographic variables like relief, slope, drainage density, etc. have their great impact on fluvial landform occupied by a drainage network system has long run sequence of landform development. In any area, be it a basin area or any other there has been its far-reaching relationship with topography, drainage network, availability of water in addition to many others. Land-use, Land cover in an area reflects the historical and socio-economic background along with its physiographical elements. Land-use is related to the human activity or economic function associated with specific portion of land. Land cover consists of the biophysical material covering the earth's surface. Flood is a body of water which raises to overflow land which is not normally submerged. Flood hazard has a great impact upon the land and landform development, especially in the fluvial aspect. Discharges for a pretty long period leads to establish the frequency of such events on the one hand and their impact on the landform and land use dynamics on the other.

The Nona-Baralia River basin under study conforms to a major tributary basin of the Pagladia river system in the Brahmaputra valley of Assam. It covers an area of about 764 km^2 of which an area of 338 km^2 is drained by the Baralia and the rest by the Matanga-Nona. The Matanga-Nona River is considered as a tributary of the Baralia river. The Baralia receives highest peak discharge of 338 m^3/s at Chamukha Ghat gauge site and 513 m^3/s at National Highway 31 crossing near Rangia in 1974 and 1973 respectively.

The basin has about 309 villages as per 2011 census (with in Assam part) occupied by more than 5 lakhs people of different communities and creeds. The methodology is concern about the quantitative and analytical along with the field observation. The paper tires to analyse the impact of flood on the land-use, Land cover and its significance sustainable development upon the people of the Basin.

Keywords: *Drainage Basin, Land-use, Land cover, Fluvial landform, Flood hazards, Sustainable development*

I. Introduction:

River basin is a spatial unit of study in a long run history of human habitation. Drainage basin has geomorphic variables like relief, slope, drainage density, etc. have their great impact on fluvial landform occupied by a drainage network system has long run sequence of landform

development. In any area, be it a basin area or any other, there has been its far-reaching relationship with topography, drainage network, availability of water in addition to many others. Land-use/Land cover in an area reflects the historical and socio-economic background along with each physiographic element. Land-use is related to the human activity or economic function associated with specific pieces of land. Land cover consists of the biophysical material covering the earth's surface.

And so, while analysing the existing or future pattern of land-use/Land cover in an area, there is the need of detailed investigation and assessment of physiographic, climatic and edaphic conditions in addition to that of social, economic and overall environmental aspects.

Again, on the other hand, it has been very important to come to the close contact with the quality and capability of land and land units, cropping pattern, intensity of cropping and production pattern along with the problems of land-use, etc. as discussed in the following few lines in order to understand the nature of land-use/ Land cover, land capability, quality for sustainable utilization of various lands in the area concerned.

Land and soil are the two inseparable components of non-renewable natural resources upon which the economy of a country greatly depends. The quality of these two resources justifies the economic quality of an area.

The term land-use is related to the human activity or economic function associated with specific pieces of land. In other words, land-use refers to man's activities on land which are directly related to the land. On the other hand, Land cover relates to the type of land cover classified as land-use from the traditional point of view. There are some other opinions also. Landcover denotes vegetational and artificial coverage on the land surface as used by man (Gogoi R. et al., 2006). It means Land cover consists of the biophysical material covering the earth's surface. To some of the scholars, land-use refers to the man-land relationship. The human existence is not only controlled by bio-physical variables but also by socio-economic conditions. Here it is a foundation of economic and biophysical variables (Dutta, 2011).

Singh and Rastogi (1992) in their analysis on morpho-agricultural regionalization of Belasor inter stream areas of the eastern Rewa Plateau stated that a number of attempts have

been made by scholars only to reveal agricultural aspects without giving serious attention on the influences of land morphology and the morpho-agricultural regionalization.

The climatic factors play an important role on determining agricultural regions. But where the climatic variation is not high nor the region is climatically homogenous, geomorphological characteristics are seen to play their important roles in determining the pattern of variation in land uses. In a geomorphological study of the Sonar-Berma basin, Rai (1980) has observed that erosional plain formed the agricultural land in the basin. In another work Mukhopadhyaya (1986) has studied the relationship between landform and land use in Kangasabati basin. Similar works were made by Iyer and Srinivasan (1977), Hironi (1991), etc.

Slope also influences the land-use systems. Shing and Dhillon (1984) stated that steepness of slope renders limitations to cultivation. They also found that variations of slope reflect variations of climate and soil and, therefore, there is the change of practices of cultivation on land. Mukherji (1985) worked on zonation of principal land-use components in the western Himalayas (Himachal Pradesh) based on altitudinal variations. The river basin maintains gentle gradient virtually with no variation of slope.

II.Objectives of the Study:

There are two main objectives of the study:

1. To examine the land-use, Land cover and its impact of the people in the Nona-Baralia River basin and to relate its flood flows and hazards and sedimentation problems, stages of water level and run of behaviour and their characteristics.

2. To examine erosional and depositional aspects of landform development at different locations of the basin and its impact on people.

III. Methodology:

The study is based on empirical method of investigation. The entire paperwork is framed and categorised within the definite and precise stages one after another. Personal experience and interest have helped in the selection and formulation of the study.

In the second phase of the work, the proper field works and observation are conducted for the collection of primary data and information. Field data are also recorded at the time of direct site-seeing. The secondary data are collected from different official sources, such as Water Resources Department of the Government of Assam, Brahmaputra Board of Government of India, Department of Irrigation, Government of Assam for hydrological data and information, Central Groundwater Board, Government of India, Assam Remote Sensing Application Centre (ARSAC), Guwahati, Census of India, Guwahati, are also touched for relevant data and information for the work.

The Geo-informatics System based data sources are used from the NRSC cartoset of 2005-2006. The Google Earth imagery of 2014 is also used for different aspects of the work. Topographical sheets of scales 1:63360 and 1:50000 of different points of time are also used for identification of morphometric and hydrological situation.

IV. Study Area:

The Nona-Baralia River basin under study conforms to a major tributary basin of the Pagladiya river system in the Brahmaputra valley of Assam (Fig. 1). This basin covers an area of about 764 km^2 of which an area of 338 km^2 is drained by the Baralia and the rest by the Mutanga-Nona. The Mutanga-Nona River is considered as a tributary to the Baralia river. The Nona-Baralia River basin extends latitudinally from 26°18′N to 26°53′37″N and longitudinally from 91°29′E to 91°41′E. The Baralia river, a tributary of the Pagladiya, oozes at an altitude of about 2098 m at the Kurmed district of the Himalayan Kingdom of Bhutan. The basin holds parts of Kamrup and Nalbari districts of Assam in the Indian Territory and parts of Bhutan Kingdom in its upper catchment. The Baralia River flows for more than 110 km in a north-south direction before joining the Pagladiya. A stretch of the Baralia before joining the Pagladiya is known as the *Chawl-Khoa Nadi*, which meets the Pagladiya at an elevation of 46 m near the Arangmura village. The channels are very low in gradient. The Baralia River is marked by a channel gradient of 0.62 m/km, while the Mutunga-Nona shows the gradient of 0.52 m/km. The maximum absolute relief of the basin is 2052 m, while the local relief is high (1183 to 150 m) on mountainous and foothill areas.

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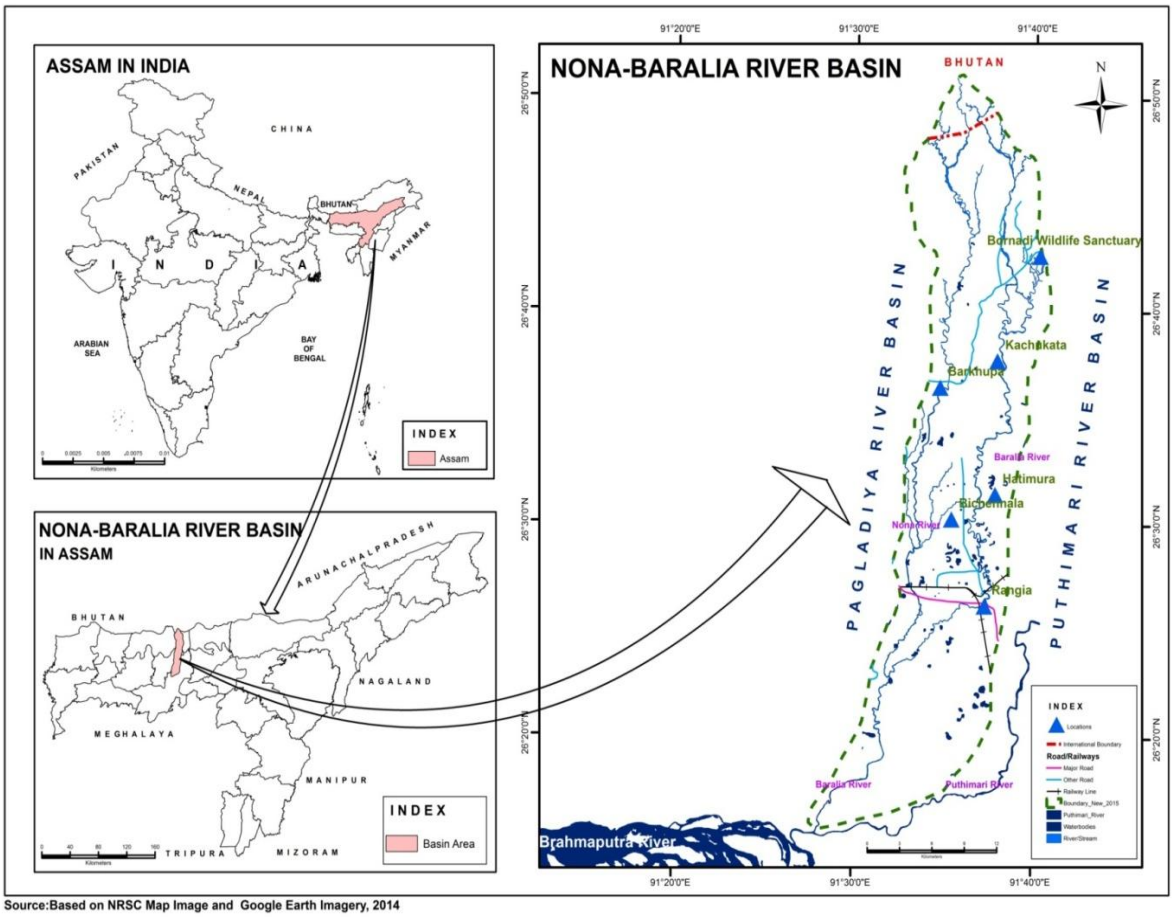

Source:Based on NRSC Map Image and Google Earth Imagery, 2014

The Baralia river receives the highest peak discharge of about 388.25 m^3/s (6 June, 1974) and the minimum of 49.39 m^3/s (6 July, 1983) at the Chamukhaghat gauge site. On the other hand, it had flood discharges of about 513.26 m^3/s on 17th June and 51.10 m^3/s on 19th June at the National Highway 31 road crossing near Rangia in 1973 and 1977 respectively. The basin has about 309 villages as per 2011 census (within its Assam part) occupied by more than half a million people of different communities and creeds.

V. Result and Discussion:

Land Quality and Capability

The land capability and quality reflect some of the important aspects of basin's fluvio-geomorphic and land system. Any kind of plant development activity depends upon the quality of land and its capability to grow types of crops or plants.

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Land capability and utility in an area depend basically upon the landform development processes and stages which have a link with fluvio-geomorphic as well as hydrological processes in the area. Land quality denotes the state of land marked by richness or otherwise with nutrients and elements that help variously to grow crops, etc. The capability is a relative term used to find out whether it is suitable or not for cultivation and kinds of human habitation. It holds some of the basic parameters like acidity or PH values, humidity, etc.

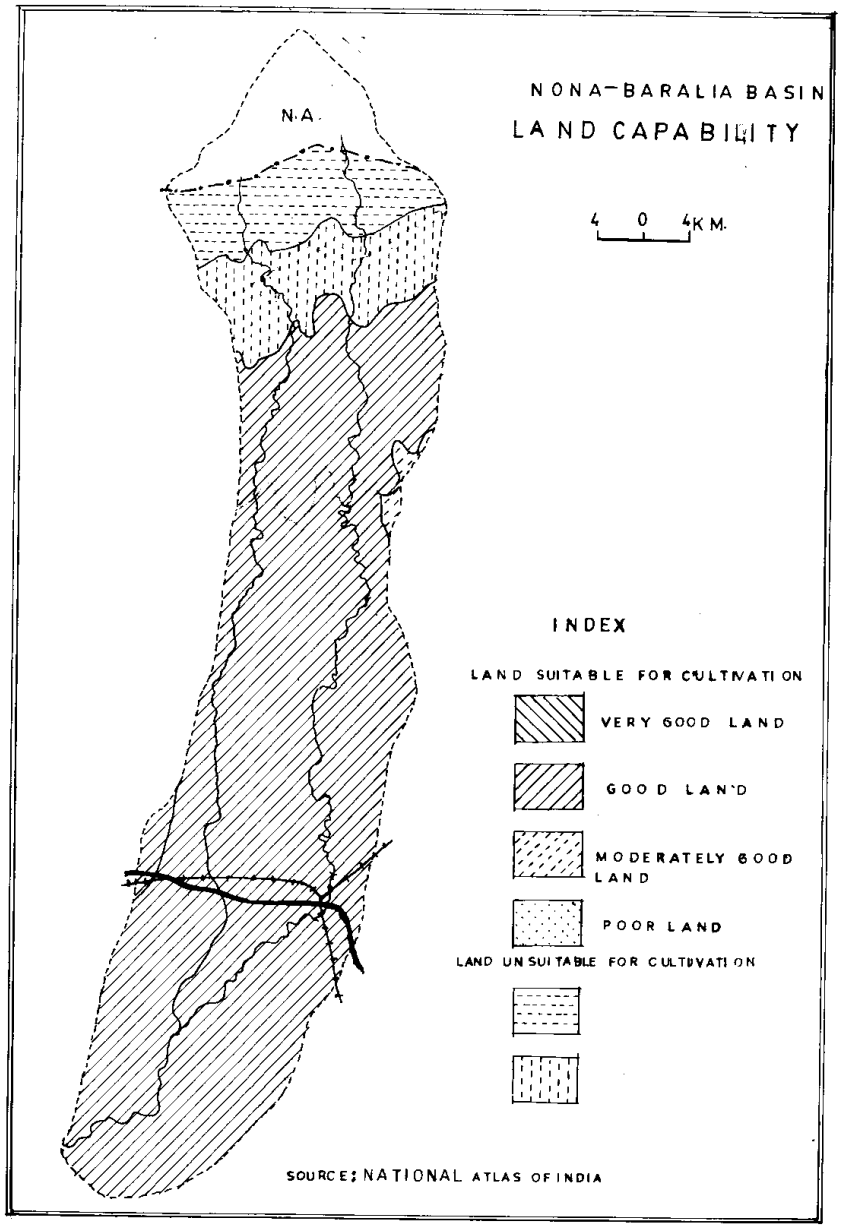

Figure :2

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Land unsuitable for cultivation with severe limitations and some limitations are the two categories that lie on the Assam-Bhutan boarder area. These are suitable for forestry and grazing. Moderately good land capable for cultivation has small pockets towards the boundary of Puthimari river basin.

Land-use/Land cover in the Nona-Baralia River Basin

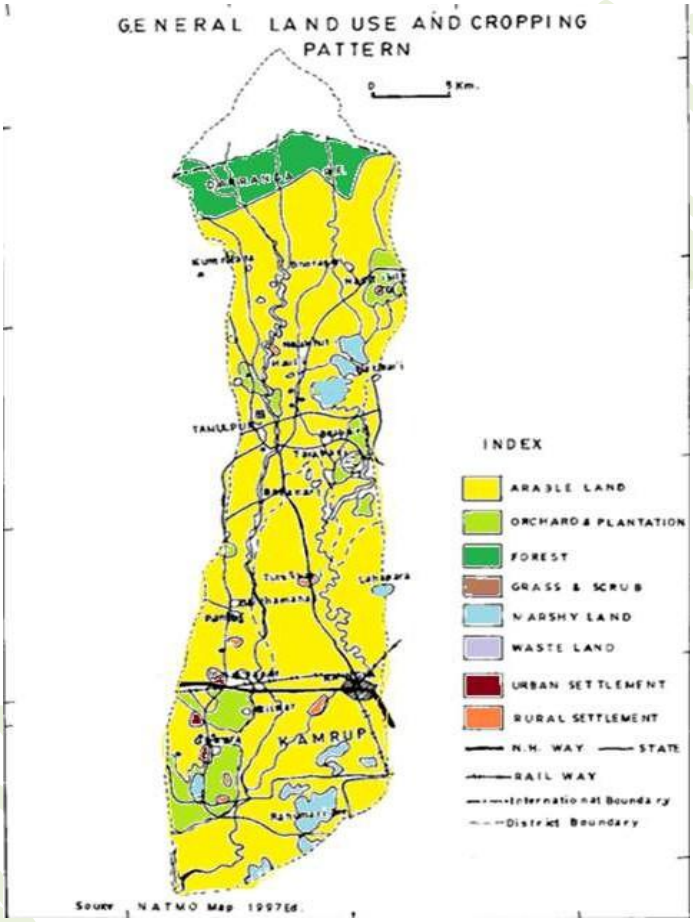

Figure -3

An integrated analysis based on physical data and geo-information is found to be outstanding result on land-use/Land cover (Figs. 3 and 4).

The Nona-Baralia basin being a basin characterised by hill-slopes and foothills, built-up plains, and flood plains, wetlands, etc. has its characteristic reflections in land quality and land-uses. The study of the land-use characteristics may help to identify the existing land- use complexities in the basin in response to physiographic and other influences. It may also help

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ameliorate the haphazard and untoward pressure of man on land. Pal (1991) substantiated the meaning of land-use with a connotation of land development plan for future as incorporated in a book edited by Jana (1991). Lindgreen (1955) stated that investigation on land-use is necessary for developing land-use policies and carrying various conservation activities.

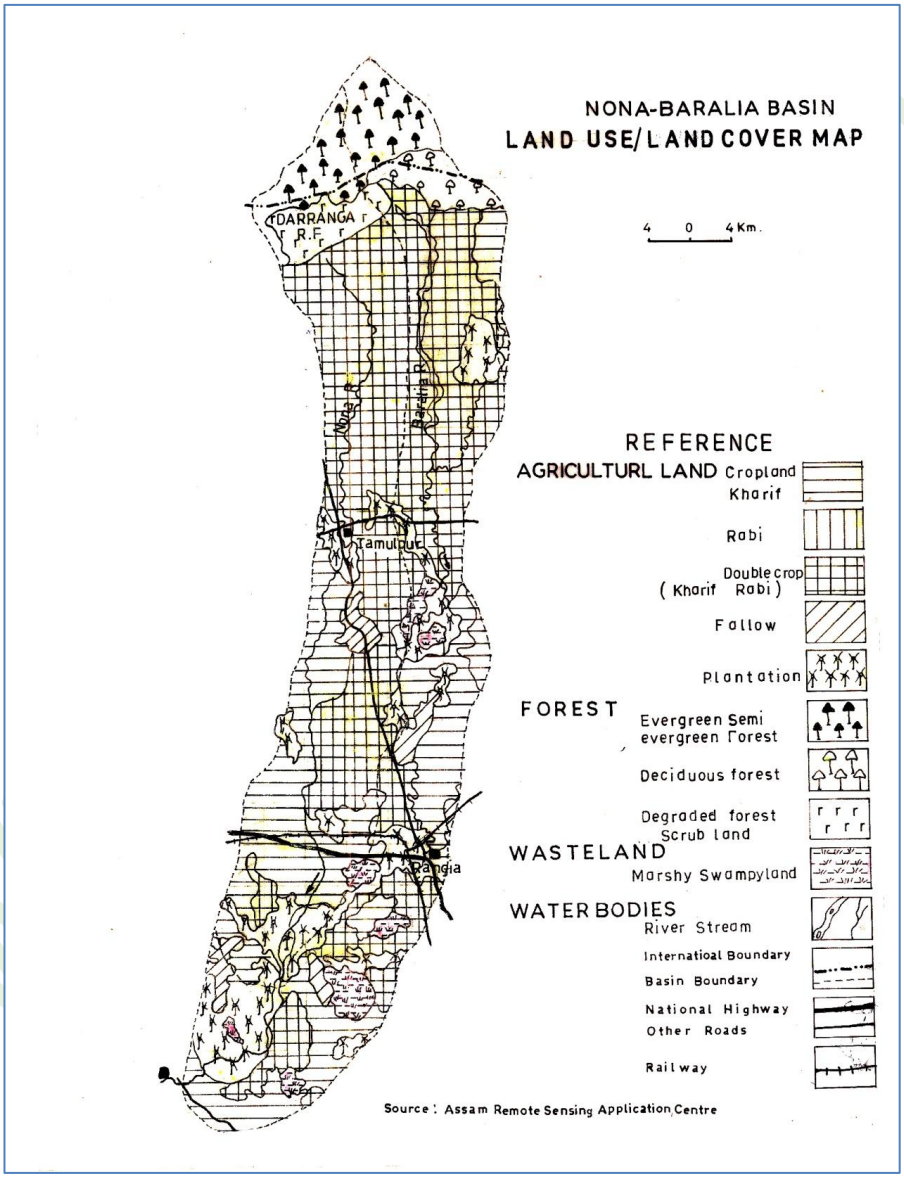

Figure 1

Since the bulk of the land-use in the Nona-Baralia basin is restricted to agriculture, it can be said that "there is an acute need for a much better adjustment of agriculture to the physical environment, not only to gain a surely needed increase in agricultural production but also to maintain a healthy economy" (Bennett, 1943).

The land-use categories are (i) Agricultural land, (ii) Forestland, (iii) Wasteland and (iv) Waterbodies (Table 1).

The table shows that, the total agricultural land including the fallow and land under plantation in the basin covers an area of 65,442.86 hectors equivalent to 85.66 percent of the basin's total area. The total area under cropland including that for kharif, rabi and double crops (kharif + rabi) accounts 54244.44 hectors i.e. 82.89 percent of the total area of the basin.

The area under plantation crop covers 9386.81 hectors or 12.287 percent, while an area of 1811.61 hectors or 1.907 percent falls under fallow land category. (Fig. 4 and Table 1).

The forestland including areas of reserve forest (R.F.) in the basin covers an area of only 8159.74 hectors equivalent to 10.68 percent of the basin's total area. There are three categories of forestlands. These are evergreen/semi evergreen, deciduous and degraded/scrub forest. The evergreen/semi evergreen forest comprises the highest share i.e. 4829.30 hectors equivalent to 59.19 percent of the basin's land, while 1456.88 hectors of land lie under deciduous forests. This is equivalent to 17.85 percent, degraded/scrub forest accounts for 1873.56 hectors or 22.96 percent. However, the basin lacks in the required level (33%) of forest cover for keeping a sound ecological balance in the basin. The wasteland comprising waterlogged lands along with marshy/swampy land covers altogether an area of 1866.42 hectors equivalent to 3.156 percent of the basin's total area. Again, water bodies i.e. river/stream, tank/reservoir etc. together comprise 728.44 hectors or 0.95 percent of the area of the basin's (Table 1).

A number of models have also been developed to explain regional variation of agriculture. For example, the models of Von Thunen (1826), Jonasson (1926), Baker (1925), Whittesey (1927), in delimiting agricultural regions can be mentioned here. But it is found that even a single model has not been able to explain the land-use diversity in the Nona-Baralia River basin. In the Nona-Baralia basin the dominating crop is rice which does not leave scope for

development of any other crop. In the vast agro-landscape there are very limited areas devoted to plantations including tea gardens. In the middle upper part of the basin, some areas are having tea plantation. For example, in Nagrijuli there lies a Tea Garden. In the lower middle part, some areas have been devoted to vegetables, horticultural garden crops in addition to rice.

Table 1: Land-use/Land cover of the Nona-Baralia River basin, Assam, 2005-2006

Land Pattern/Category	Land-use/Land Cover	Area (in hectors)	Percentage of Total Basin's Area
Agricultural land	Crop land Kharif	15362.23	20.109
	Rabi		
	Double Crop (Kharif + Rabi)	38882.21	50.89
	Fallow	1811.61	2.371
	Plantation	9386.81	12.287
Forest Land	Evergreen/Semi Evergreen Forest	4829.30	6.321
	Deciduous Forest	1456.80	1.907
	Degraded/Shrub Forest	1873.56	2.452
Wasteland	Waterlogged Land	337.59	0.704
	Marshy/Swampy Land	1528.83	2.452
Waterbodies	River/Stream	546.54	0.781
	Total	76397.88	100.00
Source: Prepared by the researcher based on maps on Land-use/Land cover map, 2005-2006, ARSAC, Guwahati			

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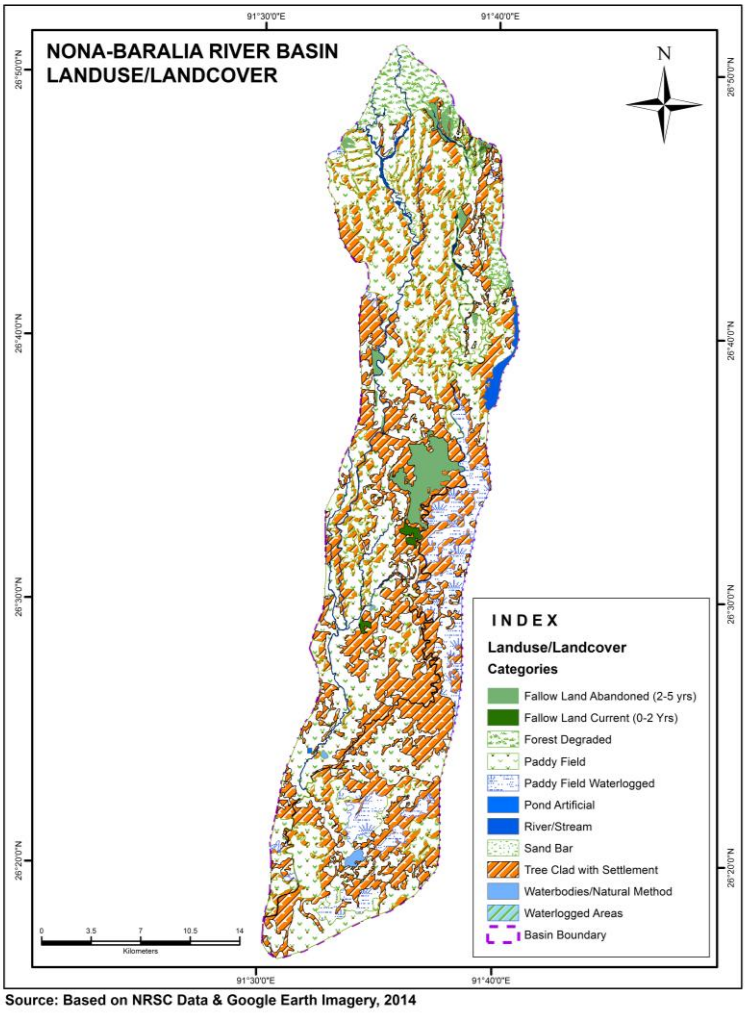

Figure 5

Present Land-use/Land cover, 2014

The Table 2 when compared with 1 on land-use/Land cover shows that an area of -139.74 km^2 has been lost by the basin as on 2014. The fallow land has increased by about 245 hectors over the fallow land as on 2005-2006. Comprising about 659.4 hectors or 26.03% land under forest has drastically changed. Area under degraded forest has increased by about 659.4 hectors as because of continuous conversion from forest area to tree clad with settlement area. Land under agriculture has increased 5660.30 hectors. Similarly, areas under waterbodies and waterlogged have decreased by about 266.13 hectors. The changing scenario of the river plain

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forms of caused fluvial processes and arrival of new techniques in land-use have together caused such a changed in land-use/ Land cover pattern of the basin (Figs. 5 and 6).

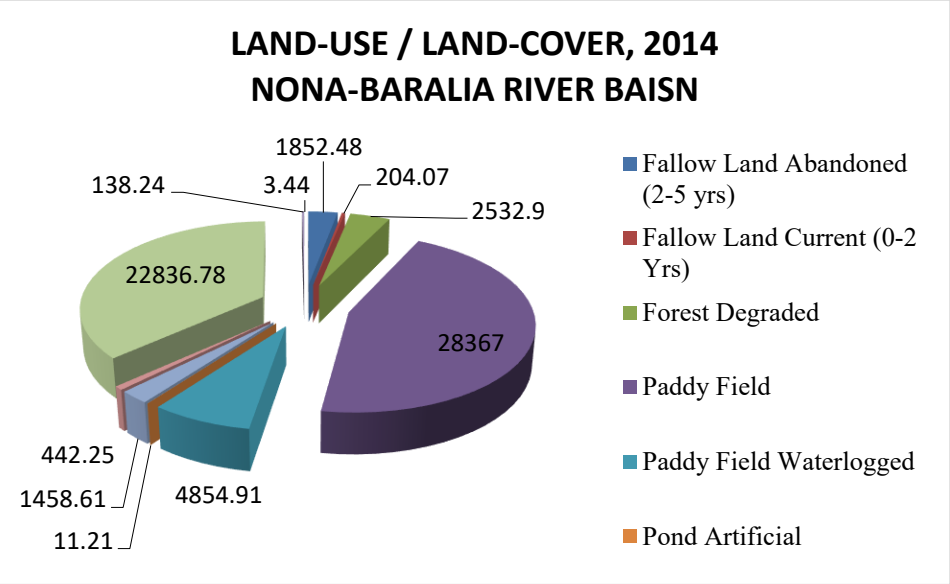

Figure 6

Table 2: Land-use/Land cover of the Nona-Baralia River Basin, Assam, 2014

SI. No.	Land-use/Land cover	Area (In hectors)	Percentage of Total Basin's Area
1	Fallow Land Abandoned (2-5	1852.48	2.95
2	Fallow Land Current (0-2	204.07	0.33
3	Forest Degraded	2532.90	4.04
4	Paddy Field	28367.00	45.24
5	Paddy Field Waterlogged	4854.91	7.74
6	Pond Artificial	11.21	0.02
7	Riverine area	1458.61	2.33
8	Sand Bar	442.25	0.71
9	Tree Clad with Settlement	22836.78	36.42
10	Waterbodies/Natural Wetland	138.24	0.22
11	Waterlogged Areas	3.44	0.01
	Total	62701.89	100.00
Source: Based on NRSC data and Google Earth Imagery, 2014			

VI.Conclusion:

Landform of a region or a basin has its strong relationships with the region's land capability units. A particular landform process develops a specific land capability zone or unit. The land capability and quality are highly influenced by mainly the landform structure in addition many others. Geological condition, climate, vegetation cover, slope, relief and topography have their exercising rules in this case. In the Nona-Baralia River basin the structure of the whole catchment area has directly related to particular land capable units and their structure and composition of rocks. All these along with permeability of soil layers has been working together in developing specific land capability types in the basin. For instance, land with coarse land and soil structure usually develops land with poor capability, whereas fine texture produces good capability.

The Nona-Baralia basin has very high to medium rainfall. This has caused high influence on development of landform and soil cover of mostly alluvial nature consisting of silt, clay and loam at different proportions. The soil for land-use here ensures good capability.

Slope and relief in the upper catchment of the basin has also been playing important roles. Here, there has developed rugged to uniform relief areas. This has resulted a significant base for land-capability and utility. The areas having slope less than four degrees have been capable for the luxuriant growth of natural vegetation of evergreen and semi-evergreen types.

After crossing 80 m contour levels soil capability category has drastically changed. This sort of soil capability exists beyond the Nagrijuli Tea Garden. From this scrap-land area hydrological situation (surface run off, flash flood, water gullies, etc.), along with sequences of old and new alluvial deposits of clay, loamy and sandy soil. It has been observed that the topographical situation has to a large extent, changed the land-use/Land cover scenario from Tamulpur downward up to the confluence limit of the Baralia with Pagladiya. Fertile alluvial soil, availability of soil moisture and streams and wetlands has all caused such changes. Both the Kharif and Ravi crops dominate this part of land unit of the basin.

It can be concluded here that landform processes have a long continuous impact and relationships with the development of a particular land unit or for its capability condition. It is one of the most important aspects of fluviogeomorphic arena of riverine landform.

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