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# A SPATIO-TEMPORAL CHANGE DETECTION ANALYSIS IN CENTRAL BRAHMAPUTRA VALLEY OF ASSAM

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## ABSTRACT

*The rapid increase of human population, especially developing country like India, is putting extraordinary pressure on the land resources leading to an irrational change of land use and land cover types. Not only urban areas but also numerous rural areas of the country face such problems due to nominal or non-existent planning efforts compounded by rampant population growth. The Sipajhar revenue circle of Darrang district is situated in central Brahmaputra valley of Assam wherein the pressure of population growth on land is gradually gaining ground. As per census report, the population of the circle increased from 59130 in 1971 to 122937 in 2011, witnessing 107.90% increase of population over 40 years. It is also estimated from satellite imageries that an area of 37km$^2$ has been put to rural settlements from 1977 to 2013. With the growing population pressure and unplanned land use in the circle, the need for judicious utilization of land assumes much greater relevance. The present study assesses the trajectory of land use/ land cover changes using the information derived from the Landsat MSS Satellite Image of 16$^{th}$ Dec.1977, Landsat TM Satellite Image of 18$^{th}$ Nov. 1991 and IRS P6 LISS III Satellite Image of 24$^{th}$ Nov. 2013. ERDAS Imagine and ArcGIS software are used as a geospatial tool for processing these satellite images. Based on remote sensing data and primary field investigation this study analyses the spatio-temporal transition of land use/ land cover types as a prerequisite of judicious land-use planning across Sipajhar revenue circle of Darrang district, Assam.*

**Key words:** Central Brahmaputra valley, Land use-Land cover (LULC), Land-use planning, Spatio-temporal transition

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# 1. INTRODUCTION

Land presents an extremely complex pattern of different types of uses. It is found to have been over-used and even mishandled which is considered as the most significant segment for existing life support system (Sharma, 1990). One of the most critical elements for worldwide topographic changes in LULC (land use and land cover) types are being increasingly perceived as anthropogenic and natural processes. The continued interplay of the social and physical factors has prompted spatio-temporal contrasts in Land use and land cover types. The land-use and land-cover are frequently used interchangeably, they are not similar from the geographical viewpoint. "Land cover data documents how much of a region is covered by forest, wetlands, impervious surfaces, agriculture, and other land and water types. Land use shows how people use the landscape- whether for development, conservation or mix uses" (National Oceanic and Atmospheric Administration US Department of Commerce, 2020). The term land use can explicitly be comprehended as all courses of action and arrangements done by the individuals while performing different kinds of activities on space while land-cover is not quite the same as land-use, it is the bio-physical cover found over the surface of the earth particularly all the vegetation cover, water bodies, rock structures and built-up area (Abbas et al., 2010). It is quite important to know the potentialities and constraints of terrestrial surface for various sorts of sustainable use of land resources (Nagamani & Ramachandran, 2003). That is why the knowledge of physical and cultural settings is very essential before implementing planning or undertaking any inputs in a certain area.

Remote sensing and GIS technique has progressed a lot over the last forty years and it has contributed immensely to management and monitoring of natural resource and the environment (Kumar et al., 2015). The change detection analysis of Land-use and land-cover can be investigated effectively by technical integration of remote sensing with geographic information system (Mallupattu & Sreenivasula Reddy, 2013; Reis, 2008). This kind of analysis through geospatial technologies is quite significant for policymakers, planners, environmentalists, geographers and engineers for making efficient decisions for sustainable growth and development. A lucid understanding of the forces and processes behind the land cover change is much needed very essential for environmental management and planning strategy. The past transition and future trend of land-use are derived from baseline data acquired through change detection analysis (Tegene, 2002).

The Sipajhar revenue circle is a part of the central Brahmaputra valley of Assam which represents an ideal area for agricultural practices. Like most of the places, land in Sipajhar revenue circle is also put to various uses, mostly farming and settlement. The population pressure on land is a prime factor of agricultural land-use changes in an area (Borah, 2003). Such findings are also made by Das, (1973) for the Kosi area of Bihar. As per Census Hand Book of the district, the population of the circle increased from 59130 in 1971 to 122937 in 2011 witnessing 107.90% increase of population during the period of 40 years (1971-2011) (Directorate of Census Operations & Assam, 2011). The high growth of population and consequent pressure on land cover types has been keenly experienced in the circle over time. Currently, there is a higher degree of demand for judicious use of land resources because of escalating population pressure on the circle. Therefore, this paper focuses on exploring spatio-temporal land-use and land-cover as prerequisites for land-use planning in the study area.

# 2. AIMS AND OBJECTIVES

The present study puts before itself the following objectives:

i. To understand the geographical background of the study area.

ii. To identify the existing spatial pattern of land-use and land-cover types of the area.

iii. To investigate the spatio-temporal land-use and land-cover change in the concerned area.

## 3. DATABASE AND METHODOLOGY

This study largely employs the data acquired from remote sensing techniques through processing with the geographical information system. ERDAS Imagine and ArcGIS software are used simultaneously to handle all the data acquired from these satellites. The temporal change on space has been analysed from Landsat MSS, Landsat TM and IRS P6 LISS III satellites for 1977, 1991 and 2013 respectively. A Separate treatment has been applied to carry out the study for analyzing land-use and land-cover pattern in the circle. Post-classification comparison technique is used for change detection analysis which further helps researchers to understand the spatio-temporal extent and nature of changes. Furthermore, sub-pixel accuracy is achieved in the geometric correction. Maximum likelihood classification (MLC) rule under the supervised classification technique is operated to conclude the nine major land-use and land-cover classes. Ground truth verification and collection of primary data have been accomplished through field observation and survey. Moreover, relevant secondary data regarding the geographical background and population composition of farming communities have been collected from Revenue Circle Office, Darrang; District Agriculture Office, Darrang; A.D.O. Circle, Sipajhar; Department of Irrigation, Darrang; Census Hand Book of Assam and Darrang and Directorate of Economics and Statistics, Assam. The gram panchayats of the revenue circle are taken as the spatial units for investigating the spatio-temporal change pattern of land-use and land-cover types in Sipajhar revenue circle. Topographical Map No. 78 N/15 and 78 N/16 at a scale of 1:50000 are used for preparing the base map of the revenue circle.

## 4. THE STUDY AREA

Sipajhar revenue circle is situated in the south-western corner of Darrang district in Assam, India. Its north-south and east-west extension range from 26˚09/ N to 26˚22/N latitude and 91˚45/E to 91˚52/E longitude respectively(Fig.1). It occupies an area of 299.87 $km^2$ (29987 ha) comprising 89 villages, 14 Gram panchayats and 3 Mouzas (unit of revenue circle), namely Sipajhar, Lokrai and Hindughopa Mouza. The total population of the revenue circle is 1, 22,937 as per 2011 census. It is surrounded by Patharighat circle, Mangaldai revenue circle, and Morigaon district on the north, east, south respectively while Kamrup district surrounds it from both southern and western side.

Physiographically, Sipajhar revenue circle is situated in the central Brahmaputra valley of Assam. The region is composed of alluvial deposits of the Brahmaputra River and its three main north bank tributaries coming from Himalayas of Bhutan and Arunachal Pradesh. In general, large open plain with an average elevation of 75 meters from mean sea level form configuration of the circle. The plain slopes gradually southwards to the Brahmaputra River. Despite the fact that it has generally an even topography, local differences in elevation is also prominent within the area. Thus, the circle consists of three micro physiographical units- the active flood plain or *char*(40 to 45m), marshy low lying area with low hills(<40 to >100M) and the middle plain of the built-up region (45-60m)(Fig.3).

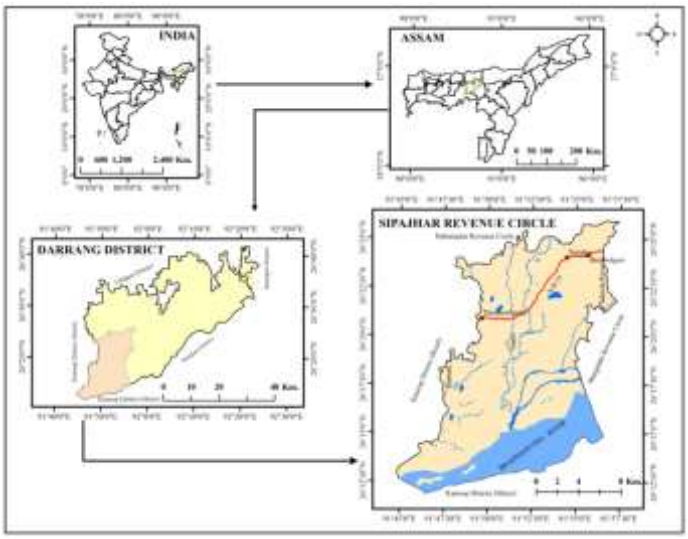


**Figure 1** Location of Case Study Area, Sipajhar Revenue Circle in Darrang District, Assam

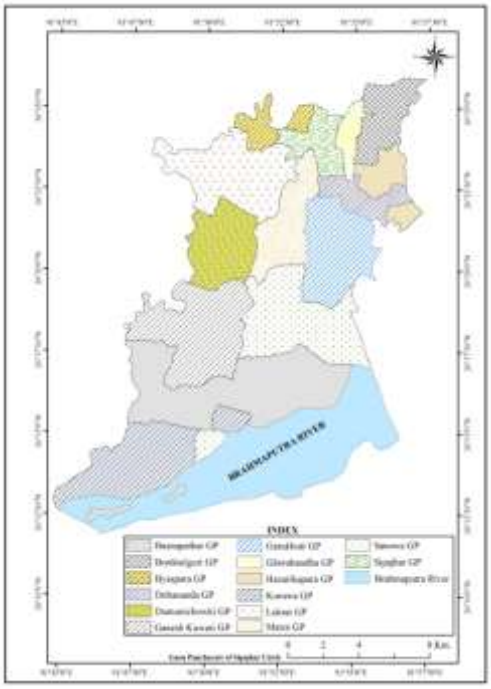


**Figure 2** Sipajhar Revenue Circle; Distribution of Gram Panchayats

The active flood plain or *chars* is a riverine zone lying between the high and low water marks of the Brahmaputra River. There are a number of *charland* (strip of sand bars) formed in this region caused by the frequent shifting of the courses of the tributaries at their confluences with the Brahmaputra. The marshy and low lying areas are lying near the Brahmaputra and to the south-west of Sipajhar revenue circle. These marshy areas are shallow pools of past depressions formed by the Nanoi and the Barnadi rivers. Pukhuria, Baro, Mailata, Diplinga, Gathia, Batha, and Tupurachala are such major *beels* or wetlands and on the other hand, some hills and hillocks in this physiographical unit are Kurua, Mailata, Ganesh, Baman, Khalihoi, Gakhirkhoa and Silar Chotal. The whole central and northern part of Sipajhar revenue circle constitute the built-up region which is a thickly settled area of the region. The National Highway No. 15 passes through this built-up region of the north bank of

the Brahmaputra valley. The plain of the built-up region is composed of old alluvium soil with high fertility.

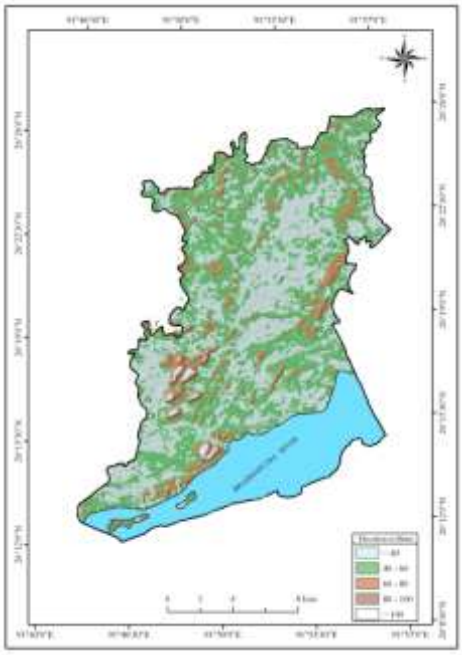

**Figure 3** Sipajhar Revenue Circle; Digital Elevation Model Source: ASTER DEM

The diversity of castes and communities is well reflected in the densely populated area of Sipajhar revenue circle. Of the total population of the circle 58% belongs to the non-tribal Hindu community, 19% to indigenous Muslim, 18% to Bengali speaking Muslim, 4% to Nepali and only 1% belongs to scheduled tribe (Bodo) community. Out of non-tribal Hindu community, 78% comprises Other Backward Class, 15% High Caste and 7% Scheduled Caste group. In the riverine *charland,* the Bengali speaking Muslim community is highly concentrated while to the north of *charland* there lies the built-up area inhabited by the both Assamese speaking non-tribal Hindu and Muslim community. There are a few concentrations of Bodo tribe and Nepali community in the low-lying area with some low hills of the southwestern part of the circle. Thus these varied physical and socio-cultural base play a dominant role in bringing about variation in land uses of the study area.

# 5. RESULT AND DISCUSSION

## 5.1. Land-Use and Land-Cover Types

This study attempts to give an insight of Sipajhar revenue circle about the spatio-temporal change in land-use and land cover types on the basis of the processed satellite images of 1977, 1991 and 2013 (Fig.4, 5 & 6). The spatial pattern of land-use and land-cover types across gram panchayats has been interpreted through elements of image interpretation and field observation. Following are the nine such classes of land use and land cover type (Table 1&2), of which proportionate distribution is represented by Fig.7

a) Mixed Moist Deciduous Forest
b) Agri-plantation and Settlement
c) Cropland (Kharif)
d) Cropland (Rabi)
e) Swampy Area
f) Grass Land

g) Scrub forest
h) Water Body
i) Sandy Area

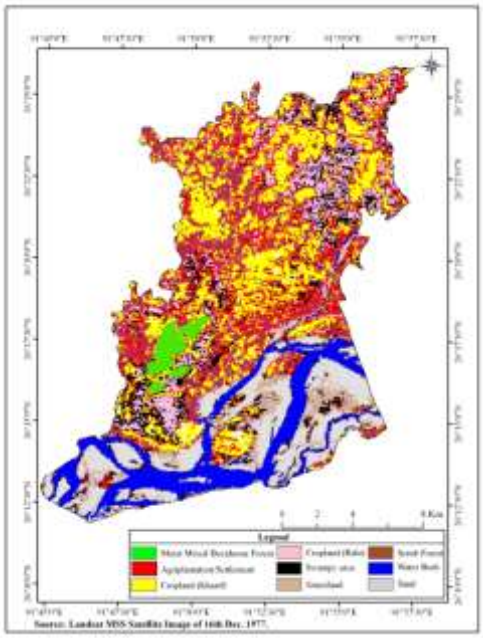

**Figure 4** Sipajhar Revenue Circle; Land-use and Land-cover pattern, 1977

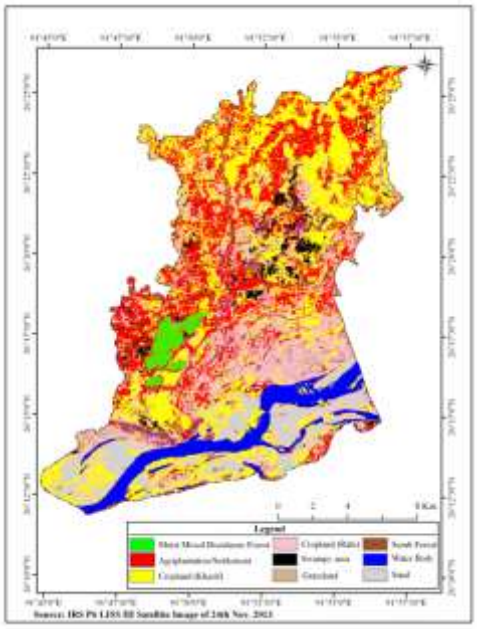

**Figure 6** Sipajhar Revenue Circle: Land-use and Land-cover pattern, 2013

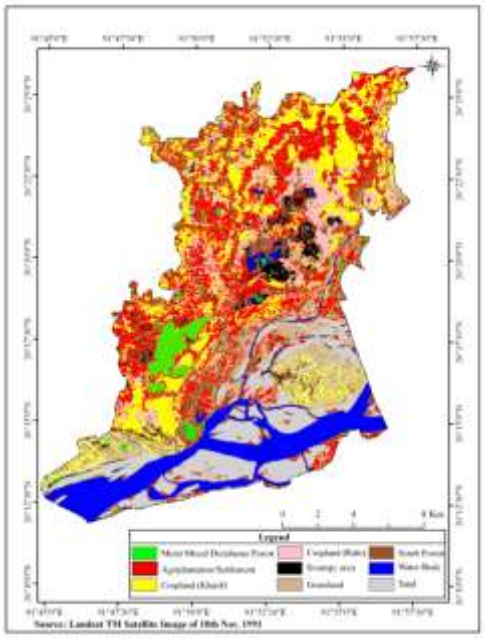

**Figure 5** Sipajhar revenue circle; land-use and land-cover pattern, 1991

**Table 1** Gram Panchayat wise Land Use/Land Cover Pattern (in sq.km.) in Sipajhar Revenue Circle, 2013

| Gram Panchyat | a | b | c | d | e | f | g | h | i |
|---|---|---|---|---|---|---|---|---|---|
| Hazarikapara | 0.89 | 1.20 | 2.11 | 1.02 | 0.21 | 0.11 | 0.87 | 1.00 | 0.19 |
| Debananda | 0.20 | 1.38 | 1.03 | 1.09 | 0.50 | 0.39 | 0.73 | 1.03 | 0.51 |
| Ghorabandha | 0.51 | 1.10 | 1.40 | 0.80 | 0.12 | 0.06 | 0.03 | 0.39 | 0.08 |
| Lokrai | 1.54 | 6.97 | 6.77 | 3.12 | 0.75 | 0.02 | 0.91 | 1.98 | 0.89 |
| Sipajhar | 0.87 | 4.00 | 3.00 | 1.90 | 0.87 | 0.32 | 0.21 | 1.20 | 0.31 |
| Byaspara | 0.58 | 1.15 | 1.01 | 0.95 | 0.21 | 0.11 | 0.09 | 1.08 | 0.41 |
| Bordoulguri | 0.45 | 2.80 | 4.81 | 1.80 | 0.98 | 0.45 | 0.71 | 0.95 | 0.86 |
| Maroi | 0.97 | 2.56 | 3.49 | 1.78 | 0.89 | 0.97 | 1.10 | 1.20 | 0.98 |
| Sanowa | 1.73 | 4.91 | 5.89 | 6.85 | 2.19 | 1.08 | 0.87 | 2.99 | 1.91 |
| Bazanapathar | 1.87 | 4.93 | 11.98 | 8.21 | 2.10 | 1.99 | 1.81 | 3.98 | 2.93 |
| Kuruwa | 1.90 | 5.10 | 7.73 | 2.60 | 3.12 | 0.60 | 0.54 | 2.10 | 0.51 |
| Ganeshkuwari | 5.58 | 6.42 | 3.14 | 4.66 | 2.08 | 0.69 | 0.71 | 2.45 | 0.94 |
| Garukhuti | 1.96 | 3.48 | 6.30 | 2.89 | 0.87 | 0.90 | 0.74 | 1.44 | 0.87 |
| Dumunichowki | 1.61 | 3.14 | 4.49 | 1.68 | 1.87 | 0.36 | 0.15 | 1.30 | 0.56 |

*Source: IRS P6 LISS Satellite Image of 24th November 2013*

**a) Mixed Moist Deciduous Forest** These forests are found in areas where the annual rainfall is between 100cm and 200cm. This class of land cover type comprises tree species mostly belonging to moist deciduous forest represented by *Sal (Shorea robusta), Teak (Tectona grandis), Simul (Bombax ceiba), Khoir (Acacia catechu), Au Tenga (Belenia indica), Jack fruit (Atrocarpus integrifolia), Sonaru (Cassia fistula), peepal (Ficus religiosa) and Gamari (Gmelina abborea).* To the extreme south-west of the circle, between the Nanoi and the Barnadi rivers, there are some low hills and hillocks namely Kurua, Mailata, Ganesh, Baman, Khalihoi, Gakhirkhoa, Silar Chotal and Barar Pahar where there lies the high concentration of mixed moist deciduous forest. Table No.2 reveals that in the year 2013 this land cover type covers an area of 28 sq. km (9.34%) in the revenue circle and from Table No.1 it is estimated

that of all the gram panchayats, Ganeshkuwari G.P. with 5.58 sq. km registers the highest concentration of mixed moist deciduous forest distributed over the low hilly areas of this gram panchayat. Apart from the aforesaid area it is also sparsely scattered over the built-up belt of the circle.

**b) Agri-plantation and Settlement** Agri-plantation and settlement refer to the orchard of beetle nut and beetle leaves attached to homestead land in the built-up area whereas plantation of banana and bamboo grooves are nearby settled land in *char* areas. As per 2013, it is seen from Table No.2 that out of the total area of the circle 77.69 sq km. (25.91%) is recorded in this land cover type. Lokrai (6.97 $km^2$.), Ganeshkuwari (6.42 $km^2$) and Kuruwa (5.1 $km^2$) recorded the highest area under agri-plantation and settlement followed by Bazanapathar (4.93 $km^2$), Sanowa (4.91 $km^2$), Sipajhar (4 $km^2$) and Garukhuti (3.48 $km^2$) (Table No.1). Indigenous tribal and non-tribal Assamese people have the practice of growing areca nut plants along with betel vines in their homestead orchard. It is viewed that with exception of non-indigenous Muslim of *char* all the indigenous caste and communities of the region have areca nut plantation in their homestead.

**c.&d) Cropland (Kharif and Rabi)** Based on the seasonal variation of cropping pattern croplands are classified into Kharif and Rabi cropland. The Kharif crop includes *sali* rice, jute, maize and summer vegetables while Rabi cropland is dominated by winter vegetables, oilseeds, pulses etc. The Kharif and Rabi crop area register 60.98 $km^2$ (20.34%) and 26.85 $km^2$ (8.95%) respectively for the study area (Table No.2). As the images to be studied are of the November and December month the Kharif cropland areas have been identified from harvested crop fields of the areas. As Table No.1 Kharif cropland area is found to the highest in Bazanapathar (11.98 $km^2$), Kuruwa (7.73 $km^2$), Lokrai (6.77 $km^2$), Garukhuti (6.3 $km^2$) and Sanowa (5.89 $km^2$) while the Rabi cropland is found maximum in Bazanapathar (8.21 $km^2$) and Sanowa (6.85 $km^2$). The spatial variation in land use pattern is brought in by the castes and communities living over the region. It can be visualized that the non-indigenous Muslim community of *char* areas have made changes in agricultural land use pattern over the years by devoting their land mostly to Rabi crop farming.

**d) Swampy Area** Swampy area refers to the area of low lying land that is frequently flooded and it is additionally the tract of wet and spongy land where the growth of certain types of vegetation like swamp grasses, water hyacinth etc takes place. As revealed from satellite data, 2013 the swampy area of the circle accounts for 4.47% (13.41 $km^2$) of the total area (Table No.2). The swampy area of this region includes *beels* or wetlands, ox-bow lakes or abandoned channels, marshy tracts and seasonally waterlogged areas. Pukhuria, Baro, Mailata, Diplinga, Gathia, Batha, Tupurachala and Badiasisa are the major *beels* or wetlands which are considered to be the creation of shifting courses of the river Brahmaputra and its tributaries. As analyzed from the satellite imagery it reveals that Kuruwa (3.12 $km^2$), Sanowa (2.19 $km^2$), Bazanapathar (2.1 $km^2$) and Ganeshkuwari (2.08 $km^2$) are the panchayats having maximum areas of swampy land cover type (Table No.1).

**e) Grassland** The area under this category is 18.87 $km^2$ (6.29%) in the circle (Table No.2). A variety of grasses characterize the natural vegetation of the Brahmaputra *chars*. The sandy soil of river banks and river islands of the Brahmaputra and its tributaries support this type of vegetation cover. The grasses like *nal (Arundo donax), khagari (Phragmites karka), tora (Alpinia allghas), kahua (S.Spontaneum) and ulu (Impereta cylindrica)* not only add to the scenic beauty of the *chars* but also fulfil the demands for building materials and fodder. Bamboo grooves are quite common throughout the study area. Out of 14 panchayats Bazanapathar and Sanowa possess the maximum area of grassland with 1.99$km^2$ and 1.08 $km^2$ respectively (Table No.1). Along with grasses these areas also contain simul, khoir, karoi and local plum (*zyzyphus*) trees.

**Table 2** Proportion of Land Use/Land Cover Pattern and its Net Change Areas in Sipajhar Revenue Circle.

| Land Use and Landcover Classes | 1977 | | 1991 | | 2013 | | Net change areas in % | |
|---|---|---|---|---|---|---|---|---|
| | Area (Sq.Km) | Area (%) | Area (Sq.Km) | Area (%) | Area (Sq.Km) | Area (%) | 1977-1991 | 1991-2013 |
| Moist Mixed Deciduous Forest | 30.94 | 10.32 | 28.29 | 9.43 | 28 | 9.34 | -0.88 | -0.10 |
| Agri-plantation/ Settlement | 40.87 | 13.63 | 64.31 | 21.45 | 77.69 | 25.91 | 7.82 | 4.46 |
| Cropland (Kharif) | 67.94 | 22.66 | 48.71 | 16.24 | 60.98 | 20.34 | -6.41 | 4.09 |
| Cropland (Rabi) | 26.6 | 8.87 | 23.05 | 7.69 | 26.85 | 8.95 | -1.18 | 1.27 |
| Swampy Area | 8.68 | 2.89 | 12.01 | 4.01 | 13.41 | 4.47 | 1.11 | 0.47 |
| Grassland | 20.59 | 6.87 | 23.9 | 7.97 | 18.87 | 6.29 | 1.10 | -1.68 |
| Scrub Forest | 42.54 | 14.19 | 37.52 | 12.51 | 23.06 | 7.69 | -1.67 | -4.82 |
| Water Body | 31.61 | 10.54 | 28.61 | 9.54 | 25.23 | 8.41 | -1.00 | -1.13 |
| Sand | 30.1 | 10.04 | 33.47 | 11.16 | 25.78 | 8.60 | 1.12 | -2.56 |
| Total | 299.87 | 100 | 299.87 | 100 | 299.87 | 100 | | |

*Sources: i. Landsat MSS Satellite Image of 16th December 1977*

ii. Landsat TM Satellite Image of 18th November 1991

iii. IRS P6 LISS Satellite Image of 24th November 2013

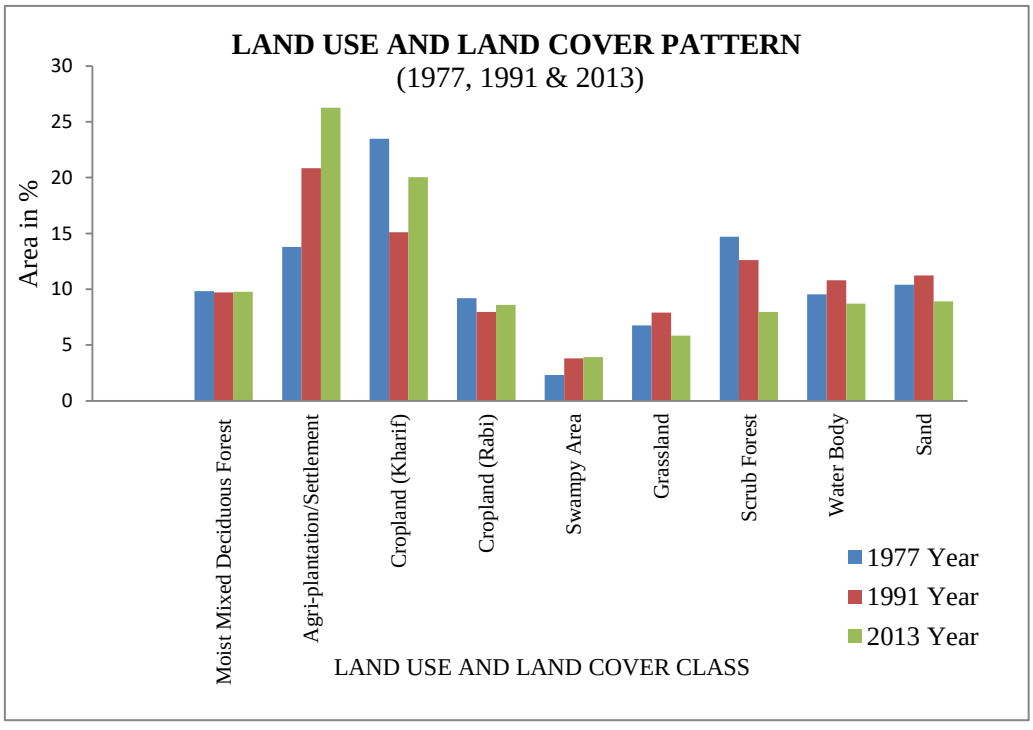


**Figure 7** Land use and land cover pattern in sipajhar revenue circle (1977, 1991 & 2013)

**f) Scrub Forest** Scrub forest refers to the vegetation dominated by shrubs, containing few or no tall trees. It includes thorny local plum (*zyzyphus)* trees, canes and *jaoban* (*Tamarix diocia*), a type of hard stemmed bushy vegetation that abundantly grows in the area with an area of 23.06 $km^2$ accounting for 7.69% of the total circle area (Table No.2). Among the panchayats of the circle, Bazanapathar (1.81 $km^2$) and Sanowa (0.87 $km^2$) occupy the highest proportion of area under this category (Table No.1).

**g) Water Body** The immediate south bank of the Brahmaputra being the southern boundary, a portion of this river, its major tributaries within the circle like Barnadi, Nanoi and Saktola constitute the water body of the Sipajhar region. It covers an area of 25.23 $km^2$ (8.41%) of the total area (Table No.2). The highest proportion of area underwater body is shared by Bazanapathar (3.98 $km^2$), Sanowa (2.99 $km^2$), Ganeshkuwari (2.45 $km^2$) and Kuruwa (2.1 $km^2$) as per 2013(Table No.1).

**h) Sandy Area** The area under this category is 25.78 $km^2$ (8.60%) in the circle (TableNo.2). The sandy area comprises of the river sand bars those are devoid of any kind of vegetation cover and such features are found to have primarily concentrated around the dried river beds of the river Brahmaputra. Therefore sandy areas are largely distributed over the *char* areas of the circle. The change in river course with excessive siltation has resulted in the formation such landforms along the river Brahmaputra and its tributaries. Among all the panchayats, Bazanapathar (2.93 $km^2$) and Sanowa (1.91 $km^2$) recorded the highest area of this land cover type while the rest of the panchayats occupies lesser than 1$km^2$ in 2013 (Table No.1).

## 5.2. Land Use and Land Cover Change Detection Analysis in Sipajhar Revenue Circle

Post-classification comparison technique is adopted for change detection analysis for this investigation. In this method, two images are overlayed by cross operation overlaying and comparison of previously classified images is done. The benefit of cross operation overlaying is that it helps in knowing the extent and nature of spatio-temporal changes occurred in land-use and land-cover types of the area under investigation.

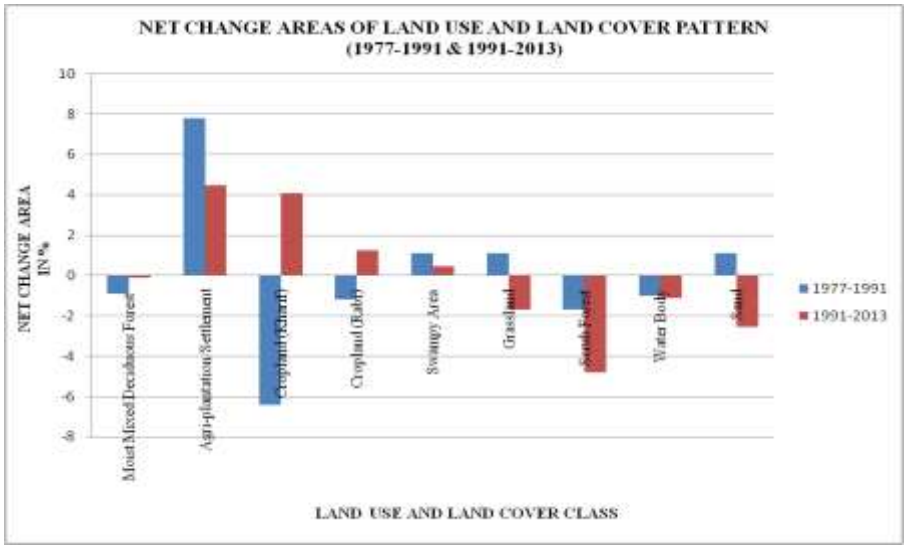


**Figure 8** Net Change areas of Land use and Land Cover Class in Sipajhar Revenue Circle (1977-1991 and 1991-2013)

The final land cover change analysis of sipajhar revenue circle is accomplished by applying the procedure mentioned above. It is noticed that there is a spatio-temporal variation in various categories of land cover type of the circle. The geographical area of mixed moist deciduous forest has been steadily decreasing since 1977. In that very year, it was 10.32% which decreased to 9.43% in 1991 and 9.34% in 2013(table no.2 & fig.8). So it clarifies that there is -0.88% of net change during 1977-1991 and -0.10% during 1991-2013. It can be assumed that there has been a loss of 2.65 $km^2$ of forest coverage during 1977-1991 and 0.29 $km^2$ during 1991-2013 due to increasing population pressure on the land.

It is to be noted that the land cover type of agri-plantation and settlement recorded the highest positive net change with 7.82% and 4.46% during 1977-1991 and 1991-2013 respectively. It can be visualized that an area of 23.44km2 has been extended under this class during 1977-1991 and 13.38km$^2$ during 1991-2013(Table No.2 and Fig.8). High growths of population and consequent pressure on cultivable land and grazing ground have affected the expansion of this land cover type over the years. The change of land cover type has been intensified over the years particularly towards the *char* areas of the region due to high growth of population and settlement over there.

There has been a negative net change of kharif (-6.41%) and rabi crop(-1.18%) area during 1977-1991(Table No.2 and Fig.8). About 19.23km$^2$ of kharif crop and 3.55km$^2$ of rabi cropland area have been reduced during that period. Channel shifting, bank erosion, growing settlement, replacement of farmland by brick industries etc. Can be attributed to the decline of kharif and rabi crop area from 1977 to 1991. In contrast, the land area under kharif and rabi crop has shown positive net change respectively with 4.09% and 1.27% during 1991-2013. It reveals that an area of 12.27km$^2$ of kharif crop and 3.8km$^2$ of rabi crop added to the cultivable land of the circle during the concerned period. It can be assumed that extensive areas of the south Sipajhar revenue circle have been brought under agriculture practices by *char* dwellers due to large scale siltation by the river Brahmaputra after 1991.

A perusal of Table No.2 and Fig.8 clarifies that the area under swamp (1.11%) and grassland (1.10%) experienced a positive net change during 1977-1991 when 3.33 km$^2$ of a swampy area and 3.31km$^2$ grassland have been newly created. On the other hand, there has been a steady positive net change in the class of swampy area (0.47%) and negative net change in grassland (-1.68%) area during 1991-2013. The area under scrub forest shows that a negative net change of -1.67% is registered during 1977-1991 and -4.82% during 1991-2013. It is viewed that an area of 5.02km$^2$ and 14.46km$^2$ scrub forest have been lost respectively during 1977-1991 and 1991-2013. As for the sandy area of the circle, it is found that there is a positive net change of 1.12% under this category during 1977-1991 while it recorded negative net change of -2.56% during 1991-2013. The loss of scrub forest and sandy area is basically due to the extension of farming practice and increase of rural settlement in the concerned area over the period of time. It is a matter of concern that over the last 36 years there has been a steady decrease in water body area due to drying up of various braided channels of the river brahmaputra. It is noticed that there has been a negative net change of water body area by -1.0% during 1977-1991 and -1.13% during 1991-2013 which hinted at a decrease of 3km$^2$ and 3.38km$^2$ of water body area during the respective period. At present, the bed of dried-up channels have been occupied by crop farming and the new settlement of *char* dwellers

## 6. CONCLUSIONS

The present study reveals that spatio-temporal changes in land use and land cover types can be attributed to high population growth over the last couple of decades. It is to be noted that the remote sensing technique provides spatio-temporal database through which the change detection becomes easy to analyze. The main findings from the foregoing discussion can be summarized as follows.

- The land-use type of agri-plantation and settlement is extending mostly towards south-western part of the circle, especially in Ganeshkuwari, Kuruwa, Bazanapathar and Sanowa gram panchayat. The impact of this process is reflected in declining proportions of the area under moist mixed deciduous forest, grassland, scrub forest and sand cover of the circle.

- The area under land-use of kharif and rabi crop has shown positive net change particularly in Sanowa and Bazanapathar gram panchayat.
- There has been a consistent positive net change in the class of swampy area while it prompts decline in area under grassland, scrub forest and sandy area in recent years.
- There has been a steady decrease in water body area due to continuous sedimentation and drying up of various braided channels of the Brahmaputra River. The bed of dried-up channels has been converted into farming and new settlement sites by *char* dwellers.
- Different farming communities of the circle are concentrated in three micro physiographical units of this lower Brahmaputra valley of Assam.

The loss of mixed moist deciduous forest, grassland, scrub forest, sandy area and water body is basically due to unplanned extension of farming practice and increase of rural settlement in the concerned area over time. In the near future, the main emphasis should be given on the intensification of agriculture rather than to increase the arable land physically. The present discussion validates that there is limited scope for physical expansion of arable land within the circle. So crop intensification is one way that will facilitate a higher degree of productivity per hectare on existing cultivable land. The study indicates that the entire area is on the process of human-induced land-use changes. This process would intensify if the proposed bridge linkage between Kuruwa and Guwahati materialize in the near future. At present, the need for judicious utilization of land resource and land-use planning through proper identification of land use /land cover pattern assumes much greater relevance in the study area. Therefore spatio-temporal change detection analysis is worthy of its study as a prerequisite of land use planning in sipajhar revenue circle.

## REFERENCES

[1] Abbas, I. I., Muazu, K. M., & Ukoje, J. A. (2010). Mapping Land Use - land Cover and Change Detection in Kafur Local Government , Katsina , Nigeria ( 1995 - 2008 ) Using Remote Sensing and Gis. *Research Journal of Environmental and Earth Sciences*, *2*(1), 6–12.

[2] Belay Tegene. (2002). Land-Cover/Land-Use Changes in the Derekolli Catchment of the South Welo Zone of Amhara Region, Ethiopia. *Eastern Africa Social Science Research Review*, *18*(1), 1–20. https://doi.org/10.1353/eas.2002.0005

[3] Bhagabati, A. K. (1985). Pattern of Land Utilization in the Brahmaputra Valley. *Indian Journal of Landscape Systems and Ecological Studies*, *18*(2), 62-69.

[4] Borah, B. (2003). *Population Characteristics and Agricultural Development in Jorhat District,Assam.* Unpublished Ph.D. Thesis, Department of Geography,North Eastern Hill University,Shillong.

[5] Das, H., & Das, M. M. (1989). Land Use Pattern in the Pagladiya-Puthimari Basin. *Norh Eastern Geographer, 21*(1&2), 9-25.

[6] Das, K. N. (1973). Population Pressure and Intensity of Cropping in the Kosi Area,Bihar. *Geographical Review of India, 35*(4), 309-321.

[7] Das, M. M., & Dutta, L. (1986). Regional Variation in Land Use and Agriculture in N.E.India. *North Eastern Geographer, 18*(1&2), 28-48.

[8] Devi, G. (1990). *Changing Pattern of Land Use in Barpeta District.* Unpublished Ph.D.Thesis, Gauhati University, Guwahati.

[9] Directorate of Census Operations, & Assam. (2011). *District Census Handbook Darrang*. http://censusindia.gov.in/2011census/dchb/1826_PART_B_DCHB_DARRANG.pdf

[10] Das, K. N. (1973). Population Pressure and Intensity of Cropping in the Kosi Area,Bihar. *Geographical Review of India*, *34*(4), 309–321.

[11] Kumar, N., Yamac, S. S., & Velmurugan, A. (2015). Applications of Remote Sensing and GIS in Natural Resource Management. *Journal of the Andaman Science Association, 20*(1), 1-6.

[12] Mallupattu, P. K., & Sreenivasula Reddy, J. R. (2013). Analysis of land use/land cover changes using remote sensing data and GIS at an Urban Area, Tirupati, India. *The Scientific World Journal*, *2013*(Figure 1), 1–7. https://doi.org/10.1155/2013/268623

[13] Mohapatra, A. C., & Alempokba, I. (1982). Land Use in Naga Village. *Himalaya*, *6*(7), 13-19.

[14] Nagmani, K., & Ramachandran, S. (15-17 th December,2003). Land Use/Land Cover in Pondicherry using Remote Sensing and GIS. In M. j. Bunch, V. M. Suresh, & T. Vasanthakumaran (Ed.), *Third International Conference on Environment and Health* (pp. 300-305). Chennai,India: Department of Geography,Madras University and Faculty of Environmental Studies,York University.

[15] Nath, L. (2005). *Darrang District Through The Ages.* Sonitpur(Assam): Karuna Medhi Publication.

[16] National Oceanic and Atmospheric Administration US Department of Commerce. (2020). *What is the difference between land cover and land use?*

[17] Reis, S. (2008). Analyzing land use/land cover changes using remote sensing and GIS in Rize, North-East Turkey. *Sensors*, *8*(10), 6188–6202. https://doi.org/10.3390/s8106188

[18] Sharma, H. N. (1990). Integrated Land Use Planning: An Urgent Need Of North East India. *North Eastern Geographer*, *22*.

[19] Singh, R. R. (1982). *Pattern Of Land Use in Manipur Valley.* Unpublished Ph.D. Thesis, Gauhati University, Guwahati.

[20] Tegene, B. (2002). Land Cover-Land Use Changes in the DereKolli Catchment of the South Welo Zone of Amhara Region,Ethiopia. *Eastern Africa Social Science Research Review, 18*(1), 1-20.