

## A GIS based analysis of urbanization and its impact on arable land: A study on selected municipalities of upper Assam, India

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**Abstract:** Urbanization, the conversion of other types of land to uses associated with growth of populations and economy, is a main type of land use and land cover change in human history (Weng 2001). The urbanization takes place either in radial direction around a well-established city or linearly along the highways (Ramchandran & Jagadish 2003). The integration of remote sensing and geographic information systems (GIS) has been widely applied and been recognized as a powerful and effective tool in detecting urban land use and land cover change (Ehlers et al. 1990, Treitz et al. 1992, Harris and Ventura 1995). Jorhat, Dibrugarh and Tinsukia area the major urban Agglomeration of upper Assam. These towns demonstrated a very rapid development and results a very haphazard expansion of market areas and residential establishment over the arable land. Such urbanization in the upper Assam not only develops a complex land use structure but also creating several other associated environmental issues. Jorhat, Dibrugarh, Sivasagar and Tinsukia municipal areas of Assam depicts eventually the urban growth with regard to the land use change most dominate being the built up area, which have shown a substantial increase i.e. 178 hectare for Dibrugarh, 309 hectares for Jorhat, 155 hectares for Sivasagar and 154 hectare for Tinsukia. Therefore, the present study therefore is an attempt to analyze the impact of urbanization on land use pattern (specifically impact on arable land) of selected Municipality Area of Jorhat, Dibrugarh, Sivasagar and Tinsukia of Assam and thereby produce Land use Land cover Map of the selected Municipality areas. The change detection through image difference between has been highlighted for the period of 1972 to 2014 for Dibrugarh, 1960 to 2014 for Jorhat, 1972 to 2014 for Sivasagar town and 1975 to 2014 for Tinsukia town.

**Keywords:** - Urbanization, Land use, Growth

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### I. INTRODUCTION

Urbanization is a cyclical process through which the nation passes as they evolve from agrarian to industrial societies. It is a spatial concomitant phenomenon involving population concentration, structural transformation and socio-psychological change affecting both people and place (Roy & Saha, 2011). It comprehends the study of physical and cultural grounds on which a town rests to an appraisal of their effects on the growth and character of the town, the structure and the influence it exerts upon its surrounding lands. Moreover, the rapid urbanization generates serious challenges to towns and cities and is the primary sources of generating pollution, often struggling to provide and maintain already inadequate level of urban services and healthy environment. The process of society's transformation from a predominantly rural to a predominantly urban population is called urbanization (Khullar, 2000). Trewartha (1969) consider Urbanization is cyclic process through which the nations pass as they evolve from simply agrarian to industrial societies (Chandana, 2002). Urbanization mostly in the developing nations of the world is taking place at the cost of valuable agricultural land. Urbanization in most of the cities of India leads to rapid transformation of productive land to build up areas. Rapid urban population growth and their consequent pressure on arable land have significantly changing the land use pattern of most of the cities of India (Atiqur et.al. 2011). Deka et al. (2012) in their study on Jorhat town, it is found that the built up area around Jorhat city was 11.08 sq km with a total urban population of 1.12 lakh in 1996, which increased to 20.96 sq km with a total urban population of 1.53 lakh, which indicates an increase of 9.87 sq km in 15 years with an annual growth rate of 5.93%. Dibrugarh town locating in the south bank of river Brahmaputra at upper Assam experiencing a very rapid urban population growth due to large scale rural to urban migration leading to the rapid transformation of the land use pattern. The total population of Dibrugarh town was 80,348 persons in the year 1971 which increased to 138,661 persons in 2011, which leads

to the decrease of agricultural land (paddy field) from 104.11 hector to 19.96 hector during the same period. Dibrugarh, Jorhat and Tinsukia Municipal areas of Assam portrays a spontaneous and gradual urban expansion. All these municipal areas are being located in the south bank of river Brahmaputra at upper Assam experiencing a very rapid urban population growth due to large scale rural to urban migration leading to the rapid transformation of the land use pattern where substantial increase in the land use pattern has been found to be the built up areas of the municipalities followed by gradual reduction of the agricultural lands.

### **Study area:**

The study has been conducted on the Municipal area of Dibrugarh town, which has a total Geographical area of 15.5 km<sup>2</sup> with a total population of 1, 38,661 having the latitudinal extension of 27° 27' 0'' N to 27° 31' 20''N and longitudinal extension of 94° 52' 0''E to 94° 57' 0'' E. Jorhat on the other hand is located between 94°09'20.6"-94°16'40.8"E and 26°41'25.7"-26°49'22.1"N covering 9.20 Km<sup>2</sup> of the total municipal area. While Tinsukia has a longitudinal extension of 95°19'20.00"E - 95°24'00.00"E and latitudinal extension of 27°31'20.00"N -27°28'80.00"N with a total municipal area of about 10.54 Km<sup>2</sup> and Sivasagar has a longitudinal extension of 94°36'20.00"E - 94°40'00.00"E and latitudinal extension of 26°58'20.00"N -27°00'00"N with a total municipal area of about 7.45 Km<sup>2</sup>.

### **Objectives**

The objective of this work is to study the pattern of urbanization of Dibrugarh, Sivasagar, Jorhat and Tinsukia Municipality interpreting the population from 1971 to 2011. Thereby to analyze the impact of urbanization on land use transformation (specifically on arable land) and produce LULC map of some selected town of upper Assam i.e. Dibrugarh, Sivasagar, Jorhat and Tinsukia municipality and thematic map (including the following layers: rail, municipality area boundary, road, river, and LULC classes) of Municipality area and thereby examine the urban land use changes analysis between 1972 to 2014 for Dibrugarh, 1972 to 2014 for Sivasagar, 1975 to 2014 for Tinsukia and 1960 to 2014 for Jorhat.

### **Data base and methodology**

The data on population and areal expansion aspects have been collected from various sources viz. from the Census reports of Census of India (from 2001 to 2011) and available literature, records of Dibrugarh, Sivasagar and Tinsukia Municipal Board, Dibrugarh, Sivasagar and Tinsukia Development Authority and Town and country planning etc. and the data have been ordered, tabulated. Graphing / charting and mapping have been made for several meaningful parameters computed from the dataset. The types of data used in the course of this study, includes: Google satellite Imageries of 2014 for each Municipal area of Dibrugarh, Sivasagar and Tinsukia, used for the land use classification for the period. The study area was extracted from these satellite images and was separately rectified into common geographic coordinate base. The geographic properties of the images were further refined to merge with the topographic maps of the study area and also the base map collected from the various sources i.e. Town and Country Planning, Assam, Municipal boards of each towns etc were used. Surveys of India Toposheet no. **83I/15** for Dibrugarh, **83J/9** for Sivasagar, **83J/2, J/3, J/5, J/6** for Jorhat and **83M/7** for Tinsukia were used for vector layer creation. Further, all the layers were integrated in GIS environment using the software tools Quantum GIS 2.6 for preparation of thematic map, Data base generation and analysis.

#### **1. Urbanization of the selected municipal areas**

The growth rate of urban population of Jorhat town is very rapid. The town has shown a dramatic increase of urban population from 30,247 in 1971 to 71,782 in 2011, with a total growth rate of 135.06 during 40 years (1971 to 2011). At the same period the total urban population of Sivasagar town has increased for 27,426 to 50,595 with a total growth rate of 84.47%. Whereas Dibrugarh and Tinsukia town has shown an increase of urban population from 80,348 to 1, 38,661 and 54,991 to 98,798 with a total growth rate of 72.57% and 79.92% respectively (**Fig.2**).

The urban population density of Jorhat town was 6,147 persons/sq km in 1971, which increases to 7,802 person /sq km in 2011. At the same period the population density of Dibrugarh town increases from 5,183 persons/ sq km to 8,948 persons / sq km, whereas in Tinsukia and Sivasagar town, the urban population density increases from 5,209 to 8,948 persons / sq km and 3,671 to 6,791 person / sq km respectively (**Fig.1**).

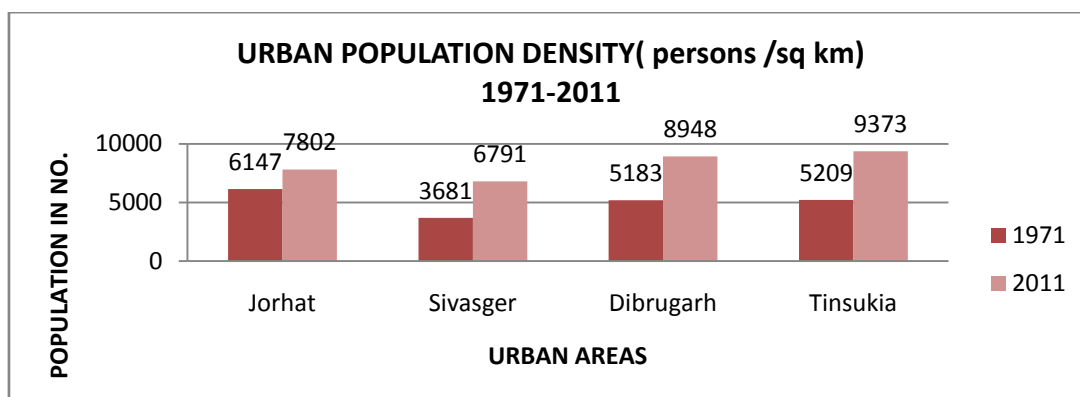


Fig.1: Urban population density of municipal areas

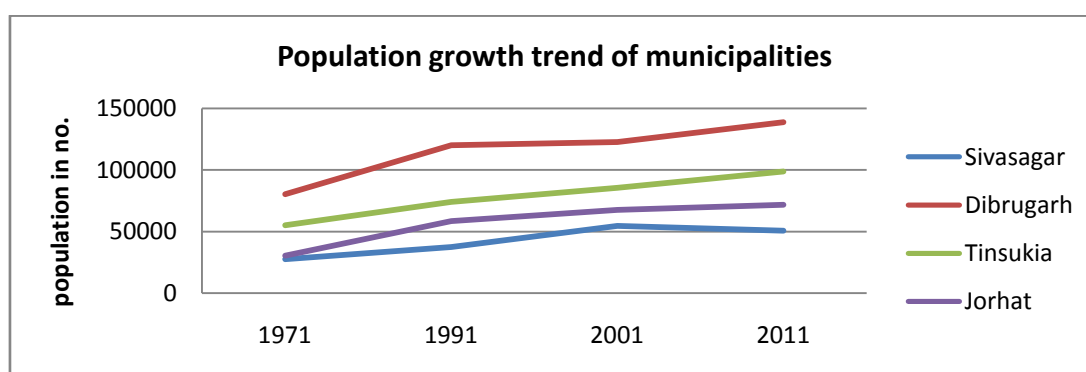


Fig.2: Population trend of Dibrugarh, Jorhat, Sivasagar and Tinsukia Municipality, 1971 to 2011

Tab 1: Population Growth and Growth Rate Pattern of the Municipalities

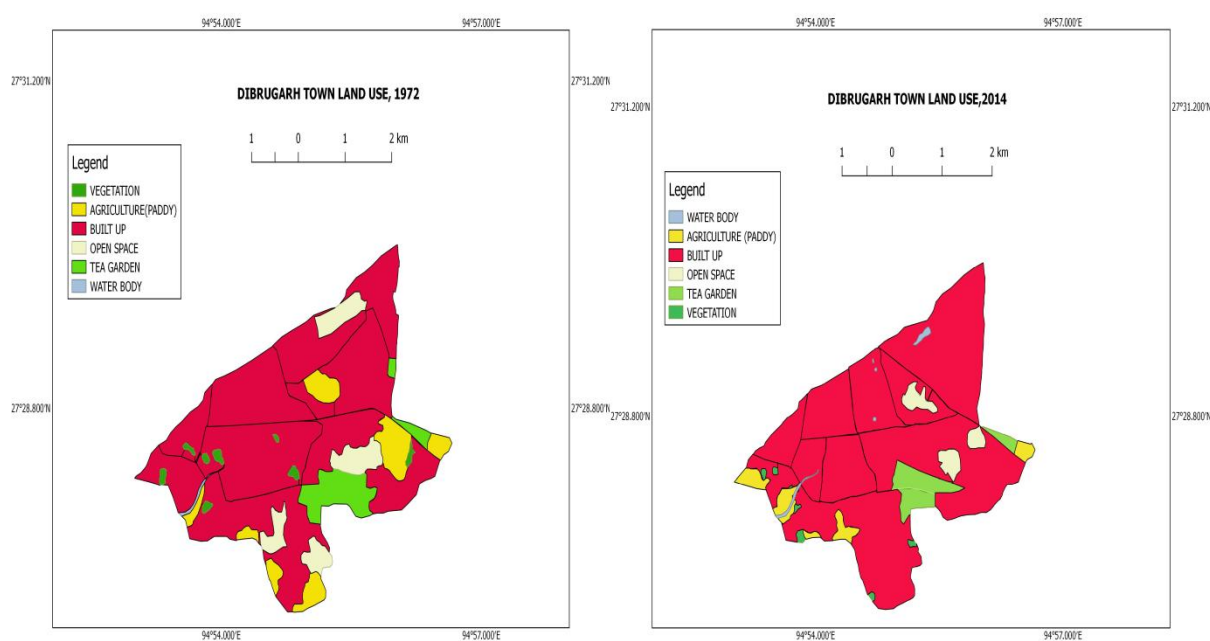
Sl. No.	Census years	Population of municipalities (in thousands)				growth rate in % ( 1971 to 2011)			
		Dibrugarh	Jorhat	Tinsukia	Sivasagar	Dibrugarh	Jorhat	Tinsukia	Sivasagar
1	1971	80,348	30247	54,911	27,426	72.57	136.05	79.92	84.47
2	1991	1,20,217	58358	73,918	37,326				
3	2001	1,22,523	67,588	85,519	54,482				
4	2011	1,38,661	71,782	98,798	50,595				

1.1 **Dibrugarh land use land covers change analysis:** The period of change analysis was divided into one epochs based on the data available covering a period of forty three years (1972-2014). Land use of the Dibrugarh town consist mainly built up land (settlements), agricultural land (paddy field), tea garden, water bodies, open spaces and tree cover along with different roads accounting for about 1550 hectares. The Table 2 shows that built up was the dominant land use land cover class in 1971, taking about 76.21 % of the total area. This is followed by agricultural land (paddy covered), which

covers an area of about 140 hectare about 9.03 % of the study area. Open space, which covers about 111 hectare constituting nearly 7.17% of the area. During the recent period (2014), the area has shown significant changes in the land use structure. The built up land have shown a maximum increase, it has become 1358 hectars with a net change of 178 hectars, followed by water body which has become 26 hectars with net change of 19 hectars. The other land use categories such as vegetal cover, Tea garden, open space and Agriculture (paddy covered) has shown a decreasing trend during the same period. The Agriculture (paddy covered) followed by teagarden & open space open has shown a dramatic decrease of 101, 47 and 41 hectars during the study period. The proportion of built up and water body was 76.12 % and 0.45% during the year 1972, which becomes to 87.61% and 1.67% of the total municipal area in the year 2014, whereas the proportion of Agriculture, tea garden, open space and vegetal cover was 9.03%, 6%, 7.17% and 1.23% during 1972, becomes 2.51%, 2.96%, 4.53% and 0.72 during the year 2014. The results of the changes in the epoch for the Dibrugarh municipal area have been presented in **Tab. 2 (Fig. 3)** and discussed in this section.

**Tab. 2: Land use Land cover of Dibrugarh Municipality area for the two observation year (1971 and 2014)**

Sl no	Land use	1972 (Area in hectare)	Area (in %)	2014 (Area in hectare)	Area (in %)	Net change
1	Built up land	1180	76.12	1358	87.61	178
2	Agriculture (paddy)	140	9.03	39	2.51	101
3	Tea garden	93	6	46	2.96	47
4	Open space	111	7.17	70	4.53	41
5	vegetation	19	1.23	11	0.72	8
6	Water body	07	0.45	26	1.67	19
<b>Total</b>		<b>1550</b>	<b>100</b>	<b>1550</b>	<b>100</b>	<b>523</b>



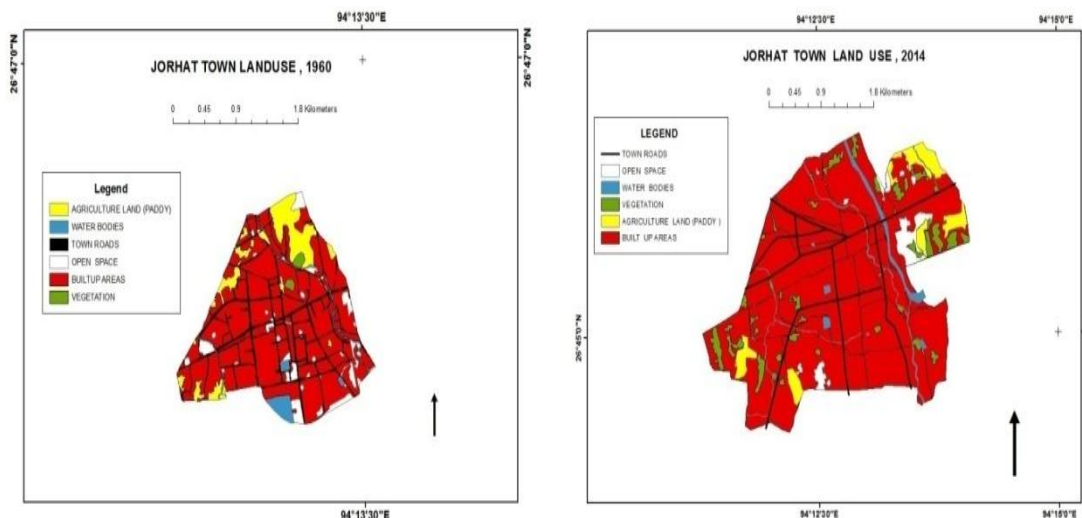
**Fig .3: Land use of Dibrugarh Municipality, 1971 to 2014**

**1.2 Jorhat land use land covers change analysis:** Land use of the Jorhat has been the result of spontaneous urban growth consisting mainly of built up land (settlements), agricultural land (paddy field), water bodies, and open spaces and along with some patches of vegetation. The total municipal area accounted for about 495 hectares out of which built up has been dominant land use covering about 74.15% of the total municipal area. During the recent period (2014), the municipal area have experienced an outgrowth of about 53.80% i.e. it has showed an expansion to 920 hectares as opposed to 495 hectares in 1960. The agriculture land followed by open space has reduced substantially giving way to urban development accounting for about 5.04% and 3.26% as opposed to 13.98% and 5.62% in 1960. Surprisingly, the total vegetal cover, water bodies have shown a positive growth due to the expansion of the area as well as inclusion of the land uses into it which accounted a growth of about 7.84% and 10.37% of the total municipal area. Taking into consideration the built up area it has showed a gradual increase consisting around 73.49% of the total municipal area. The results of the changes in the epoch for the Jorhat municipal area have been presented in **Tab. 3 (Fig.4)** and discussed in this section. The analysis shows that spontaneous growth where built up areas showed a significant change of 65.66 % accounting for a net change of around 309.16. The agricultural fields, which was about 69.22 hectare in 1960 becomes 46.31 hectare in 2014. Thus the agricultural land has become the only recipient of built up area development of the Jorhat municipal area.

**Tab. 3: Land use Land cover of Jorhat Municipality area for the two observation year ( 1960 and 2014)**

Sl no	Land use	1960 (Area in hectare)	Area (in %)	2014(Area in hectare)	Area (in %)	Net change
1	Built up land	367.03	74.15	676.19	73.49	309.16
2	Agriculture (paddy)	69.22	13.98	46.31	5.04	22.91
3	vegetation	3.25	0.66	72.16	7.84	68.91
4	Open space	27.81	5.62	29.95	3.26	2.14

<b>5</b>	<b>Water body</b>	<b>27.69</b>	<b>5.59</b>	<b>95.39</b>	<b>10.37</b>	<b>67.7</b>
<b>Total</b>		<b>495</b>	<b>100</b>	<b>920</b>	<b>100</b>	<b>470.82</b>

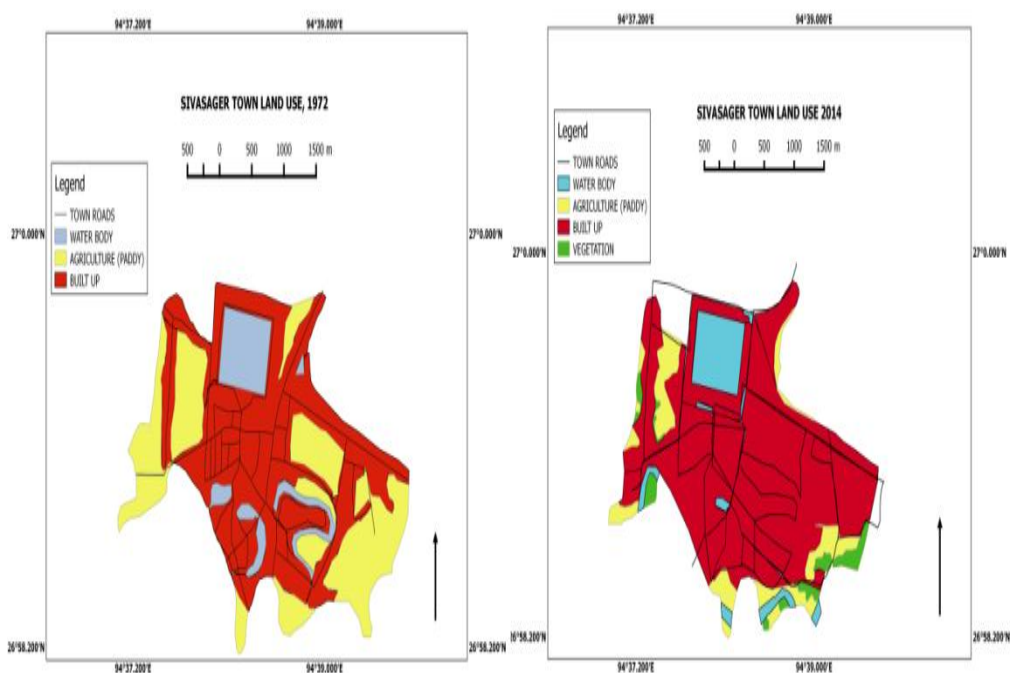


**Fig. 4: Land use of Jorhat, 1960-2014**

**1.3 Sivasagar land use land covers change analysis:** The period of change analysis was divided into one epochs based on the data available covering a period of forty two years (1972-2014). Land use of the Sivasagar town consist mainly built up land (settlements), agricultural land (paddy field), water bodies (wetlands), open spaces and tree cover along with different roads accounting for about 745 hectares. The Table 2 shows that built up was the dominant land use land cover class in 1972, taking about 55% of the total area. This is followed by agriculture land, which covers an area of about 250 hectare about 33.55 % of the study area. Water bodies which covers about 78 hectare of land, constituting nearly 10.46 % of the area with only 2 hectare of vegetation cover. The agricultural land has reduced substantially from 250 hectare in 1972 to 79.3 hectare in 2014; giving way to urban development. The total vegetal cover and water body acquires an area of 68.3 and 27.9 hectares in 2014 as opposed to 78 and 2 hectares in 1971. The built up area, which is significantly increases from 415 hectare in 1971 to 570 hectare, with a net change of 155 hectare during the period of 42 years (**Tab. 4&Fig. 5**). Thus increasing built up areas in the Sivasagar municipal area have dramatically reduces the agriculture land and water body.

**Tab. 4: Land use Land cover of Sivasagar Municipality area for the two observation year (1972 and 2014)**

<b>Land use</b>	<b>1972(area in hectare)</b>	<b>1972(in %)</b>	<b>2014( area in hectare)</b>	<b>2014(in %)</b>	<b>Net change( area in hectare)</b>
<b>Built up</b>	<b>415</b>	<b>55.83</b>	<b>570</b>	<b>76.51</b>	<b>155</b>
<b>Agriculture</b>	<b>250</b>	<b>33.55</b>	<b>79.3</b>	<b>10.64</b>	<b>170.7</b>
<b>Water body</b>	<b>78</b>	<b>10.46</b>	<b>68.3</b>	<b>9.16</b>	<b>9.7</b>
<b>Vegetation</b>	<b>2</b>	<b>0.26</b>	<b>27.9</b>	<b>3.74</b>	<b>25.9</b>
<b>total</b>	<b>745</b>	<b>100.00</b>	<b>745</b>	<b>100</b>	



**Fig.5: Sivasagar land use 1972 and 2014**

**1.4 Tinsukia land use land covers change analysis:** The total municipal area accounted for about 1054 hectares out of which agriculture was the dominant land use land cover class in 1975, taking about 45.49 percent of the total area, followed by built up, which covers an area of about 463 hectare about 43.93% of the study area. During the recent period (2014), the agricultural fields have shown a substantial decrease accounting for about only 18.99% of the total area. The total tea garden, vegetal cover, and open space areas have on the other hand shown a dramatic increase covering 6.28%, 5.47%, and 10.20% in 2014 as opposed to 5.48%, 0.93% and 3.71% in 1975. Urban development has increased to an estimated amount of 58.60 % of the entire region. The results of the changes in the epoch for the Tinsukia municipal area have been presented in **Tab. 5 (Fig. 6)**. The analysis shows that spontaneous increase of built up area from 463 hectare in 1975 to 617.64 hectares in 2014 with a net change of around 154.64 hecters. The agricultural fields are the highest recipient of the effect of urban growths with substantial reduction showing a decrease of 279 hectare during the study period. While the vegetal cover, as well as the open space, tea garden showed an increase of 68.40, 8.44 and 47.85 hectare during the period of 39 years. It is also noticed that the water bodies remained the same throughout the epoch. Thus an increasing developed land in the municipal areas has significantly reduces the amount of agricultural land during the study period.

**Tab 5: Land use land cover of Tinsukia Municipality area in the two observation year (1975 and 2014)**

Sl no	Land use	1975 (Area in hectare)	Area (in %)	2014 (Area in hectare)	Area (in %)	Net change
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1	<b>Built up land</b>	<b>463</b>	<b>43.93</b>	<b>617.64</b>	<b>58.60</b>	<b>154.64</b>
2	<b>Agriculture (paddy)</b>	<b>480</b>	<b>45.49</b>	<b>200.15</b>	<b>18.99</b>	<b>279.85</b>
3	<b>Tea garden</b>	<b>57.75</b>	<b>5.48</b>	<b>66.19</b>	<b>6.28</b>	<b>8.44</b>
4	<b>vegetation</b>	<b>9.80</b>	<b>0.93</b>	<b>57.65</b>	<b>5.47</b>	<b>47.85</b>
5	<b>Open space</b>	<b>39.10</b>	<b>3.71</b>	<b>107.50</b>	<b>10.20</b>	<b>68.40</b>
6	<b>Water body</b>	<b>4.84</b>	<b>0.46</b>	<b>4.84</b>	<b>0.46</b>	<b>0</b>
<b>Total</b>		<b>1054</b>	<b>100</b>	<b>1054</b>	<b>100</b>	<b>559.8</b>

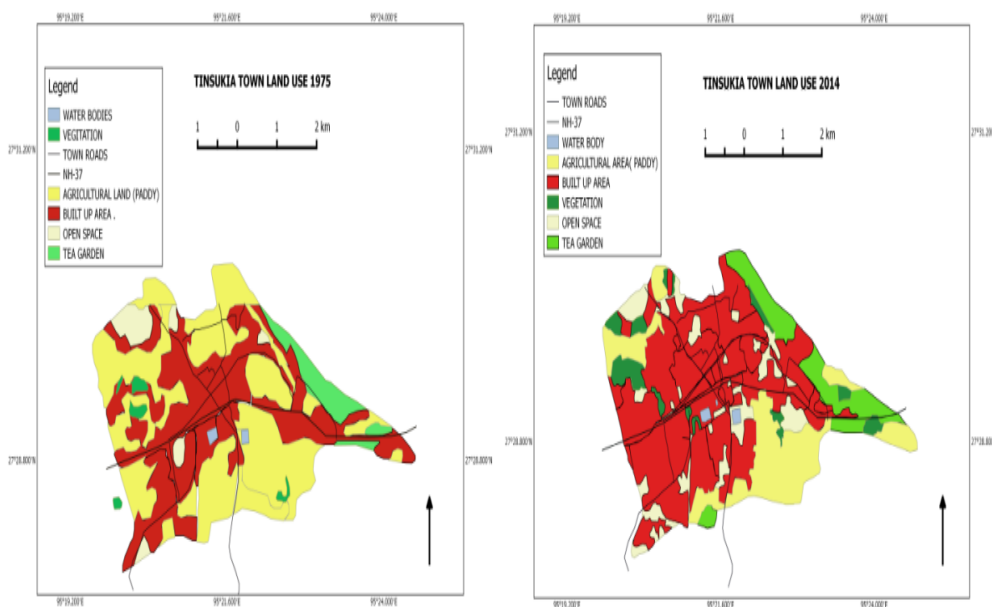
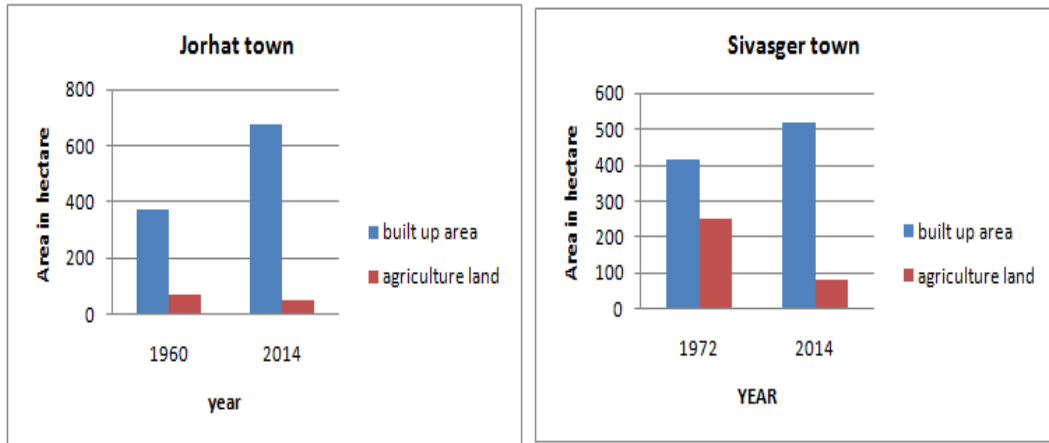


Fig. 6: Land use of Tinsukia, 1975-2014

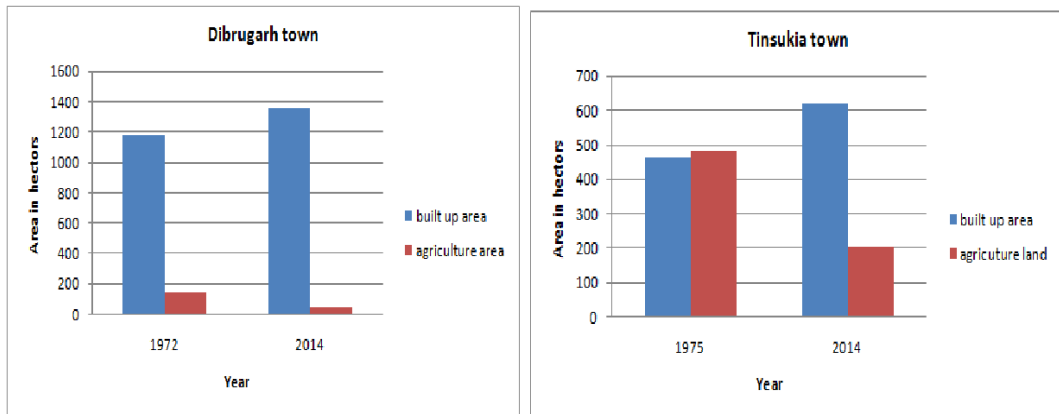
**1.5 Impact of urbanization on Agricultural Land (arable land):** urbanization has greatly influenced the arable land structure of the towns. The built up areas of the Major towns of upper Assam has been developed at the cost agricultural field (arable land). The built up areas of Sivasagar municipality was 415 hectares (56%) in 1972 which becomes 570 hectare (76%) in 2014, which consequently reduces the agricultural land from 250 hectare (33%) in 1971 to 79 hectare (11%) in 2014. Dibrugarh town has shown an increase of built up area from 1180 hectare (76%) in the year 1972 to 1358 hectare (87%) in 2014, which leads to decline of agricultural land



from 140 hectare (9.03) in 1971 to 39 hectare (2.51) in 2014. During the period 1975 to 2014, Tinsukia town demonstrated an increase of built up area from 463 hectare (44%) to 617 hectare (58%), which consequently declines the agricultural, land, from 480 hectare (45%) to 200 hectare (19%). While Jorhat town has highlighted an increased of built up area from 367 hectare (74%) to 676 hectare (74%) during 1960 to 2014, whereas agricultural land reduces from 69 hectare (14%) to 46 hectare (5%) during the same period.



**Fig.7: impact of built up on arable land (Jorhat and Sivasagar town)**



**Fig.8: impact of built up on arable land (Dibrugarh and Tinsukia town)**

## II. CONCLUSION

The study reveals that the rate of urbanization and urban growth of each municipal area is very high which has been significantly influencing the land use pattern of the region. Ever increasing urban population and their consequent pressure on land resources have developed built up area on the productive land, which subsequently altering the urban environment. Increasing population density in the core as well as peripheral area of the towns leads to the horizontal expansion of urban areas, which rapidly deteriorates the water, land and air quality at the urban environment. Generally however the land use types that are subject of major changes are agricultural land, vegetal covers and built up areas.

### Suggestion:

- Haphazard expansion of built up areas over the productive land should be checked.
- Green belt should be developed around the municipal area so that horizontal expansion of towns can be minimized.
- Proper disposal of municipal waste should be done to ensure healthy urban environment,
- Proper plantation of the trees in the municipal areas of the towns should be introduced to reduce the pollution loads of the towns.
- Rural to urban migration should be checked so that rapid urbanization and land use modification can be minimized.
- Proper drainage system should be developing in order to reduce the intensity of urban flash flood.

## REFERENCES

- [1] Chandana R.C.(2000), Geography of Population, 4<sup>th</sup> Edition, Kalyani Publishers
- [2] Deka Jyotishman, Tripathi Om Prakash Latif Khan, Mohamed(2012)- “Urban growth trend analysis using Shannon Entropy approach – A case study in North-East India” International journal of geomatics and geosciences, Volume 2, No 4
- [3] Dibrugarh, Census Report, Census of India 2011
- [4] Ehlers, M., Jadcowski, M. A., Howard, R. R., and Brostuen, D. E., 1990, Application of A remote sensing–GIS evaluation of urban expansion 2013 SPOT data for regional growth analysis and local planning. Photogrammetric Engineering and Remote Sensing, **56**, 175–180.
- [5] Harris, P. M., and Ventura, S. J., 1995, The integration of geographic data with remotely sensed imagery to improve classification in an urban area. Photogrammetric Engineering and Remote Sensing, **61**, 993–998.
- [6] Khullar D R, India- A Comprehensive Geography, 2<sup>nd</sup> Edition,
- [7] Rahman Atiqur, Aggarwal Shiv Prashad, Netzband Maik, and Fazal Shahab(2011)“Monitoring Urban Sprawl Using Remote Sensing and GIS Techniques of a Fast Growing Urban Centre” India, IEEE Journal of selected topics in Applied Earth Observations and Remote Sensing, vol. 4, no. 1
- [8] Ramchandran.T.V and Jagadish.K.S.(2003); Map India Conference
- [9] Roy Tamal Basu and Saha Sanjoy (2011) : A study on factors related to urban growth of a municipal corporation and emerging challenges: A case of Siliguri Municipal Corporation, West Bengal, India;Journal of Geography and Regional Planning Vol. 4(14), pp. 683-694, 18 November
- [10] Treitz, P.M.,Howard, P. J.,and Gong, P., 1992,Application of satellite and GIS technologiesfor land-cover and land-use mapping at the rural-urban fringe: a case study. Photogrammetric Engineering and Remote Sensing, **58**, 439–448.
- [11] Weng,Q., 2001, A remote sensing–GIS evaluation of urban expansion and its impact on surface temperature in the Zhujiang Delta, China. International Journal of Remote Sensing, vol. 22, no. 10, pp: 1999.