1. Introduction

Land cover (LC) change is one of the most significant and effectively discernible pointers of progress in biological system administrations and vocation emotionally supportive networks. Financial drivers can actuate changes in LC that may disturb social and cultural practices and the organizations related with overseeing normal assets, which thus expands individuals’ weakness to environmental change (Gilani et al., 2014). Urban communities are dynamic; this is on the grounds that change is unavoidable. These progressions can be credited to one factor or the other relying upon financial, political and climatic state of a given territory. In any case, one basic factor behind city change both as far as size and example continues as before for most urban communities, for example “population development”. All things considered, different elements crediting to Land Use Land Cover (LULC) change are straightforwardly or in a roundabout way reliant on population upliftment (Kafi, Shafri & Shariff, 2014). Land use and land cover change has become a focal segment in current methodologies for overseeing normal assets and checking ecological changes. Survey the Earth from space is currently pivotal to comprehend man’s exercises on his common asset base after some time. In circumstances of quick and frequently unrecorded land use change, perceptions of the Earth from space give target data of human usage of the scene. Over the previous years, information from the Earth detecting satellites have gotten crucial in mapping the Earth’s highlights and frameworks, overseeing characteristic assets and contemplating natural change (Kaul & Sopan, 2012).

Land use rehearses for the most part create over a significant stretch of time under various ecological, political, segment, and financial conditions. These conditions frequently fluctuate and directly affect land use/land cover. To all the more likely comprehend the effect of land use change on earthly biological systems, the components influencing land use change must be completely analysed. Land use and land cover (LULC) changes have become a focal segment in current methodologies for overseeing common assets and observing ecological changes (Muttitanon & Tripathi, 2008).
Escalation of agricultural exercises is the rule purpose behind land use land cover change (LULC) especially in tropical areas (Geist & Lambin, 2002). Fundamental reasons for LULC changes prompting deforestation and land corruption incorporate fast monetary turn of events, population development and needness (Porter-Bolland et al., 2011).

Tripura is located in the north eastern part of India (23.9408° N, 91.9882° E). It is flanked toward the north, west, and south by Bangladesh, toward the east by the territory of Mizoram, and toward the upper east by the province of Assam. It is among the littlest of India's states and is situated in a confined bumpy area of the nation, with different indigenous individuals or clans representing a huge bit of the populace. The State capital is Agartala, close to the Bangladesh outskirt in the north western piece of the state. The state covers a geographical area of 4,049 square miles (10,486 square km) and is home to a population of 3,671,032 people as per 2011 census data.

Tripura is one of the eight sisters among the Northeastern states of India which belongs to the rich biodiversity hotspot zone of India. However, major influx of population from neighbouring Bangladesh (erstwhile East Pakistan), before and after independence, created major change in land use/land cover pattern of this State in general. Natural forests were converted to build up areas and agricultural lands (Debnath, Das, Ahmed & Bhowmik, 2017).

Shifting Cultivation or cut and consume agriculture practices (privately called as Jhum) is the primary type of agriculture in the hilly regions (privately called as Tilla) of Tripura in the north-eastern area of India by the indigenous individuals. Jhum agriculture practices begins with cutting and consuming of trees and prompts debasement of woods or deforestation in the uneven zones where they utilized the land to do jhum. Deforestation effects nature negatively which eventually prompts environmental change which these days a matter of worldwide concern and numerous universal, national and territorial level offices are chipping away at it. Deforestation may likewise influence the greenery which is existing in the forests (Longkumer, Raj & Solanki, 2019).

3. Study Area

Tripura, province of India. It is situated in the north eastern part of the subcontinent (23.9408° N, 91.9882° E). It is circumscribed toward the north, west, and south by Bangladesh, toward the east by the territory of Mizoram, and towards northeast by the province of Assam. It is among the littlest of India’s states and is situated in a segregated hilly area of the nation, with different indigenous people groups or clans representing a noteworthy bit of the population. The capital is Agartala, close to the Bangladesh outskirt in the north western part of the state. Area 4,049 square miles (10,486 square km). Population (2011) 3,671,032.

Table 1: Tripura Land Use

| Sl. No | Land Use Pattern | Area (mha) |
|-------|-----------------|------------|
| 1     | Geographical area | 1.05       |
| 2     | Land utilisation | 1.05       |
| 3     | Biomass producing area | 0.92 |
| 4     | Non-Biomass producing area | 0.13 |
| 5     | Biomass producing common land/Forest area | 0.61 |
| 6     | Biomass producing Private land | 0.31 |
| 7     | Percentage of Biomass producing common land | 58.09% |
| 8     | Percentage of Biomass producing land | 87.62% |

Source: (ENVIS, 2013)  *mha- million hectare
3. Changing Land-Use of Tripura

The land-use of Tripura has undergone quite interesting changes in the last 22 years from 1995 to 2017. On one hand, there has been an increase in the forested area in the State, the area under culturable wasteland, on the other hand, has also increased greatly especially due to the shortening of the *jhum cycle* which has been reduced to 2-3 years from previously 20-30 years (Das & Das, 2014).

The area put to non-agricultural use was 134500 hectares in 1995-96 which had increased to 147413 hectares in 2016-17, thereby, registering a growth rate of 9.6 per cent and adding a total area of 12913 hectares during a period of 21 years. The area under permanent pastures and other grazing lands had greatly reduced over a period of time. The area under this land use was 3737 hectares in 2006-07 (the data is unavailable prior to this point), which fell down to 944 hectares in 2016-17, thereby, registering a decline of 2793 hectares and negative growth rate of 74.74 per cent. Similarly, there has been a substantial decline of 15475 hectares in the land under miscellaneous tree crops and groves not included in net sown area over the period 1995-96 to 2016-2017 displaying a negative growth rate of -59.52 per cent. On the other hand, the area under cultivable waste land had an exponential growth of 328.48 per cent where the area increased from 660 hectares in 1995-96 to 2878 hectares in 2016-17. Although the total increase in the area under this land use had been 2218 hectares, there had been fluctuation in area in between years as the area had increased to 3777 hectares in 2006-07. After recording a decline of 437 hectares in 2007-08 and no change in 2008-09, it again increased by 389 hectares in 2009-10. However, there has been a constant decline in the area under this land use after 2009-10. Overall, the combined land under permanent pastures & grazing lands, miscellaneous tree crops and groves and cultivable waste land had decreased from 26600 hectares in 1995-96 to 14347 hectares in 2016-17, recording a negative growth rate of 46.06 per cent (Table 2). The total fallow land in the state had decreased from 3901 hectares to 2493 hectares during 1995-96 to 2016-17. However, the area under this land use was as high as 5862 hectares during 2007-09 and remained fluctuating throughout the study period. Overall, the growth rate of total fallow land had been -36.09 per cent. Interestingly, while the area under fallow other than current fallow land had increased greatly, the area under current fallow land, on the other hand, had recorded enormous decrease during 1995-96 to 2016-17. The change in the area under fallow other than current fallow land and current fallow land for the study period had been (+) 895 hectares and (-) 2303 hectares, respectively, thus, displaying a growth rate of 127.86 per cent and -71.95 per cent for

![Location Map of Tripura](image_url)
fallow other than current fallow land and current fallow land, respectively (Table 2).

The total cultivated area in Tripura had shown a decline of -8.48 per cent as there has been a decrease in the area under this landuse by 23918 hectares during the study period. The net shown area had declined by 22510 hectares (-8.10 per cent) while the area sown more than once had increased by 38050 hectares (19.31 per cent) resulting into an increase of 15540 hectares in the total cropped area, thus, growing nominally by 3.27 per cent. The increase in area sown more than once had also improved the intensity of cropping in 2016-17 (192 per cent) by 12.28 per cent over 1995-96 figure (171 per cent, Table 2).

| Year       | Geographical area | Area under forest | Land not available for cultivation | Land put to non-agricultural use | Baren uncultivable land | Permanent pasture & other grazing land | Other un-cultivated land excluding Cultivable waste land | Fallow land | Total (7+8-9) | Fallow land other than current fallow | Current fallow | Total | Area sown more than once | Total cropped area | Cropping intensity (%) |
|------------|-------------------|-------------------|-----------------------------------|---------------------------------|------------------------|--------------------------------------|-----------------------------------------------|-------------|----------------|--------------------------------------|----------------|-------|--------------------------|---------------------|------------------|
| 1995-96    | 1049169           | 606168            | 134500                            | NA                              | NA                     | 26000                                | 660                                           | 26600       | 700             | 3201                                | 3901            | 278000 | 197000                   | 475000              | 171               |
| 1996-97    | 1049169           | 606168            | 134500                            | NA                              | NA                     | 27151                                | 660                                           | 27751       | 700             | 1050                                | 1750            | 280000 | 194000                   | 473000              | 170               |
| 1997-98    | 1049169           | 606168            | 134500                            | NA                              | NA                     | 27151                                | 660                                           | 27751       | 700             | 1050                                | 1750            | 280000 | 205000                   | 485000              | 173               |
| 1998-99    | 1049169           | 606168            | 134500                            | NA                              | NA                     | 25500                                | 660                                           | 26100       | 700             | 1701                                | 2401            | 281000 | 207000                   | 488000              | 174               |
| 1999-2000  | 1049169           | 606168            | 134500                            | NA                              | NA                     | 27151                                | 660                                           | 27751       | 700             | 1050                                | 1750            | 279000 | 208000                   | 479880              | 172               |
| 2006-07    | 1049169           | 606168            | 136754                            | 2000                            | 138754                 | 3737                                | 14238                                          | 3777        | 21752          | 1070                                | 3250            | 4320    | 255077                   | 448935              | 176               |
| 2007-08    | 1049169           | 606168            | 137320                            | 1843                            | 139163                 | 3252                                | 14214                                          | 3340        | 20806          | 2120                                | 3742            | 5862    | 253909                   | 445681              | 176               |
| 2008-09    | 1049169           | 606168            | 137409                            | 2000                            | 139409                 | 3737                                | 14238                                          | 3777        | 21752          | 1070                                | 3250            | 4320    | 255077                   | 448935              | 176               |
| 2009-2010  | 1049169           | 606168            | 131465                            | 8213                            | 139178                 | 2766                                | 14118                                          | 3729        | 20613          | 1759                                | 2607            | 4366    | 255511                   | 446703              | 175               |
| 2011-12    | 1049169           | 629426            | 143234                            | NA                              | 143234                 | 1889                                | 12758                                          | 3449        | 18096          | 1730                                | 1200            | 2930    | 255485                   | 472494              | 185               |
| 2012-13    | 1049169           | 629426            | 144440                            | NA                              | 144440                 | 1679                                | 12248                                          | 3070        | 16997          | 1712                                | 1380            | 3092    | 255213                   | 474368              | 186               |
| 2013-14    | 1049169           | 629426            | 145389                            | NA                              | 145389                 | 1345                                | 11695                                          | 3020        | 16060          | 1729                                | 1495            | 3224    | 255070                   | 474498              | 186               |
| 2014-15*   | 1049169           | 629426            | 146155                            | NA                              | 146155                 | 1130                                | 11213                                          | 3020        | 15363          | 1715                                | 1150            | 2865    | 255360                   | 478328              | 189               |
| 2015-16*   | 1049169           | 629426            | 146920                            | NA                              | 146920                 | 1077                                | 10684                                          | 2878        | 14639          | 1635                                | 1096            | 2731    | 255460                   | 478328              | 189               |
| 2016-17*   | 1049169           | 629426            | 147413                            | NA                              | 147413                 | 944                                 | 10525                                          | 2878        | 14347          | 1595                                | 898             | 2493    | 255490                   | 490540              | 192               |

Growth Rate (%)

| NA         | 3.84              | 9.6                             | NA                               | 9.6                             | -74.74                           | -59.52                                           | 328.48                          | -46.06              | 127.9                            | -71.95                       | -36.09                  | -8.10                     | 19.31                       | 3.27                             | 12.28             |

Source: Statistical Abstract of Tripura, 2014 (*Economic Review of Tripura, 2016-17).

North-east India is the home to largest forest cover in the country and exhibits the most pristine environment. A substantial portion of the Total Geographical Area (TGA) in the eight states of this region is under forest cover. The total forested area in north-east India has increased from 638879 km² in 1995 to 708273 km² in 2017, thereby recording an increase of 69394 km² with a growth rate of 10.86 per cent over a period of 22 years.

Tripura had witnessed a remarkable increase in the forest cover to the tune of 2188 km² over a span of 22 years. However, when analysed temporarily, this period can be divided into two parts – the period of increase in the forest area (1995-2005) followed by the period of decline in the forest cover (2005-2017). The forest cover, which was 5538 km² in 1995, increased to 8155 km² in 2005, leading to an increase of 2617 km² in forested
area whereas, it registered a constant decline in area since 2005. In 2017, the total area under forest cover was 7726 km², leading to a decline of 429 km² in forested area during 2005-2017. Despite of this, the state registered an overall growth rate of 39.51 per cent in forest cover during the period 1995-2017 which is highest among all the north-eastern states of India, followed by Assam, Meghalaya and Sikkim (Table 3). On the other hand, the states recording negative growth rate in forest cover are Nagaland, Arunachal Pradesh, Mizoram and Manipur which lost 1802 km², 1657 km², 390 km² and 212 km² of area, respectively during the same period.

Table 3: State-wise Forest Cover in North-East India (1995-2017) (Area in Km²).

| States/UTs          | 1995  | 1997  | 1999  | 2001  | 2003  | 2005  | 2007  | 2009  | 2011  | 2013  | 2015  | 2017  | Growth Rate (%) |
|---------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-----------------|
| Arunachal Pradesh   | 68621 | 68602 | 68847 | 68045 | 68019 | 67777 | 67353 | 67484 | 67410 | 67321 | 67248 | 66964 | -2.41           |
| Assam               | 24061 | 23824 | 23688 | 27714 | 27826 | 27645 | 27692 | 27692 | 27673 | 27671 | 27623 | 28105 | 16.81           |
| Manipur             | 17558 | 17418 | 17384 | 16926 | 17219 | 17086 | 17280 | 17280 | 17090 | 16990 | 16994 | 17346 | -1.21           |
| Meghalaya           | 15714 | 15657 | 15633 | 15584 | 16839 | 16988 | 17321 | 17321 | 17275 | 17288 | 17127 | 17146 | 9.11            |
| Mizoram             | 18576 | 18775 | 18338 | 17494 | 18430 | 18684 | 19240 | 19183 | 1917 | 19054 | 18748 | 18186 | -2.10           |
| Nagaland            | 14291 | 14221 | 14164 | 13345 | 13609 | 13719 | 13464 | 13464 | 13318 | 13044 | 12966 | 12489 | -12.61          |
| Sikkim              | 3127  | 3129  | 3118  | 3193  | 3262  | 3262  | 3357  | 3359  | 3359  | 3358  | 3357  | 3344  | 6.94            |
| Tripura             | 5538  | 5546  | 5745  | 7065  | 8093  | 8155  | 8073  | 7985  | 7977  | 7866  | 7811  | 7726  | 39.51           |
| India               | 638879| 633397| 637293| 675538| 67833 | 677088| 690899| 692394| 692029| 697898| 701673| 708273| 10.86           |

Source: Ministry of Environment and Forest, Govt. of India

As is well known, the north-eastern states of India have very thick forest cover occupying a substantial portion of the respective state area. Tripura has displayed a significant improvement in the percentage of the forest cover with respect to the Total Geographical Area (TGA) of the state. However, the analysis of the percentage of forest cover to the Total Geographical Area (TGA) during 1995-2017 revealed that the state of Tripura gained 20.87 per cent points of forest cover in this period although the maximum forest cover was recorded in 2005 from whereon the state lost 4.09 per cent points of forest cover in the next 12 years to reach 73.68 per cent of the total geographical area in 2017 (Table 4). Apart from Tripura, only three more states of north-eastern India witnessed an increase in forest cover in the same period, namely, Meghalaya (6.39 per cent points), Assam (5.15 per cent points) and Sikkim (3.06 per cent points). On the other hand, the most significant loss of forest cover was seen in the Nagaland followed by Arunachal Pradesh, Mizoram and Manipur which was 10.87 per cent points, 1.98 per cent points, 1.85 per cent points and 0.94 per cent points, respectively.

Table 4: State-wise Percentage of Forest Cover to Total Geographical Area in North-East India (1995-2017) (Area in Km²).

| States/UTs          | TGA   | 1995  | 1997  | 1999  | 2001  | 2003  | 2005  | 2007  | 2009  | 2011  | 2013  | 2015  | 2017  | Growth Rate (%) |
|---------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-----------------|
| Arunachal Pradesh   | 83743 | 81.94 | 81.92 | 82.21 | 81.25 | 81.22 | 80.93 | 80.43 | 80.58 | 80.50 | 80.39 | 80.30 | 79.96 |
| Assam               | 78438 | 30.68 | 30.37 | 30.20 | 35.33 | 35.48 | 35.24 | 35.30 | 35.30 | 35.28 | 35.28 | 35.22 | 35.83 |
| Manipur             | 22327 | 78.64 | 78.01 | 77.86 | 75.81 | 77.12 | 76.53 | 77.40 | 77.40 | 76.54 | 76.10 | 76.11 | 77.69 |
| Meghalaya           | 22429 | 70.06 | 69.81 | 69.70 | 69.48 | 75.08 | 75.74 | 77.23 | 77.23 | 77.02 | 77.08 | 76.76 | 76.45 |
| Mizoram             | 21081 | 88.12 | 89.06 | 86.99 | 82.98 | 87.42 | 88.63 | 91.27 | 91.00 | 90.68 | 90.38 | 88.93 | 86.27 |
| Nagaland            | 16579 | 86.20 | 85.78 | 85.43 | 80.49 | 82.09 | 82.75 | 81.21 | 81.21 | 80.33 | 78.68 | 78.21 | 75.33 |
| Sikkim              | 7096  | 44.07 | 44.10 | 43.94 | 45.00 | 45.97 | 45.97 | 47.31 | 47.34 | 47.34 | 47.32 | 47.31 | 47.13 |
| Tripura             | 10486 | 52.81 | 52.89 | 54.79 | 67.38 | 77.18 | 77.77 | 76.99 | 76.15 | 76.07 | 75.01 | 74.49 | 73.68 |

Source: Ministry of Environment and Forest, Govt. of India. (*TGA-Total Geographical Area)
The land use land cover changes directly related with the climate of Tripura as natural disaster like flash floods, landslides, heavy downpour etc are become a common issue for their people. In the year 1995 to 2014, the most extreme yearly temperature recorded as 39.4 degree centigrade and it has seen in the year 2014 where the greatest temperature recorded as 33 degree centigrade in the year 1997. The pattern esteem has watched the expanding pattern of yearly temperature and it has expanded to 37 degree centigrade from 32 degree centigrade. The pattern of yearly temperature which is expanding a seemingly endless amount of time after year and it isn’t the acceptable heading for future. The preparatory advances are to be taken in a matter of seconds by the peak authority with the end goal of controlling the pattern of expanding temperature (Bhowmik, 2019). In 2014 Tripura State Climate Change Cell was established under the Department of Science, Technology & Environment Government of Tripura.

4. Government Policies and Initiatives for Saving the Forest Cover

One of the most important and recent strategies adopted for Jhumia rehabilitation in Tripura is the raising of rubber plantations. The rubber plantation project was conceived to provide a lucrative alternative to Jhum cultivation. By the time of the 9th five-year plan, the raising of rubber plantation had become one of the main strategies for rehabilitation of Jhumias through the World Bank Aided India Rubber Project (Das, Choudhury & Roy, 2012).

Here the Central Government, Rubber Board and Bank had come together to aid the Tripura government to raise rubber plantations and development itself as the “Second Rubber Capital of India”.

A proposal to amend a land reforms act to keep rubber plantations out of tea estate land and prescribe a ceiling for land holding has generated a lot of heat with 1,184 people and 40 organisations, including indigenous people and political parties, filing objections to the draft bill. While the tea planters have opposed the amendment on the ground that it will vest in government the surplus or uncultivated land in the tea gardens, that they use profitably for cultivating rubber, the Indigenous Nationalist Party of Tripura (INPT) is worried that it will affect the land rights of the indigenous people. The genesis of the unrest, which has seen land use change over the years, lies in the 10th amendment of the Tripura Land revenue and Land reforms Act, 1960.

Conclusion

Problems relating to Shifting cultivation or slash and burn agriculture (locally called as Jhum) are not new in Tripura. As early as 1876, W.W. Hunter in his book, 'Statistical Account of the Hill Tipperah' had marked that the "regression of forests had already started in hills because of shifting cultivation practiced by almost the whole population numbering less than 50000 who were all tribals".

However, one can without much of a stretch comprehend that this training is pervasive for the most part because of absence of feasible elective business openings. Jhumias are innate individuals who work on shifting cultivation or jhumming. In Tripura more than 10,039 hectares of land is under jhum development 10 years prior. Throughout the years the jhum economy has experienced numerous changes-land accessible for jhumming has diminished; prompting a shortening of the jhum cycle and a fall in wages. For this it is suggested that government needs to provide for alternate source of income by extending MGNREGA opportunities along with continued emphasis on rubber plantation. Allowing the use of the empty stretches of tea estates to grow rubber plantations will not only augment the income of the tea estates especially the ones under financial burden but will also provide financial support to the tribal population.

Land use/land cover effects must be assessed thoroughly as part of all future temperature change assessments. This includes not only climate effects within the regions where land use/land cover occurs, but also their role in altering hemispheric and global atmospheric and ocean circulations at large distances from the placement of land use/land cover. We also conclude that a regional focus is far more appropriate so as to better understand the human effects on climate, including LULCC, it's the regional responses, not global average, that produce drought, floods, and other societally important climate impacts.

Suggestions

• Alternate Source of Income by extending MGNREGA opportunities.
• Continued emphasis on rubber plantation.
• Allowing the use of the empty stretches of tea estates to grow rubber plantations which will not only augment the income of the tea estates especially the ones under financial burden but will also provide financial support to the tribals.

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