Indian Forester, **149** (2) : 111-119, 2023
DOI: 10.36808/if/2023/v149i2/169708

ISSN: 0019-4816
eISSN: 2321-094X

Land Use Land Cover Change and Hotspot Identification of Upper Meghna River Basin, India

River basins always play a vital role in human habitation. Talking about land use cover, consideration of river basins is one of the most impotent aspects of land use study in terms of sustainable use of land resources. River Meghna is a transboundary river shared by India and Bangladesh. However, regarding the basin area of the river, a small portion of the basin also comes under Myanmar. The total geographical area of the basin is 82,000 Km^2 including 29 transboundary sub-basins. Hydrologically India shares a part of the Upper Meghna basin, habited by less than 10 million indigenous populations, spread over six northeastern states of India. It has been noticed that the topography of the region and the demographical structure together has a particular impact on the land use pattern of the region, where some land areas are undergoing periodically repeated land use change. The primary aim of the present study is to identify the hotspots of land use/cover change (LUCC) of the basin area based on the frequency of change in six (6) different time frames from 2005 to 2019 and further to assess the rate of land use/cover change (LUCC) of the region by calculating annual land use change rate (ALUCR) within the study period.

Key words: Land use, Land cover change, Transboundary river basin, Forest cover, Hotspot identification.

The periodic alteration between agricultural land and forest cover is the prominent driver, making the Barak and Tripura catchments of the Meghna river basin extremely susceptible to a high concentration of hotspot of land use land cover change.

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Received November, 2022
Accepted January, 2023

Introduction

It is beyond doubt that human activities have modified the natural environment considerably (Goldewijk, 2001). Land use/ Land cover change (LUCC) is one of the primarily expected circumstances of human activities on land cover. It is a very basic as well as most widely studied anthropogenic phenomenon that correlates with geoscience, environmental science as well as social sciences. A change in land use is one of the nine "planetary boundaries", and humanity may soon approach the boundary that jeopardizes the safe operating space of humanity with respect to the earth system process (Rockström *et al*., 2009; Duraisomy *et al*., 2018). It is the major underlying cause of global environmental change (Sala, 2000; Duraisamy *et al*., 2018). It has been noticed that nowadays it becomes clear that during the last centuries, the intensity and scale of these modifications have increased significantly (Watson *et al*., 1996; Goldewijk, 2001). About three-quarters of the Earth's land surface has been altered by humans within the last millennium (Luyssaert *et al*., 2014; Arneth *et al*., 2019; Winkler *et al*., 2021). According to FAO (Food and Agriculture Organization, UN) 2001 report, during the period of 1990s the world forest covers were converted to other land uses at a rate of 0.38 per cent per year. About 17 per cent of the earth's land surface has changed at least once between six (major) land categories from 1060 to 2019, summing up all of the individual change events (including areas of multiple changes), the total land change extent is 43 million sq. kilometres (Winkler *et al*., 2021).

These changes are more dominant and noticeable in developing countries, which are undergoing rapid urbanization. Thus, land use/cover changes (LUCC) are the most common phenomenon in different regions of the world including South East Asia (Vadrevu and Ohara, 2020).

INDIAN FORESTER

Monitoring land use/ cover change has become an impotent them of research due to the extent to which these changes influence the global fluid system; the atmosphere, world climate, and sea level (Asubonteng, 2007). LUCC, therefore, has been a heated topic in geoscience (Li, 1996; Li *et al*., 2017). It is also a core subject co-supported by the international geosphere biosphere program (IGBP) and the international human dimensions program (IHDP) (Li *et al*., 2017). This paper attempts to identify the hotspots of land use/cover change during the last two decades of the Upper Meghna River basin and evaluate the annual land use change rate within a time frame of 5 years.

Study Area

Neighbours India and Bangladesh share a largely cordial relationship (Thakur, 2020). Both countries share 54 transboundary sub-basins and all of them are part of the drainage system of the Ganga Brahmaputra Meghna (GBM) Basin. Among those 29 transboundary sub-basins come under the Meghna River basin. Meghna River is formed due to the joining of the river Surma and river Kushiyara; together it is known as the Barak River, in India. Thus, the river often is called; the Brak-Meghna River. It originates in the hilly region of eastern India. Till Chandrapur (Bangladesh), the hydrological term of the river is Upper Meghna. At

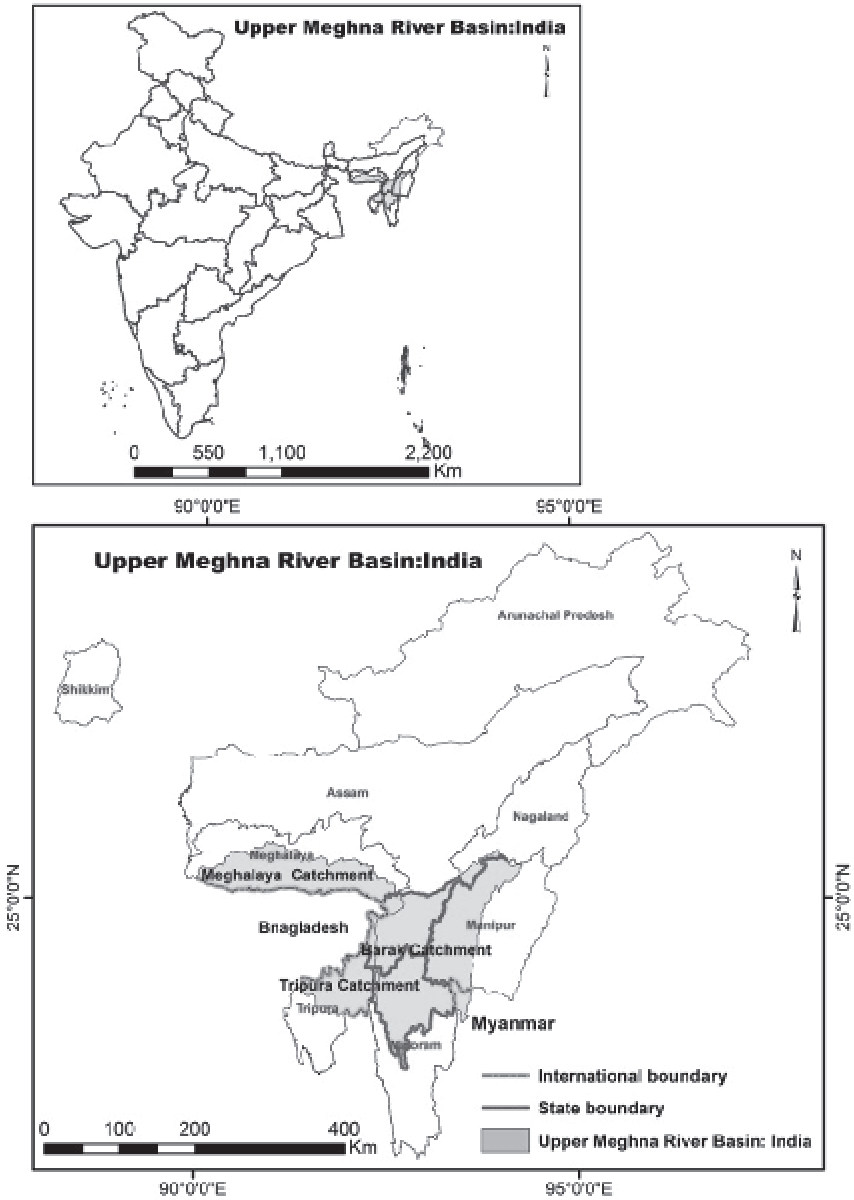

Fig 1: Upper Meghna basin, India

Chandrapur, it joins with the Padma River and it is known as Lower Meghna till its mouth. Thus, the basin area falls under Indian Territory and is a part of the Upper Meghna River basin. Traditionally negotiation between the countries regarding Meghna has focused on sharing water only.

According to IUCN 2018 report, despite its transboundary nature, the biodiversity and livelihood significance of the Meghna River Basin is one of the less discussed basins, when it comes to discourse on transboundary water governance between India and Bangladesh. Here the basin is not only shared by India and Bangladesh but also a very small proportion comes under Myanmar too. As per previous records, the total area covered by the Meghna basin is 82,000 km^2 of which 47,000 km^2 (57%) of the area comes under the Indo-Myanmar part. However, the study confirms that by combining India and Myanmar the basin covers an area of approximately about 43,961.57 km^2. The basin includes six (6) North East Indian states (Assam, Meghalaya, Manipur, Tripura, Nagaland and Mizoram) and the northeast corner of Myanmar as well (Fig. 1). This part of the Meghna basin is subdivided into three (3) catchments; Barak catchment, Tripura catchment and Meghalaya catchment. Geographically the basin lies between 26°00' N and 23°05' N latitude and 90°00' E and 94°05' E longitude.

Methodology

Identification of hotspots using satellite data is one of the effective methodological approaches in terms of land use /cover change (LUCC) study and research. It is an important research method to discover the active regions of regional development (Yu *et al*., 2016; Li *et al*., 2017). The methodology can identify and highlight the regions that under rapid and frequent land use changes and land cover becomes at high risk of losing their original biodiversity. Over the last three decades, the availability of global satellite data products has aided in the development of spatially explicit global and regional land cover databases at various spatial resolutions (Grekousis *et al*., 2015). However, it is considered that each satellite data with a certain spatial resolution has its limitation in terms of image interpretation and mapping as well. The hotspot identification for the present study is based on the frequency of land use/cover changes in six different periods; 2005-2010, 2005-2015, 2005-2019, 2010-2015, 2010-2019 and 2015-2019 (Table 1). The study has used Landsat data, with 30 m. of spatial resolution for the hotspot assessment.

Each image was projected to Universal Transverse Mercator projection, with spheroid and datum as WGS 84, Zone 46 North projection parameters. Visual image interpretation technic has been used for the initial assessment of land use/cover change with a minimum

Table 1: List of selected landsat images of the study area, India

Sl. No	Year	Satellite	Sensor	Path	Row	Image acquisition Date
1	**2005**	LT5	TM	135	42	10-Feb-05
2		LT5	TM	135	43	1-Mar-06
3		LT5	TM	135	44	16-Jan-05
4		LT5	TM	136	42	8-Mar-06
5		LT5	TM	136	43	13-Apr-05
6		LT5	TM	136	44	17-Mar-06
7		LT5	TM	137	42	1-Mar-06
8		LT5	TM	137	43	16-Feb-05
9		LT5	TM	138	42	27-Feb-05
1	**2010 and 2015**	LT7	ETM+	135	42	8-Feb-10 & 30-Jan-15
2		LT7	ETM+	135	43	27-Feb-09 & 23-Mar-15
3		LT7	ETM+	135	44	30-Jan-10 & 11-Apr-15
4		LT7	ETM+	136	42	6-Mar-10 & 21-Feb-14
5		LT7	ETM+	136	43	21-Jan-10 & 9 Mar-15
6		LT7	ETM+	136	44	23-Mar-09 & 17-Mar-15
7		LT7	ETM+	137	42	7-Mar-09 & 11-Mar-15
8		LT7	ETM+	137	43	17-Apr-08 & 17-Mar-15
9		LT7	ETM+	138	42	27-Feb-11 & 24-Mar-15
1	**2019**	LS8	OLI/TIRS	135	42	16-Jan-19
2		LS8	OLI/TIRS	135	43	2-Mar-18
3		LS8	OLI/TIRS	135	44	17-Mar-19
4		LS8	OLI/TIRS	136	42	9-Mar-18
5		LS8	OLI/TIRS	136	43	3-Mar-19
6		LS8	OLI/TIRS	136	44	9-Feb-18
7		LS8	OLI/TIRS	137	42	17-Mar-19
8		LS8	OLI/TIRS	137	43	3-Feb-19
9		LS8	OLI/TIRS	138	42	9-Mar-18

mapping unit (MMU) of 0.8 ha. To quantify the hotspots, the Gi* statistic was computed which is a measure of the degree of spatial clustering of a local sample and how it is different from the expected value. It is calculated as the sum of the difference between values in the local sample and the mean and is standardized as a 'z' score. For statistically significant positive z-score, the larger the z-score is the more intense clustering of high values for hotspot identification. For statistically significant negative z-scores, the smaller the z-score is, the more intense the clustering of low values (cold spot). The Gi* statistic is a two-tailed statistical experiment, where positive values of Gi* represent clusters that are, on average, greater than the mean (Hotspots), the negative values represent clusters that are less than the mean (Cold spots) (Getis and Ord, 1992; Ord and Getis, 1995). It represents the frequency of detection as a hotspot relative to the number of inputs covered in the area. The following equation is used for the calculation of Getis-Ord Gi;

$$G_i^* = \frac{\sum_{j=1}^{n} w_{i,j} x_j - \bar{X} \sum_{j=1}^{n} w_{i,j}}{S\sqrt{\frac{\left[n \sum_{j=1}^{n} w_{i,j}^2 - \left(\sum_{j=1}^{n} w_{i,j}\right)^2\right]}{n-1}}}$$

$$X = \frac{\sum_{j=1}^{n} x_j}{n} \quad [1]$$

$$S = \sqrt{\frac{\sum_{j=1}^{n} x_j^2}{n} - (\bar{X})^2}$$

Where, Xj is the attribute value for feature j, Wi,j is the spatial weight between feature i and j, and n is equal to the total number of features. The Gi* statistic is a z-score so no further calculations are required

An Annual Land Use Change Rate (ALUCR), of susceptible and frequently changing land use patterns was calculated for a better understanding of the change ratio. Annual Land Use Change Rate (ALUCR) (Tian *et al*., 2014; Guite and Bora, 2018) defines as is calculated in per cent per year;

$$ALUCRa,t = \frac{(LUa,t - LUa,t-1) / LUa,t-1}{Nt - Nt-1} * 100 \quad [2]$$

Where t is the current year and time t - 1 is the former year LUa, t and Lua t-1 are the total land area of one land use class in square kilometres at two different times, N is the total number of years (time frame) from time t (current year) to time t -1 (former year).

Results and Discussion

The land use/cover classes of the basin area are primarily classified as; aquaculture, cropland, forest cover, grassland, orchard and other Plantation, other Land, Settlement, wetland and river.

Total 11631 numbers of grids (2 km x 2 km) have been created using a fishnet to cover the entire part of the Upper Meghna River Basin of India for hotspot analysis. The study shows a total number of 1705 grids indicating hotspots covering an area of about 658861 ha. The grids those are falling within 99% level confidence have a 0.01 significant level, where P Value = 0.004998 and Z score ± 2.576. Further, the grids those are falling within 95% confidence have a 0.05 significant level, where P Value = 0.024998 and Z score ± 1.960. Both are considered to be statistically significant hotspots. Superimposing the locations of the villages it has to find out about 826 hamlets/villages fall within the identified hotspot areas.

A total of 20 hotspot patches were identified within the study area *i.e.*, shown in Fig. 2. The administrative locations of hotspots represent 15 districts of India comprising 34 administrative blocks and 826 villages.

Table 2 is representing the confidence level of the hotspots and the total number of hotspot grids and the geographical area within each level. Regarding the significance of hotspots, it has been noticed that the hotspot patches are mostly concentrated in the Barak and Tripura catchments of the Indian part of the basin. Whereas in the Meghalaya catchment, the presence of hotspots is almost negligible. In order to understand this significant concentration of hotspots the catchment-wise land use change has been analysed. In the Barak catchment, the most frequent changes are identified regarding forests, orchards and other plantation and cropland. Calculating the annual land use change rate of cropland, it is found that between the years 2005 to 2010, it was 2.36% per year. From 2010 to 2015 it was 2.43% per year and from the year 2015 to 2019 it is 5.36% per year. On the other hand, in terms of forest cover the annual land use change rate between the years 2005 to 2010 was 2.87% per year. From the year 2010 to 2015 the estimated rate of change was 0.34% per year and from the year 2015 to 2019 it is 0.73% per year. Concerning orchards and other plantations it is estimated as, from 2005 to 2010 it was 1.25% per year, from 2010 to 2015 it was 0.27% per year and from 2010 to 2019 it was 0.25% per year. It has been observed that these changes in forest cover and cropland are due to the prevailing practice of "Jhum" or shifting cultivation in hilly states like Manipur and Mizoram. Here it is important to note that "Jhum" or shifting cultivation is a typical agricultural practice that connects cropland and forest land, where both the land use classes show a pattern of indirect proportion to each other. Districts such as; Churachandpur of Manipur and Champhai and Aizawl of Mizoram show a strong presence of shifting agriculture. In 2005 and 2019 there are some fresh and new land patches of "Jhum" were identified. Whereas in 2010 and 2015 rejuvenation of some old Jhum land patches can be seen.

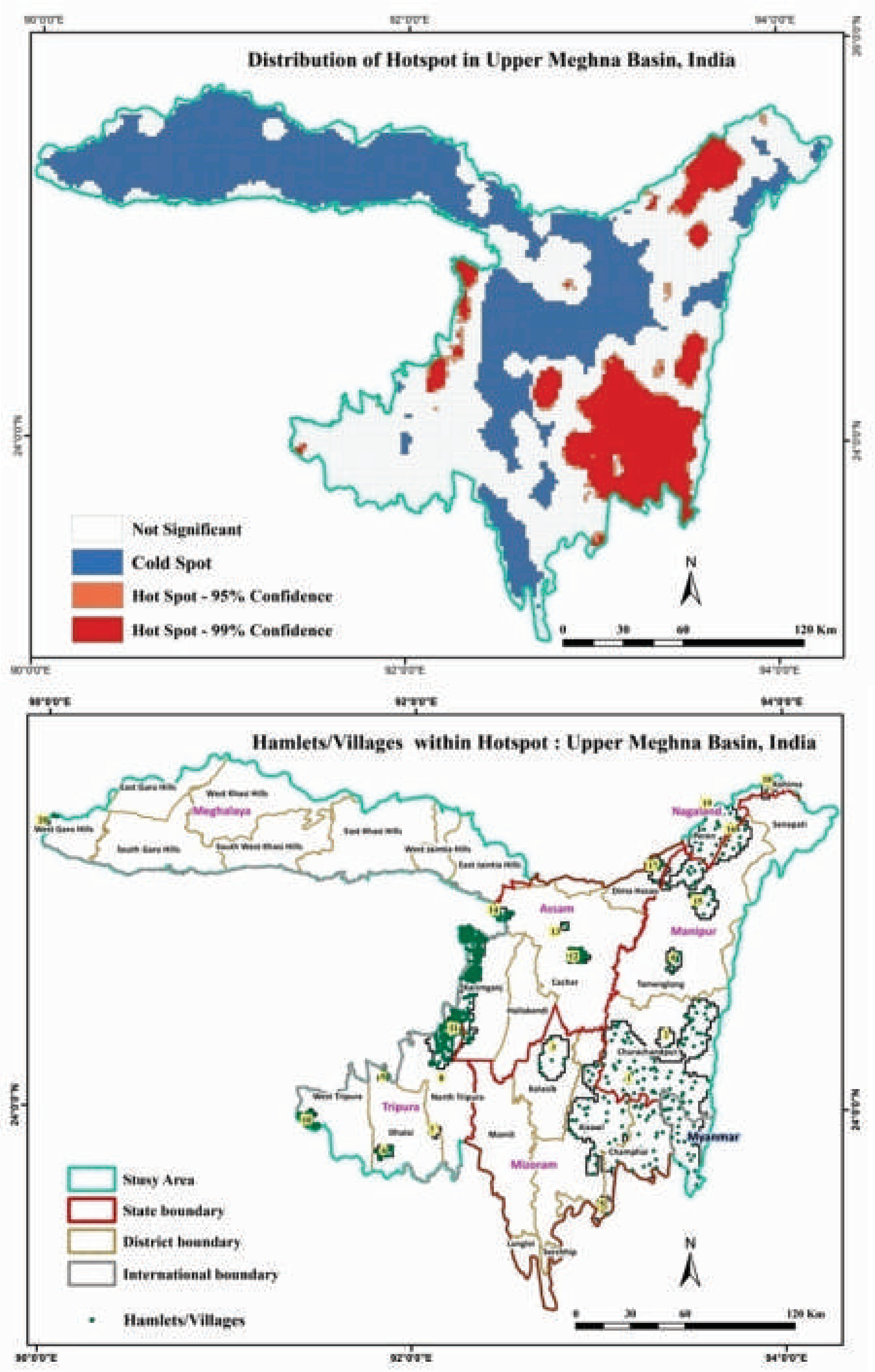

Fig 2 : Hotspots, Upper Meghna basin, India

Table 2 : The confidence level of Hotspots and area coverage in hectors: Upper Meghna River basin, India

Sl No	Total hotspots (Grid)	Area (ha)	Confidence level
1	1487	576175	99%
2	218	82686	95%
Total	**1705**	**658861 ha.**	

INDIAN FORESTER

Table 3 : Area statistics of LUCC: Barak catchment, Upper Meghna Basin, India. (+ is representing an increase & - is representing a decrease).

Land use Land cover Classes	2005	2010	Change 05_10	2015	Change 10_15	2019	Change 15_19
	Area in ha	Area in ha	Area in ha	Area in ha	Area in ha	Area in ha	Area in ha
Aquaculture	1170	1205	+35	1205	0	1183	-22
Cropland	351141	310272	-40869	347324	-37052	273990	-73334
Forestland	2145765	2181617	+35852	2144721	-36896	2208034	+63313
Grassland	0	0	0	258	258	0	-258
Orchard and other Plantation	49128	52210	+3082	51499	-712	52012	+513
Other Land	239	256	+17	256	0	244	-12
Settlement	50748	50761	+13	51247	+486	57587	+6340
Wetland	428	2297	+1870	2370	+72	6123	+3753
River	8780	8780	0	8519	-261	8227	-292
Grand Total	**2607399**	**2607399**		**2607399**		**2607399**	

Table 4 : Area statistics of LUCC: Tripura catchment, Upper Meghna Basin, India. (+ is representing an increase & - is representing a decrease).

Land use Land cover classes	2005	2010	Change 05_10	2015	Change 10_15	2019	Change 15_19
	Area in ha	Area in ha	Area in ha	Area in ha	Area in ha	Area in ha	Area in ha
Aquaculture	6	6	0	6	0	6	0
Cropland	74135	74193	+58	74219	+26	74391	+171
Forestland	983770	983596	-174	983106	-490	982704	-402
Grassland	12954	12805	-149	12805	0	12801	-5
Extraction or Mining site	221	329	+108	421	+92	509	+88
Other Land	32892	32860	-32	32853	-7	32852	-1
Settlements	39505	39707	+202	40115	+409	40231	+116
Wetlands	22139	22126	-13	22096	-30	22128	+32
River	4030	4030	0	4030	0	4030	0
Grand Total	**1169652**	**1169652**		**1169652**		**1169652**	

In Tripura Catchment similar scenario has been noticed in terms of cropland and forest cover. These frequent changes regarding forest and cropland are identified, indicating the practices of "Jhum" or shifting cultivation. In terms of change in forest cover the annual land use change rate for the year 2005 to 2010 was 0.14% per year. From 2010 to 2015 it was 0.48% per year and from the year 2015 to 2019 it is 0.68% per year. In terms of crop land annual land use change rate for the years 2005 to 2010, was 0.78% per year. From 2010 to 2015 it was 0.79% per year and from the year 2015 to 2019 the estimated rate of change is 0.15% per year. However, in the Tripura catchment, the most notable change has been identified in terms of the settlement. The annual land use change rate of settlement for the year 2005 to 2010 was 0.13% per year. From 2010 to 2015 it was 7.77% per year and from 2015 to 2019 it is 7.25% per year. There is a significant expansion of settlement / built-up spotted during the periods 2010 to 2015 and 2015 to 2019 in the Karimganj district of Assam and the North Tripura district of Tripura.

In Meghalaya Catchment there is no frequent fluctuation can be seen. The catchment is very much stable regarding all the classified classes. However, in terms of forest cover, the annual land use change rate between the years 2005 to 2010 was .003% per year. From the year 2010 to 2015 the estimated rate of change was 0 .009% per year and from the year 2015 to 2019 it is 0.01% per year. In terms of crop land annual land use change rate between the years 2005 to 2010, was 0.02% per year. From 2010 to 2015 it was 0.007% per year and from the year 2015 to 2019 it is 0.06% per year. On the other hand, the annual land use change rate of settlement for the year 2005 to 2010 was 0.01% per year. From 2010 to 2015 it was 0.21% per year and from 2015 to 2019 it is 0.07% per year.

Tables 3, 4 and 5 shows the periodic net change of land use/cover change between the year 2005 to 2019, of the Barak catchment, Tripura catchment and Meghalaya catchment accordingly.

Figure 3, represents the land use change in Meghna Basin India, for six different periods. Here changes in land use classes mostly concentrated in some particular areas are visible. These changes are occurring every period primarily due to indigenous

Table 5 : Area statistics of LUCC: Meghalaya catchment Upper Meghna Basin, India. (+ is representing an increase & - is representing a decrease)

Land use Land cover classes	2005	2010	Change 05_10	2015	Change 10_15	2019	Change 15_19
	Area in ha	Area in ha	Area in ha	Area in ha	Area in ha	Area in ha	Area in ha
Aquaculture	1	1	0	1	0	1	0
Cropland	87780	84329	-3451	80960	-3369	78258	-2702
Forestland	464091	467407	+3316	456121	-11286	443539	-12582
Grassland	35	24	-11	24	0	136	+112
Extraction or Mining site	802	806	+5	806	0	806	0
Other Land	20625	20622	-3	20622	0	20622	0
Settlements	840	825	-15	825	0	825	0
Wetlands	37426	37661	+235	52308	+14648	67469	+15161
River	6509	6433	-76	6440	+8	6451	+11
	997	997	0	997	0	997	0
Grand Total	**619105**	**619105**		**619105**		**619105**	

practices and also the expansion of settlement. This human involvement accelerates the frequency as well as the rate of change rather than changes due to natural events or progression.

Quantifying the nature of land use/cover change (LUCC) and finding out the pattern of these changes are always two important aspects of the land cover study.

The study of this part of the Upper Meghna River Basin represents the dynamic nature of land use/cover, where all classes of land use/cover are not following a single pattern of change. The most frequent changes that have been identified are forest cover and cropland which often primarily represents an inversely proportional relationship between them. It is so obvious that the expansion of cropland always severely affects the forest

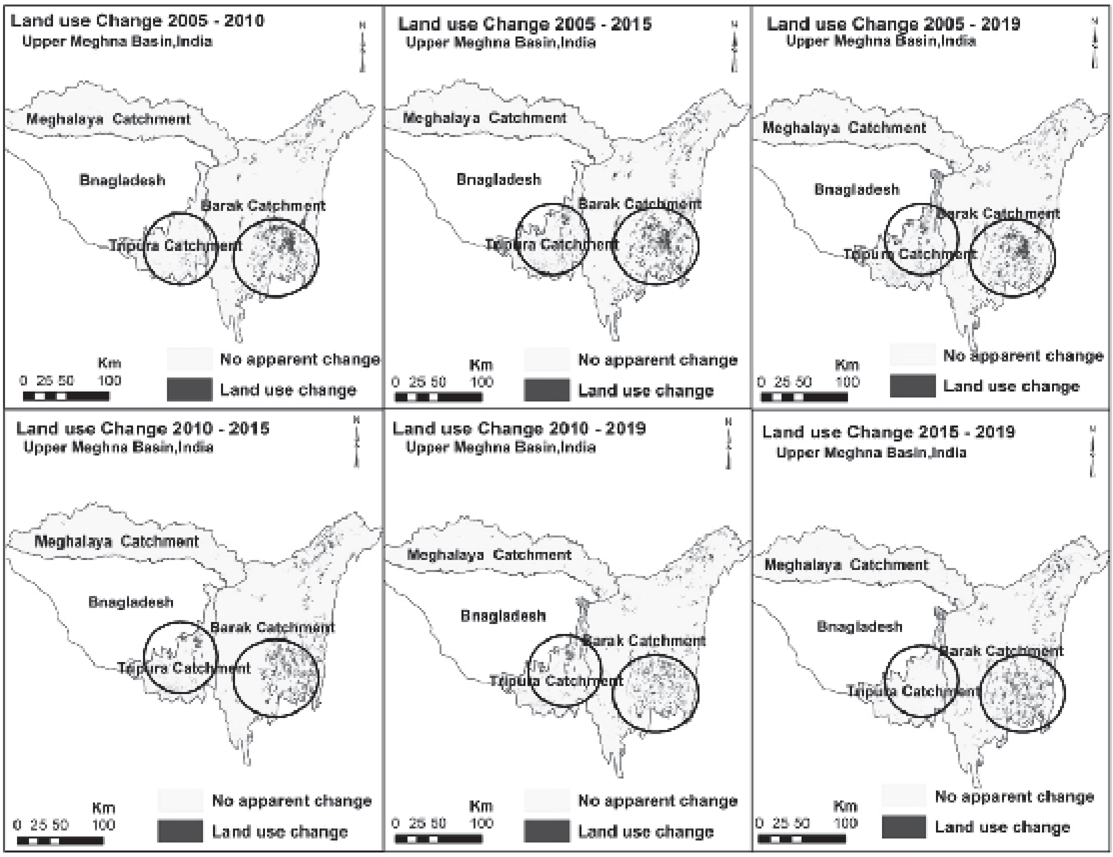

Fig. 3 : Land use/cover change, Upper Meghna Basin; India

cover. Regarding global data, a global net loss of forest area is 0.8 million km^2 per year whereas expansion of global agriculture *(i.e.* cropland and pasture/rangeland) is 0.9 to 1.0 million km^2 per year from 1960 to 2019 (Winkler *et al*., 2021). Here the peculiarity is due to its hilly topography this part of the Upper Meghna River Basin the land use/cover changes (LUCC) in terms of forest cover and cropland are highly fluctuating and more likely non-predictable as well, mostly within the Barak and Meghalaya catchments. The statistical analysis of the land use/cover change represents, that cropland in the Barak catchment, is showing a decreasing trend, during the study period, whereas in terms of forest cover Barak catchment showed fluctuation as; it increased between the years 2005 to 2010 by 35852 ha, and then it decreased during 2010 to 2015 by 36896 ha. But again it increased between the years 2015 to 2019 by 63313 ha. Moreover, another fluctuation also has been observed concerning orchards and other plantation land use classes within this catchment. Between the years 2005 to 2010, it increased by 3082 ha, from 2010 to 2015 it decreased by 712 ha and from 2015 to 2019 it increased by 513 ha. In the Meghalaya catchment; the cropland is following a decreasing trend, and on the flip side the forest cover is fluctuating. It increased by 3316 ha between the years 2005 to 2010, then it decreased by 11286 ha between the years 2010 to 2015 and further, it again decreased by 12582 ha between the years 2015 to 2019. A similar pattern is also spotted in Umtrew Basin in Meghalaya state by Sharma *et al*., in 2011. However, the land uses class orchards and the other plantation is very much stagnant within this catchment.

On the other hand, due to the plain topography of the mainland, in the Tripura catchment, there is an increasing trend regarding cropland whereas forest cover is showing a constantly decreasing trend during the study period. In terms of settlement, it has been spotted that it is expanding within all three catchments, among them Tripura catchment is showing the highest expansion of settlement. In context to other parts of the region Sarma *et al*. (2016) stated that in the Garo Hills region of Meghalaya state between the study period 1991 to 2013, the dense and open forest cover followed a declining trend. On the other side, the agricultural land and built-up followed an increasing trend. Deka *et al*. (2019) studied the land use land cover change dynamics in Eastern Arunachal Pradesh and stated that between the study period from 1985 to 2005, the region experienced expansion of cropland and built-up area and a decline in forest cover, showing similarities with the Tripura catchment. Ritse *et al*. (2020) also stated that regarding Nagaland, between the study period 1998 to 2018, Kohima and Dimapur these two districts of the state experienced a significant increase in built-up. On the other hand, forest and agricultural land both declined. Regarding the entire North East India, Jamir (2015) assessed the land use land cover changes over of North East region based on the Forest Survey of India annual reports and observed that the annual forest cover was significantly decreasing at Nagaland and Manipur while the increasing trend is reported at other six states.

The land use land cover change is always area specific and is controlled by the existing land utilization pattern and activities of the region. It has been observed that in most cases shifting cultivation, cash crop plantation and expansion of the built-up area are the prominent drivers of land use land cover change within the region. The growing population and the demand for economic growth are making land more vulnerable to change. It is true that the region needs growth, however frequent LUCC can also make land extremely susceptible to soil erosion and less productive.

Conclusion

LUCC and hotspot analysis generally allows the identification of local areas with a high concentration of a phenomenon within a landscape (Asubonteng, 2007). In terms of land use land cover, hotspot analysis is mostly applied to statistically identify the areas experiencing frequent alteration of land use. Scholars usually segregate these changes as negative or positive changes in LUCC. Duraisamy *et al*., 2018 identified a total of 9 hotspots of land use land cover change in the Mula-Pravara basin *i.e.*, belongs to the semi-arid region of India. The study mentioned that out of the 9 hotspots, 4 show negative change and the rest 5 show positive change. The major changes that had occurred related to agricultural land, showed positive and negative changes. Within this part of the Meghna basin, it is noticeable that though cropland is showing a decreasing trend within Barak and Meghalaya catchments, there is a high probability that the dynamics between forest and cropland are not only inverse but also can occur with high fluctuation and not following a single trend. It has also been observed that in hilly regions LUCC, alteration of a land cover mostly occurs and is often visible in terms of agricultural land, forest area/natural vegetation. However, the changes can be either positive or negative and not follow any specific trend of change at all.

भूमि उपयोग भूमिआवरण परिवर्तन और हॉटस्पॉट की पहचान, ऊपरी मेघना नदी बेसिन, भारत

अमृती बोरा, देवेश वालिया और बी.एस. मिपुन

सारांश

नदी घाटियाँ हमेशा मानव आवास में एक महत्वपूर्ण भूमिका निभाती हैं। भूमि उपयोग/आवरण की बात करें तो नदी घाटियों का क्षेत्र भूमि उपयोग अध्ययन के संदर्भ में सबसे महत्वपूर्ण पहलुओं में से एक है, भूमि संसाधनों का सतत् उपयोग। मेघना नदी भारत और बांग्लादेश के बीच साझा की जाने वाली एक ट्रांसबाउंड्री नदी है। हालाँकि, नदी के बेसिन क्षेत्र के संबंध में, बेसिन का एक छोटा सा हिस्सा भी म्यांमार के अंतर्गत आता है। बेसिन का कुल भौगोलिक क्षेत्रफल 82,000 वर्ग किलोमीटर है जिसमें 29 अंतर्राष्ट्रीय सीमाओं के बीच साझा सब-बेसिन शामिल हैं। हाइड्रोलॉजिकल रूप से भारत ऊपरी मेघना बेसिन का एक हिस्सा साझा करता है, जिसमें 10 मिलियन से भी कम स्वदेशी आबादी रहती है जो कि भारत के छह पूर्वोत्तर

राज्य में फैली हुई है। यह देखा गया है कि क्षेत्र की स्थलाकृति और जनसांख्यिकी संरचना का एक साथ क्षेत्र के भूमि उपयोग पैटर्न पर विशेष प्रभाव पड़ता है, जहाँ कुछ भूमि क्षेत्र समय-समय पर भूमि उपयोग परिवर्तन के दौर से गुजर रहे हैं। वर्तमान अध्ययन का प्राथमिक उद्देश्य बेसिन के भूमि उपयोग/आवरण परिवर्तन (LUCC) के हॉटस्पॉट की पहचान करना है। 2005 से 2019 तक छह (6) विभिन्न समय-सीमाओं में परिवर्तन की आवृत्ति के आधार पर क्षेत्र और आगे वार्षिक गणना करके क्षेत्र के भूमि उपयोग/कवर परिवर्तन (LUCC) की दर का आंकलन करने के लिए अध्ययन अवधि के भीतर भूमि उपयोग परिवर्तन दर (ALUCR) है।

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Acknowledgement

The present study is a part of IUCN funded project "Meghna basin land use change analysis and atlas development" jointly accomplished by India and Bangladesh in 2020. The Authors highly acknowledge IUCN, for providing necessary guidance and support throughout the study period.