Eco. Env. & Cons. 28 (January Suppl. Issue) : 2022; pp. (S311-S318)
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ISSN 0971–765X

http://doi.org/10.53550/EEC.2022.v28i01s.044

Land use and Land cover Detection using Geo-spatial Tools for Sustainable Land Use Planning

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(Received 10 August, 2021; Accepted 16 September, 2021)

ABSTRACT

Land use and land cover maps describe the landscape of a particular area by assigning each land unit to a specific category or class, such as settlement, vegetation, cropland etc. When Land use/land cover maps are completed it can be used to describe the land utilisation pattern of municipalities, accounts stages or regions. Land use and land cover helps in many way for planning purposes management and protection of environmental resources. This paper is based on secondary data used of remote sensing satellites imagery and geospatial tools. In this paper, analysis is done using Spatial versus Non-spatial model. Spatial models aim at spatially explicit representations of land-use change at some level of spatial detail, in which land-use change is indicated for individual pixels in a raster or other spatial entities such as administrative units. The group of non-spatial models focuses on modelling the rate and magnitude of land-use change without specific attention for its spatial distribution. After comparative analysis, it is made that the land use category of various classes has undergone many changes from past to contemporary period due to involvement of natural and cultural activities. Crop land and Forest land use and land cover loss their rate of changes to a great extent, and it's a continuous process all over the world because of conversion of crop land and forest cover into human settlement, human activities in terms of social, economic, political, cultural and environmental issues. On the other hand Settlement, Sand bar, River, Tea garden land use and land cover gain in their rate of area. Usually crop land are converted to activities land, River and sand bar also play an important role in gaining of their rate of increase in land area. It is a natural process, where river expand their bank with great extent causing tremendous changes in the landscapes by bringing changes in erosion and deposition features. If this will continue in this way, it will impact on the functions of the ecosystems, and it will affect the provision, regulations and supporting systems of the ecosystems. Therefore, Land use and land cover changes can lead to interventions and strategic planning in order to maintain sustainability of an ecosystem.

Key words : *Land use, Land cover, Remote sensing, GIS.*

Introduction

Today most land cover data include elements of land use and vice versa. Historically, mapping land were concerned with land use and manually recorded socio-economic activities and land management practices(Jonathan, 2008).

Land use and land cover maps describe the landscape of a particular area by assigning each land unit to a specific category or class, such as settlement, vegetation, cropland etc. When Land use/land cover maps are completed it can be used to describe the land utilisation pattern of municipalities, accounts stages or regions. Land use and land

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cover helps in many way for planning purposes management and protection of environmental resources.

These two concepts "Land use" and Land cover" are connected by the change sources like the human actions that modify directly the physical environment (Turner and Mayer, 1994). Land use refers to how a particular land area is utilised by humans, while land cover refers to the natural vegetative communities. The influences of human beings dramatically change the land leading to its considerable overuses and abuses. A systematic and regional description of land use pattern has a great significance and the changing nature of land use practices is able to explain the causes of increasing intensity of resources use and changing relationship between man's activities with nature (Singh and Singh, 1995). As Veldkamp and Verburg (2004) note, many land use and/ or land cover modelling approaches have often treated land use and land cover as if they were interchangeable concepts. However, the conflation of the two concepts in most geographical information derived from remotely sensed data is problematic for the research community who require either land cover for environmental model or land use for policy making (Veldkamp and Verburg, (2004)).

Researchers are conscious about the dynamic changes of land cover into land use due to human interference, climatic changes, environmental issues etc. Many international agreement are made on climate have relevance on land use, land-use change, and forestry dynamics. Land represent as the role model of food providing, energy product and in return service sector urgency to develop a proper land representation (El-Hage Scialabba and Hattam, 2002).

As a result, researchers are working eagerly on collaboration and produce sophisticated modelling strategies. This to the aim of (i) bringing together economical with physical and spatial characteristics of land; (ii) reconnecting the global with the regional dimension of land use; (iii) investigating feedbacks amongst the land, the economic and the Earth systems; and (iv) assessing the implications of land-use change for climate policies. In this direction moves the effort of those researchers involved in the development or enhancement of Integrated Assessment and Earth System models, as well as impact assessment frameworks. In this context, land-use change has been identified as one of the main examples of potential human–physical system interactions for which tighter linkage of Integrated Assessment and Earth System models is most desirable (Van Vuuren, *et al*., 2012).

Objective

A) To Study the Land use/Land cover characteristics of the study area.
B) To study the change in land use pattern over consecutive years (1966-2020) at the interval of 10 years.

Methodology

Data

Table 1. Details of Satellite imagery

Sensor	Date of acquisition	Bands used	Resolution
MSS	6 Feb, 1977	MTL	60 m
MSS	22 March, 1987	2,3,4	30 m
MSS	16 Feb, 1997	2,3,4	30 m
LISS III	1 Feb 2007	2,3,4	24 m
OLI and TIRS	22 Dec, 2020	3,4,5	30 m

Software: Arc GIS 10.4 is used in order to analyze the land use and land cover changes of Dibru River Basin and used of Excel in order to analyze the simple statistical functions to prepare, charts, pie, bar etc.

Method

Survey of India, toposheet is taken as a base map to identify the land use category; analysis is done taking the interval of 10 years in order to show the changes of land use and land cover within the study area from 1966-2020. Various satellites imagery is used in order to detect the changes from 1966-2020. There are various modelling used in order to analysis the land use and land cover. In this method, analyze is done using Spatial versus Non-spatial model. Spatial models aim at spatially explicit representations of land-use change at some level of spatial detail, in which land-use change is indicated for individual pixels in a raster or other spatial entities such as administrative units. The group of non-spatial models focuses on modelling the rate and magnitude of land-use change without specific attention for its spatial distribution. All the features are visually identified and digitized using Arc GIS software and assigned their land use category of each features.

Study Area

The Dibru River is a left bank tributary of Brahmaputra River. The basin drain into the plain region of Assam experience the great sub Himalayan terrain and bounded by river Brahmaputra and Lohit in north, Noa Dihing River in the eastern and some tributaries of the Burhi Dihing River in the south and western borders of the basin. Geographically it latitude and longitudinal extension is 27° 25′30″ N - 27°46′30″ N and 95°6′0″ E - 95°58′30″ E covering about 1779 sq km area of Tinsukia, Dibugarh, Dhemaji district of Assam and part of Arunachal Pradesh with ever-green and semi-deciduous forests and the climatic condition is high humidity and moderate temperature.

Results and Discussion

As per the topographical map prepared by the Survey of India, in the year 1966 the land use and Land cover map of Dibru River Basin is prepared from the base map of topographical map bearing the toposheet number 83M/2, 83M/5, 83M/6, 83M/7, 83M/9, 83M/10, 83M/11, 83M/13, 83M/14, and 83M/15 with scale 1:50,000 and identified 7 classes of land use and land cover category like crop land, Sand bar, River, Settlement, Tea garden, Water bodies, and forest. The technique of remote sensing and GIS is used in order to analyze the change of land use in the physical landscapes due to interference by cultural activities or natural action. A different source of data is used in order to analyze the change rate. Toposheet is taken as the base map in order to identify the various land use and land cover category and at the interval of 10 years detection of changes is shown by using various years of satellites imagery. The details of data are mentioned above (Table 1). The boundary map is used in order to extract the data, and the process of digitization is used to identify various class categories by visual inter-

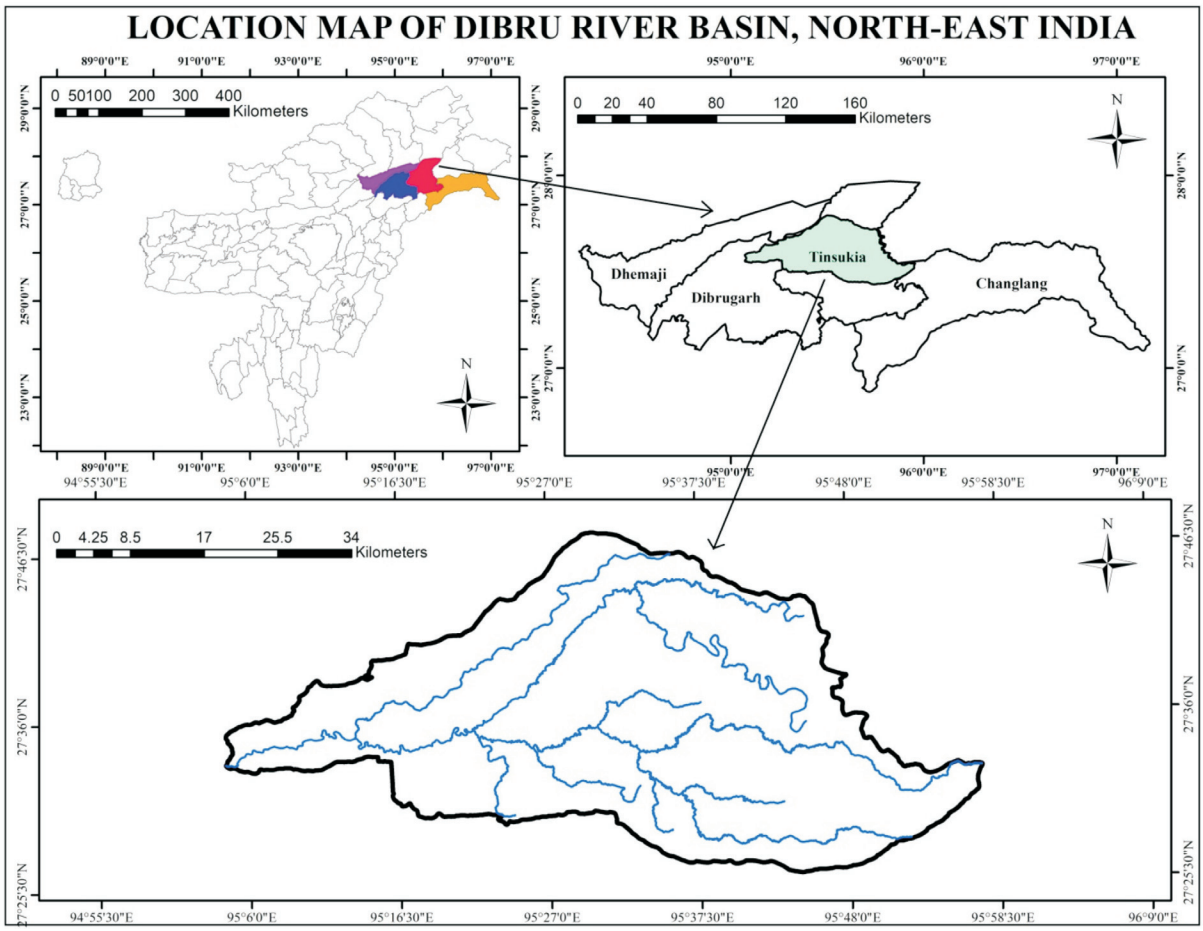

Fig. 1.

pretation on the basis of tone, colour, shape, size, texture, pattern etc. The results are presented with the help of map, charts, bar diagram, pie diagram, Tables and Graphs using appropriate computer assisted procedures.

Land Use Pattern

Below are the details of Land use pattern from 1966-2020 at the interval of 10 years.

As per Table 2, land use pattern of Dibru River Basin, analysis can be made out of various land use and land cover category of Dibru River Basin that crop land, forest and tea garden are losing the rate of their land from 1966-2020 due to increase of population, human activity on the physical landscapes and on the other hand, analysis is also made that sand bar, river, settlement are increasing their rate of changes on the land use pattern. It is natural process of increasing the rate of land use of river, sand bar because river tries to extend their channel with the help of erosion, deposition, meandering, shifting activities etc along with this activity sand bar also play hand in hand process on the natural landscapes. Increase of settlement is also a natural process, as with phases of time, there is increase of population due to fertility, mortality and migration processes. So, River, Sand bar and Settlement classes of category are increasing in the Dibru River Basin. Therefore an attempt has been made in the present chapter to examine the changing pattern of land use using toposheet and satellite imagery of different years.

Land use change in Dibru River Basin

Changes in land use and land cover imply quantitative changes in the areal extent (increases or decreases) of a given type of land use or land cover (Briassoulis, 2000). According to Lambin and Geist (2001), it is necessary to understand the utility of some types of cover to understand the process of change. Land use and land cover is a slow moving and continuous process from a long time. In fact they are disjoint processes, with fast change periods, often triggered by a sudden event. The changes rate are determined by the terrain, geology, soil, mor-

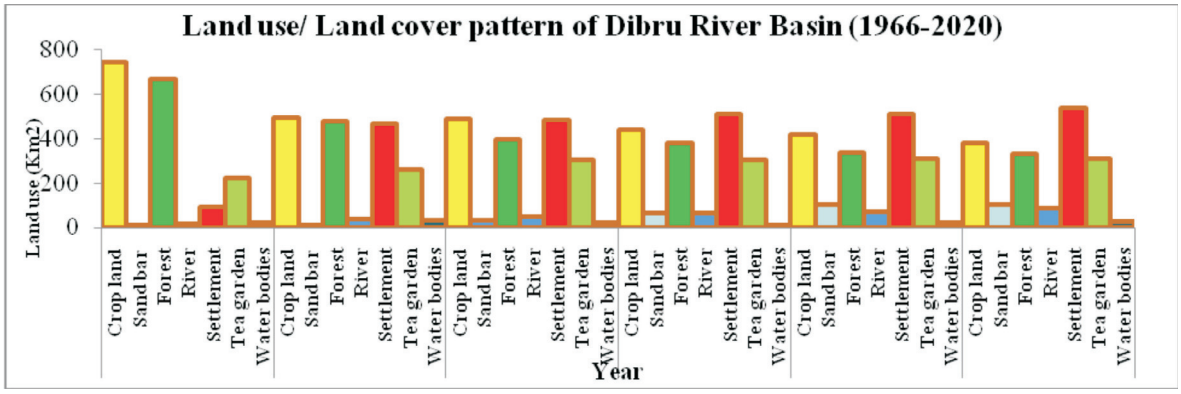

Fig. 3. Land use and Land cover pattern of Dibru River Basin (1966-2020)

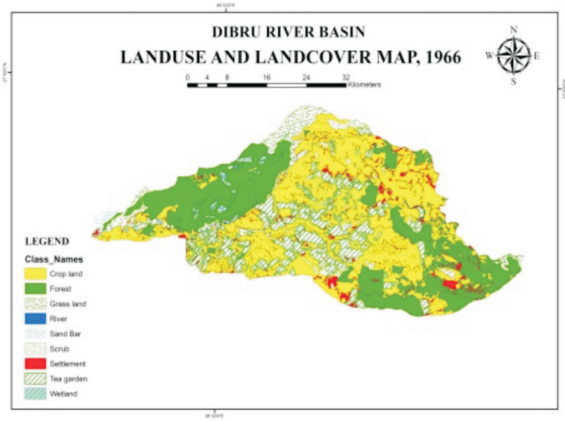

Fig. 4. LU/LC, 1966

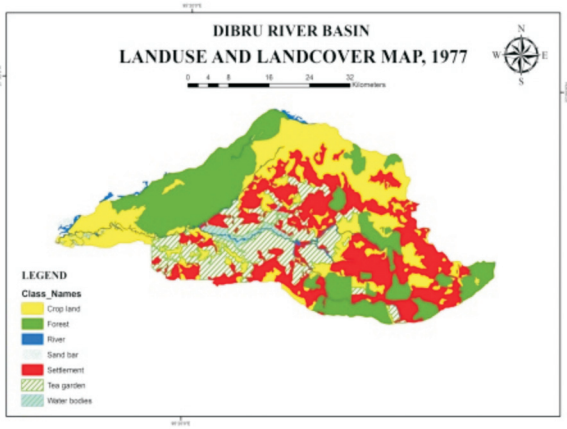

Fig. 5. LU/LC, 1977

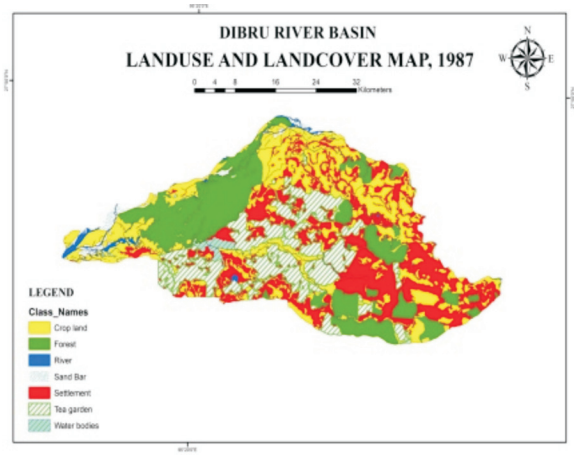

Fig. 6. LU/LC, 1987

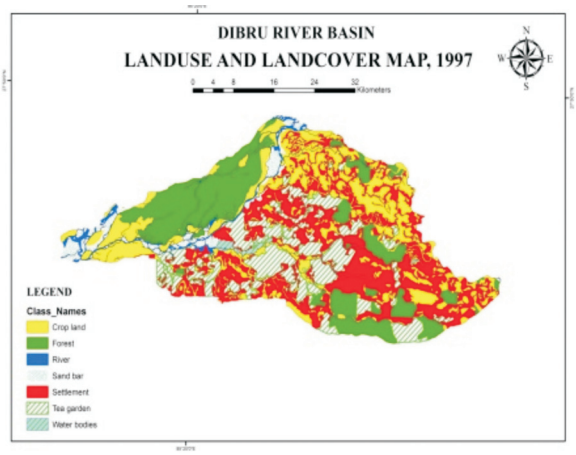

Fig. 7. LU/LC, 1997

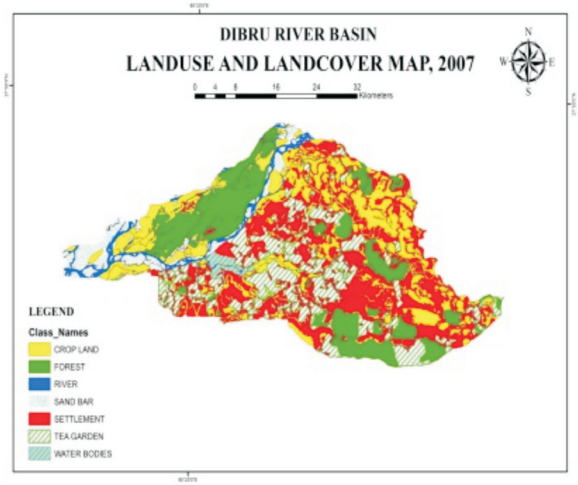

Fig. 8. LU/LC, 2007

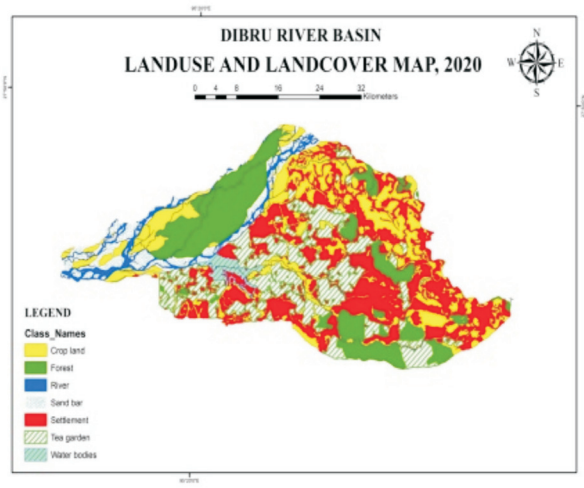

Fig. 9. LU/LC, 2020

phometric, rainfall, temperature, human activities etc. land use which is a dynamic changes over land cover, and lead to many environmental issues. The main land use changes within the study area are due to interference of human activities like increase of population, tea plantation activities, increase in water bodies like river and sand bar.

Land use and land cover change during 1966-1977

Table 3. Shows the land use and land cover

Table 2. Land use pattern, from 1966-2020 at the interval of 10 years

Class	1966		1977		1987		1997		2007		2020	
	Km^2	%	Km^2	%	Km^2	%	Km^2	%	Km^2	%	Km^2	%
Crop land	745.71	41.91	493.55	27.74	490.67	27.58	438.31	24.63	417.57	23.47	380.02	21.36
Sand bar	9.62	0.54	12.17	0.68	32.21	1.81	67.41	3.78	102.58	5.76	106.18	5.96
Forest	536.78	30.17	476.42	26.78	394.74	22.18	380.52	21.38	339.77	19.09	331.41	18.62
River	15.09	0.84	35.96	2.02	49.61	2.78	63.87	3.59	73.48	4.13	85.7	4.81
Settlement	93.41	5.25	469	26.36	486.46	27.34	512.7	28.81	512.9	28.83	537.29	30.20
Tea garden	222.42	12.50	260.43	14.63	304	17.08	304	17.08	311.54	17.51	310.5	17.45
Water bodies	21.05	1.18	31.3	1.75	20.89	1.17	12.49	0.70	20.866	1.17	27.74	1.55
Grass land	96.14	5.40	1779		1779		1779		1779		1779	
Scrub	38.6	2.16										
Total Area	1779											

change matrix from 1966 to 1977. From the Table, it is clear that there has beena considerable change during the 10 years period. There has been an overall decrease of 252.11 km^2 of crop land. It is also indicates that in 1966, area of crop land occupied about 745.57 sq km. Out of this area 23.1 sq km occupied by forest, 12.41 sq km occupied by river, 0.49 sq km occupied by sandbar, 296.06 sq km occupied by settlement, 86.35 sq km occupied by tea garden and 23.82 sq km occupied by water bodies. During the study period there has been a change of 24.78 sq km, 10.05 sq km, 1.84 sq km, 34.99 sq km and 2.2 sq km area from tea garden to crop land, forest, river, settlement and water bodies. Area of other land use and land cover category is also converted into different land use and land cover category which is analysed in change matrix Table 3.

Land use and land cover change during 1977-1988

Table 4 shows the land use and land cover change matrix from 1977 to 1987. From the Table, it is clear that there has been a considerable change during the 10 years period. There has been an overall decrease of 81.66 km^2 of forest cover. It is also indicates that in 1977, area of forest cover occupied about 476.38sq km. Out of this area 50.76sq km occupied by crop land, 8.69sq km occupied by river, 5.3sq km occupied by sandbar, 23.52sq km occupied by settlement, 11.94sq km occupied by tea garden and 2.71sq km occupied by water bodies. During the study period there has been a change of 14.88sq km, 0.003sq km, 0.43sq km, 32.25sq km, and 0.71sq km area from tea garden to crop land, forest, river, settlement and water bodies.

Land use and land cover change during 1987-1997

Table 5 shows the land use and land cover change matrix from 1987 to 1997. From the Table, it is clear that there has been a considerable change during the 10 years period. There has been an overall decrease of 52.37 km^2 of crop land. It also indicates that in 1987, area of crop land occupied about 490.64 sq km. Out of this area 31.78 sq km occupied by forest, 18.27 sq km occupied by river, 27.61 sq km occupied by sandbar, 58.76 sq km occupied by settlement, 26.52 sq km occupied by tea garden and 6.14 sq km occupied by water bodies. During the study period there has been a change of 8.77 sq km, 2.15 sq km, 7.97 sq km, and 0.02 sq km area from sand bar to crop land, forest, river, and settlement.

Table 3. Land use / Land cover change matrix, 1966-1977 (km^2)

Land use category	Crop land	Forest	River	Sand bar	Settlement	Tea Garden	Water bodies	Total 1966
Crop land	303.34	23.1	12.41	0.49	296.06	86.35	23.82	745.57
Forest	127.86	419.54	15.26	6.27	88.07	11.16	3.3	671.46
River	5.22	2.06	2	0.08	3.69	1.24	0.77	15.06
Sand bar	1.6	0.48	2.39	5.13	0	0	0	9.6
Settlement	27.85	4.85	1	0.02	46.08	13.02	0.54	93.36
Tea garden	24.78	10.05	1.84		34.99	148.52	2.2	222.38
Water bodies	2.81	16.24	1	0.13	0.06	0.12	0.65	21.01
Total 1977	493.46	476.32	35.9	12.12	468.95	260.41	31.28	
Net change	-252.11	-195.14	20.84	2.52	375.59	38.03	10.27	

Table 4. Land use / Land cover change matrix, 1977-1987 (km^2)

Land use category	Crop land	Forest	River	Sand bar	Settlement	Tea garden	Water bodies	Total 1977
Crop land	297.28	13.49	20.59	13.72	111.32	30.15	6.97	493.52
Forest	50.76	373.46	8.69	5.3	23.52	11.94	2.71	476.38
River	8.74	2.11	13.42	7.19	2.6	1.13	0.74	35.93
Sand bar	5.74	0.08	1.52	4.8				12.14
Settlement	96.82	5.47	3.59		314.22	46.39	2.49	468.98
Tea garden	14.88	0.003	0.43		32.25	212.13	0.71	260.403
Water bodies	16.42	0.1	1.35	1.17	2.25	2.74	7.24	31.27
Total 1987	490.64	394.713	49.59	32.18	486.16	304.48	20.86	
Net change	-2.88	-81.66	13.66	20.04	17.18	44.077	-10.41	

Land use and land cover change during 1997-2007

Table 6 shows the land use and land cover change matrix from 1997 to 2007. From the Table, it is clear that there has been a considerable change during the 10 years period. There has been an overall decrease of 40.72 km^2 of forest cover. It also indicates that in 1997, area of forest cover occupied about 380.49sq km. Out of this area 40.31 sq km occupied by crop land, 9.91sq km occupied by river, 10.52sq km occupied by sandbar, 9.51 sq km occupied by settlement, 3.47sq km occupied by tea garden and 0.52sq km occupied by water bodies. During the study period there has been a change of 11.21sq km, 6.42sq km, 0.93sq km, 0.04 sq km, 27.18 sq km and 0.06sq km area from tea garden to crop land, river, sand bar, settlement and water bodies.

Land use and land cover change during 2007-2020

Table 7. Shows the land use and land cover change matrix from 2007 to 2020. From the table, it is clear that there has been a considerable change during the 10 years period. There has been an overall decrease

Table 5. Land use / Land cover change matrix, 1987-1997 (km^2)

Land use category	Crop land	Forest	River	Sand bar	Settlement	Tea garden	Water bodies	Total 1987
Crop land	321.56	31.78	18.27	27.61	58.76	26.52	6.14	490.64
Forest	23.67	335.33	11.23	6.9	8.75	8.45	0.38	394.71
River	11.49	2.81	18.86	12.15	3.6	0.35	0.32	49.58
Sand bar	8.77	2.15	7.97	13.28	0.02	0	0	32.19
Settlement	54.76	3.59	2.83	2.02	403.65	19.05	0.25	486.15
Tea garden	13.81	2.83	1.19	0.03	36.89	248.95	0.76	304.46
Water bodies	4.21	2	3.48	5.39	1	0.17	4.61	20.86
Total 1997	438.27	380.49	63.83	67.38	512.67	303.49	12.46	
Net change	-52.37	-14.22	14.25	35.19	26.52	-0.97	-8.4	

Table 6. Land use / Land cover change matrix, 1997-2007 (km^2)

Land use category	Crop land	Forest	River	Sand bar	Settlement	Tea garden	Water bodies	Total 1997
Crop land	290.84	15.8	24.97	29.63	54.95	16.78	5.32	438.29
Forest	40.31	306.25	9.91	10.52	9.51	3.47	0.52	380.49
River	9.17	3.55	20.31	26.28	2.26	0.39	1.88	63.84
Sand bar	13.89	0.08	14.21	35.18	0.23	0	3.8	67.39
Settlement	48.53	7.35	2.9	0.85	418.34	32.89	1.81	512.67
Tea garden	11.21	6.42	0.93	0.04	27.18	257.66	0.06	303.5
Water bodies	3.6	0.32	0.32	0.04	0.41	0.33	7.44	12.46
Total 2007	417.55	339.77	73.55	102.54	512.88	311.52	20.83	
Net change	-20.74	-40.72	9.71	35.15	0.21	8.02	8.37	

Table 7. Land use / Land cover change matrix, 2007-2020 (km^2)

Land use category	Crop land	Forest	River	Sand bar	Settlement	Tea garden	Water bodies	Total 2007
Crop land	275.03	19.13	22.85	19.74	59.36	15.14	6.29	417.54
Forest	19	295.73	5.85	2.77	10.65	5.77	0	339.77
River	7.63	4.37	28.36	30.81	1.18	0.16	1.07	73.58
Sand bar	20.06	4.84	25.75	51.33	0.48	0.04	0.08	102.58
Settlement	46.68	4.1	2.01	1.38	427.77	29.62	1.31	512.87
Tea garden	11.22	2.3	0.29	0.03	37.44	259.62	0.61	311.51
Water bodies	0.37	0.91	0.59	0.09	0.37	0.13	18.36	20.82
Total2020	379.99	331.38	85.7	106.15	537.25	310.48	27.72	
Net change	-37.55	-8.39	12.12	3.57	24.38	-1.03	6.9	

of 37.55 km^2 of crop land. It is also indicates that in 2007, area of crop land occupied about 417.54 sq km. Out of this area 19.13 sq km occupied by forest cover, 22.85 sq km occupied by river, 19.74 sq km occupied by sandbar, 59.36 sq km occupied by settlement, 15.14 sq km occupied by tea garden and 6.29 sq km occupied by water bodies. During the study period there has been a change of 7.63 sq km, 4.37 sq km, 30.81 sq km, 1.18 sq km, 0.16 sq km and 1.07 sq km area from river to crop land, forest, sand bar, settlement, tea garden and water bodies.

Conclusion

From acomparative term, analysis is made that the land use category of various classes has undergone many changes from past to contemporary period due to involvement of natural and cultural activities. Crop land and Forest land use and land cover loss their rate of changes to a great extent, and it's a continuous process all over the world because of conversion of crop land and forest cover into human settlement, human activities in terms of social, economic, political, cultural and environmental issues. On the other hand Settlement, Sand bar, River, Tea garden land use and land cover gain in their rate of area. Usually crop land are converted to activities land, River and sand bar also plays an important role in gaining of their rate of increase in land area. It is a natural process, where river expand their bank with great extent causing tremendous changes in the landscapes by bringing changes in erosion and deposition features. Crop land which cover around 41.91% in 1966 of total area of the basin and decline to 21.36% in 2020. Settlements share an amount of 5.25% of the total area of the basin gain to 30.20% in 2020.Forest area share 37.74% of the total area of the basin and decline to 18.62% in 2020.

If this will continue in this way, it will impact on the functions of the ecosystems, and it will affect the provision, regulations and supporting systems of the ecosystems. Therefore, Land use and land cover changes can lead to interventions and strategic planning in order to maintain sustainability of an ecosystem. Critical zones of environmental vulnerability should identify from land use and land cover changes map and plan an estimate in order to preserve the functions of the ecosystems. There are different types of modelling through which, monitoring of land should be regain.

Acknowledgements

My foremost greatest thanks goes to Dr. Gitika Thakuriah, my supervisor for his insights and suggestions that helped to shape this research articles.

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