Research Article

An Assessment of Land Use and Land Cover Changes in Muthupet Mangrove Forest, using Time Series Analysis 1975-2015, Tamilnadu, India

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ABSTRACT

Anthropogenic activities are leads to changing a natural land cover, and consequences are severe to human and environments etc. The present study has examined the Muthupet mangrove forest and its surrounding land-use changes from 1975 to 2015 using the geospatial technology. An assessment of land use and land cover was done at Muthupet mangrove forest which is an occupied the three coastal district of Tamilnadu i.e. Thanjavur, Thiruvarur, and Nagappattinam. The remote sensing (MSS, TM, and OLI) data was adopted to explore the land use and land cover with help of visual image interpretation. The study had justified the results based upon the ground truth verification, and 203 sites were selected for explore the 10 land use categories. An Accuracy Assessment has done based on the KAPPA index for the year 2015 classified image and appraisal of land use change detection from 1975 to 2015 for all the categories. The study revealed that the land use and land cover condition from the 1975 to 2015, for example 1975 water bodies covered an area of about 156.1 km^2, and 2015 it has comprised 89.8 km^2. An appraisal of land use and land cover clearly is evidence in 2005 entire land use and land cover changed, and reasons for that an influence of the Tsunami. Consequently, Muthupet mangrove forest is one of the important to human and environments, and the present study has exposed that the changes of the mangrove forest, and its impact on to the coastal community.

Keywords : Mangrove Fores; Remote sensing; LULC; Classification; Change detection

1. Introduction

The earth comprises of a variety of lands. Land is facing a variety of demands due to the growing pressure of population (NRSC, 2007; Rao & Pant, 2001). Land resources played a dynamic role regional economic development of the country (Annaidasan, 2017). Therefore, land resources are essential for society, and it should be preserved. Coastal regions are always attractive areas for human development. The changes in land use can be associated with complex problems. The urban areas need to resolve such problems. Urban area expansion along the coastal areas has resulted in loss of forests and due to the urban sprawl (Mundia & Aniya, 2005). Due to the urbanization of natural resources has been declining, as a consequence has changed land cover patterns (Wu et al., 2016). 15 percent of the world's population have urbanised in 1900, now i.e. in year 2010 to 2015 it has increased and more

than half of the human population lives in the cities and the major cities are located in coastal regions (Annaidasan, 2017; Melet et al., 2020). The United Nations foresees that between 1990 and 2050, the urban population will rise to over 5 billion, and land use bring changes a fluctuating process, due to changes of human activities; resulting in manmade tragedies (Muttitanon & Tripathi, 2005). Therefore, coastal area needed that the rapid training of actual land cover and land use maps in order to notice inputs of land use on land covers; it will helps to avoid the exploitation and damage of the landscape beyond the limits of the sustainability (Güler et al., 2007). It noticed that land use and land cover categorisations are crucial for land evaluation processes; this can serve as inputs to the addition of social and ecological information and it is perspective and models. The use of Geographic Information Systems (GIS) which has analysis tools that can be easily prepared for the land management and planning is considered for means. And the increasing demand for land use and land cover for various technological necessities can be examined by using Geospatial technology (Jaganathan et al., 2010). Moreover, the spatial information can be provided through the uses of remotely sensing data, although, it is more effective solutions for sustainable environment and proper development of coastal zone (Annaidasan, 2017; Melet et al., 2020).

The remote sensing data comprises of multi resolution multi date and multi spectral images; it provides detailed information about the different level of land use categories i.e..built-up land, agricultural land, forests, wastelands and water bodies, etc. (Mohan, 2005). Therefore, the land cover maps are prepared with the help of multi spectral data and multi date which comprise spatial information for a number of years which have been used to change detection assessment (Lambin et al., 2003). Thus, the remote sensing analysis provides very essential information to assess the actual changes of a particular study area (Jaganathan et al., 2010; Lambin et al., 2003). The present study is focused on land cover and land use classification, their changes, change and trends in detection in Muthupet mangrove forest. The main intention is an appraisal of changes the land use over the periods of 1975 -1985, 1985-1995, 1995-2005 and 2005-2015, i.e. The assessment of successive decadal variation. It is explained that land uses declare all anthropogenic activities which occur in land (Brown & Duh, 2004). The land use changes influence the natural ecosystem; for example, changes in aquatic environments and wildlife habitat are established primarily through physical changes made in the landscape. Changing land use is one of the factors of land cover changes. The changes of land use and land cover based upon modelling of cellular automata for surface temperature, and it has increased significantly because of the continuous rise in its population (Hanafi et al., 2021; Widiawaty et al., 2020). The land use and land cover have certain spatial rules to allocate the human behaviour attributes (Bogale, 2020). The present study has revealed the land use pattern of the Muthupet mangrove forest and their environments, and it is an appraisal of the mangrove distribution from 1975 to 2015 in the Muthupet study area. These results explored that the recent years' mud occupied area is gradually increased. Similarly, after in the year 2004 mangrove forest distribution substantially throughout the study area, causes, there were many governments and non-government effectively involved to rejuvenate the damaged.

Impact of changing a land use and land cover based upon the land surface temperature (LST), and normalized differential vegetation index (NDVI) in Sundarbans (Thakur et al., 2021). The mangrove forest in northern Vietnam which is play major role in reducing the impacts of natural calamities i.e. typhoons and storms, which are frequently crossed at shoreline in the every monsoon season (Islam et al., 2019; Liu et al., 2021; Nguyen et al., 2021; Raj & Sharma, 2022). The novelty of the study is revealed that the variation of the spatio-temporal changes in each category at Muthupet mangroves forest, and it has exhibited 10 years interval for the last 4 decades from 1975 to 2015. In addition to this study was demonstrated that the distribution of mangroves forest, and present context of the mangroves. The variation of the land use categories are shown by corresponding statistical methods which can be perceived the changes of the land use and land cover throughout the study periods.

2. Methods

2.1 Study Area

The Muthupet mangrove forest is one of the ecologically sensitive region, and it is located Southern part of the Cauvery delta in Tamilnadu, and it has been covering from Athirampattinam to Kodiyakarai (East to West). It also shared three delta districts i.e. Thanjavur, Thriuvarur, and Nagappattinam. Total area of the Muthupet lagoon was estimated from the remotely sensed data (Landsat TM, 30 m spatial resolution), approximately 13.32 km^2. The study area is part of coastal wetland called the Great Vedaranyam Marsh, and gentle slope gradually decrease towards Palk Strait (Southern part) in Bay of Bengal. There are many Cauvery distributaries can be found across the delta i.e. Paminiyar, Koraiyar, Kandaparichanar, Kilaithangiyar and Marakkakoraiyar, discharge water to the coastal wetland where created the large lagoon and before entering into the sea. The study area encompasses many tidal streams, small channels and small bays with surrounded by mangrove forest, and there are many artificial canals can be flowing across the mangroves forest (Narmada & Annaidasan, 2019). The study area (Figure 1) has been receiving freshwater during the retrieve monsoon from the November to December which is enhancing the suitable soil for agricultural practices including mangrove swamps and aquaculture ponds. Likewise, February to September huge amount of fresh water discharge to the mangrove forest. The clay silt can be found in the coastal wetland, and it is slowly gradually became a salty clay towards landside cause implication of slit deposits.
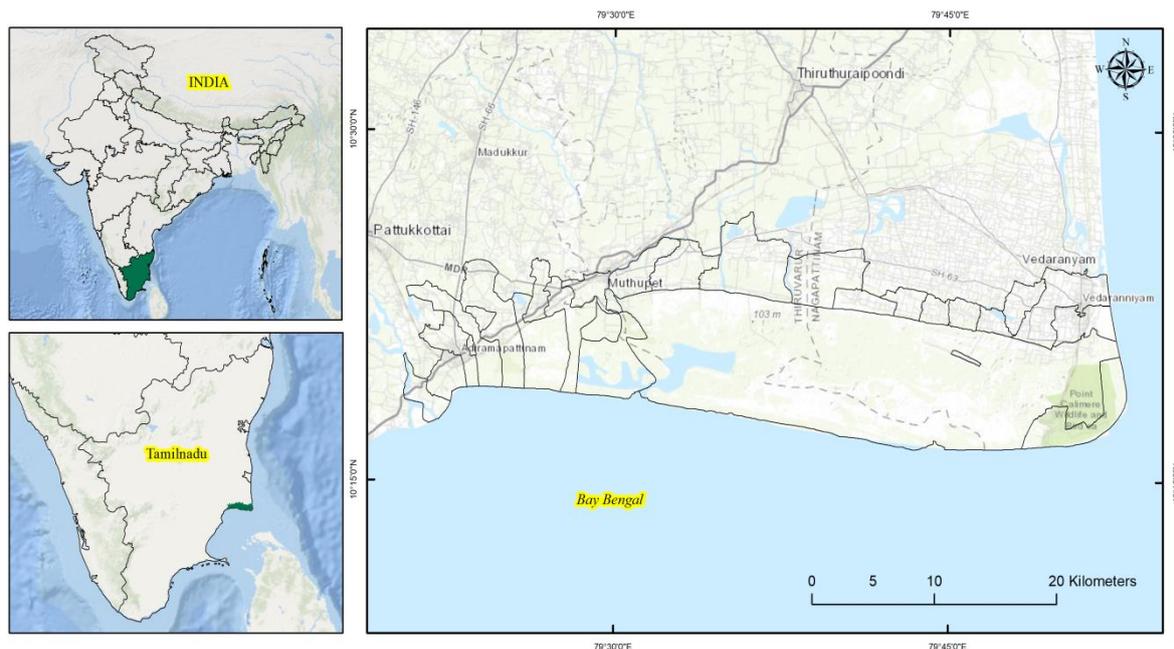

Figure 1. Study area

2.2 Classification Criteria

The pre-field stage of the topographic survey has been done for preliminary mapping. Compilation and preparation of primary map of the study area have been created using Topographic Sheet of 1:50,000 scale. Literature review and appraisal, collection of base line data on physical and socio-economic details have been collected from State Government records and various organizations. Mapping of various resources in the Mangrove ecosystem such as land use, soil and etc. have been prepared using digital image processing (Narmada & Annaidasan, 2019). Ground truth verification was

also done for accuracy assessment for the changing pattern of the Mangrove forest. Based on the survey, impact assessment, socio economic conditions, vulnerability has been evaluated using spatial statistic techniques. Mapping of Mangroves has been compiled using GIS methodology and the degradation has been assessed. Based on the relevant primary data and GIS strategy, the current scenario of the Muthupet region has been evaluated and also suggested suitable recommendations for sustaining the Mangrove ecosystem for the coastal community in Muthupet. The analysis of land use and land cover has been obtained with Visual Image Interpretation (VII). The exercise sites (ground truth) are identified using the Global Positioning System (GPS). The Eq. 1 was adopted from Cohen (1960).

$$K = \frac{N\sum_{i=1}^{r} x_{ii} - \sum_{i=1}^{r}\left(x_{i+} \times x_{+i}\right)}{N^2 - \sum_{i=1}^{r}\left(x_{i+} \times x_{+i}\right)} \tag{1}$$

Where,
N = Total number of selected places
r = number of rows
xii = Number of places 1st row ,1st column
x+i = Total row and I
xi+ = Total for column I
(Sibanda & Ahmed, 2021; Temgoua et al., 2021; Tewabe & Fentahun, 2020)

Kappa analysis is one of the multivariate techniques, and it is an important approach to classify the accuracy. Furthermore, kappa analysis was created the kappa coefficient threshold ranges from 0 to 1. The kappa index can be fewer than the overall accuracy, unless the classification very good. According to Anderson (1976) land cover and land cover classification system have been derived, based on the high-altitude satellite data and provide valuable information for planning and management. The extract the land use and land cover features from the remotely sensed data ought have a minimum degree of (interpretation) accuracy of at least 85 percent to one and other. The accuracy of the various categories' interpretations should be equal. Results should be repeatable or repetitious from one interpreter to the next and from one sensing time to the next; also, the classification method should be applicable across a large area. The classification system should allow for the usage of vegetation and other types of land cover, and it should be acceptable for data collected at different periods of the year. The use of subcategories backed by ground surveys can help to reduce the inaccuracy associated with large-scale observations. The above-mentioned criteria have been applied to land use and land cover classification. Even though, few criteria can be primarily applied for land use and land cover analysis from remotely sensed data, the results can be derived by reclassifying the results with the support of the ground truths. The spatial resolution plays an important role to assess the level of classification. Table 1 suggested by Anderson (1976) shows the level of classification and the suitable data.

Table 1. Level of classifications (Anderson, 1976)

Level of Classification	Suitable of Scale of Remote Sensing data
I	1:250,000 / 1: 1000,000
II	1:80,000 / 100,000
III	1:25,000 – 1:50,000
IV	Higher than 1:25,000

There are many land cover and land use classes that comprise on the earth surface, whereas, the following land cover and land use classes have been delineated from the study area. The classification

is modified classes of classes (NRSC, 2007; NRSC, 2014). The classes include Agricultural area, aquaculture area and dispersed Built up etc. Agricultural areas consist of a) land with paddy cultivation area and coconut plantations, b) Dense Forest area comprises of mangroves with their associates' species and mangrove degraded, c) Physical structure such as mud flats and Sandy Beaches, d) The water bodies comprise of rivers, tanks and back water. To summarise, there are 3 level classes; viz i) forest cover ii) human activity area iii) Natural land area (physical) features. They are expanded to ten land use / land cover classes of Level II after modifying NRSC classification guide. Ground truth verification (Figure 2) also carried out to finalize the land use / land cover map of the Muthupet mangrove forest. The Land use / Land cover classification has been organised with sufficient field confirmation. Change detection analysis also has done using remote sensing data. Table 2 shows imageries have been used for the study area and Figure 3 shows the flowchart of study.

Table 2. Data sets used

Source of data	Year of capture	Spatial Resolution
Landsat OLI, USGS	2015	30 Meter
Landsat TM, USGS	2005	30 Meter
Landsat TM, USGS	1995	30 Meter
Landsat MSS, USGS	1985	60 Meter
Landsat MSS, USGS	1975	60 Meter

The Landsat satellite imageries downloaded from (http://earthexplorer.usgs.gov/). The Digital Image Processing (DIP) technique was done using classification procedure. Ten land use and land cover classes have been delineated in level II. Land use and land cover classes have been reorganised as their number of levels I land use and land cover classes such as forest cover, human activities landmass and physical land covers.
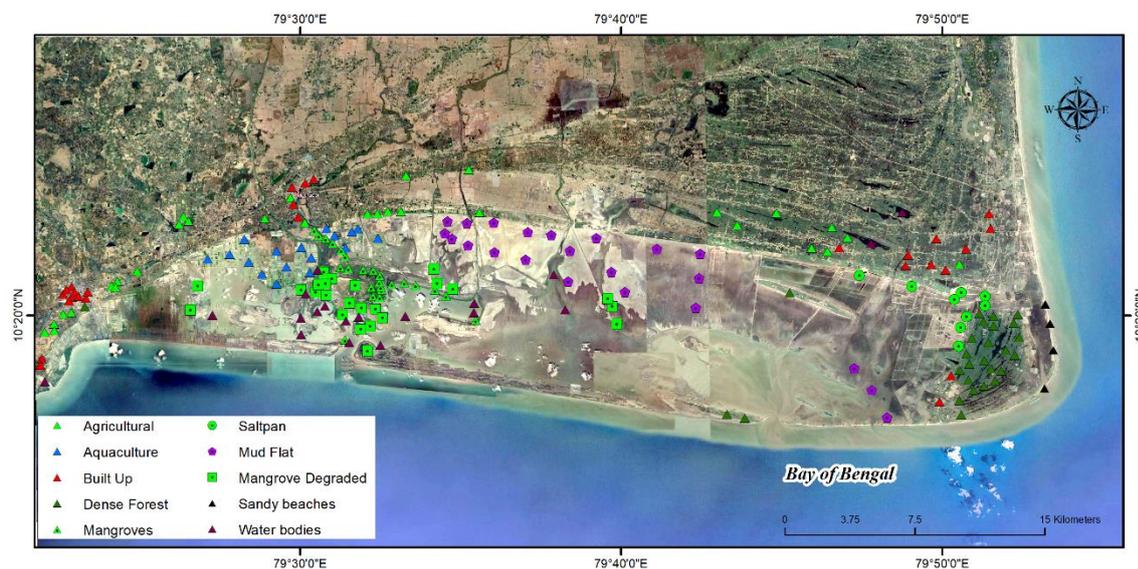

Figure 2. Locations of ground truth verification in 2015

The result of the accuracy assessment clearly shows the accepted level of accuracy in the land use and land cover in Muthupet mangrove forest. Later on, area of all the land use categories has been

calculated with the help of Arc GIS 10.4 (Bogale, 2020; Sibanda & Ahmed, 2021; Temgoua et al., 2021; Tewabe & Fentahun, 2020; Weslati et al., 2020).
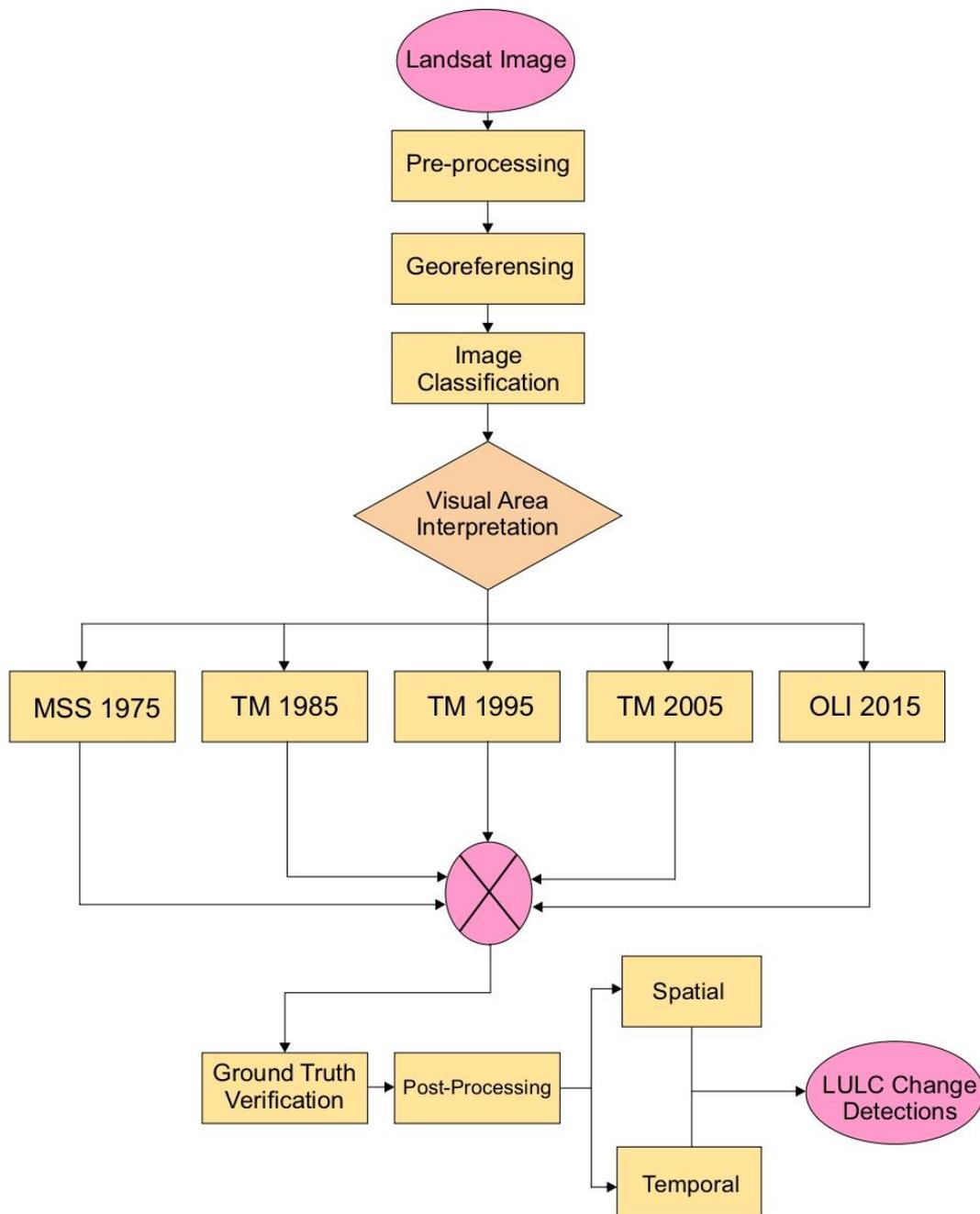

Figure 3. Flow chart of study

3. Results and Discussion

The study shows an agricultural area decreases 35.4 km^2 (-5.17 percent) during the years from 1975 to 1985, whereas, 23.4 km^2 (3.45 percent) have occupied during the period 1985-1995 and 44.2 km2 (-6.46 percent) agricultural land have found in the period of 1995- 2005. Whereas, from 2005 to 2015 agricultural land have found as 40.2 Km^2 (5.87 percent). Thus, the agricultural land shows instability in progress that means when compared with 1975 to 1985, agricultural land has degraded, which must be due to coastal disaster. In the year 1995 agricultural land has increased, may be due to the influence of adequate rainfall during the period. Agricultural land has declined in the year 2005. However, in 2004 during the tsunami disaster there were countless agricultural land degradations. It might be a cause for declining the agricultural land during the period of 2004 to 2005. In the period of 2005 to 2015 the agriculture has been expanded and suitable planning has been implemented to recovery the agriculture fields (Figure 4, 5, 6, 7, 8). The present study revealed a changes of land use and land cover, and it has been measured the five different periods since 1975 to 2015, and 10 land use and land cover categories assessed where agriculture, aquaculture, built-up, dense scrub, mangroves, and saltpan have increased for the last few decades in the positive manner of the coastal communities. In addition, rest of the categories are declining the areas i.e. Mangrove degraded area, Mud Flat, Saltpan, and Water bodies (Liu et al., 2021). It also seems to be positive changes (Table 4) for coastal environments and human society.
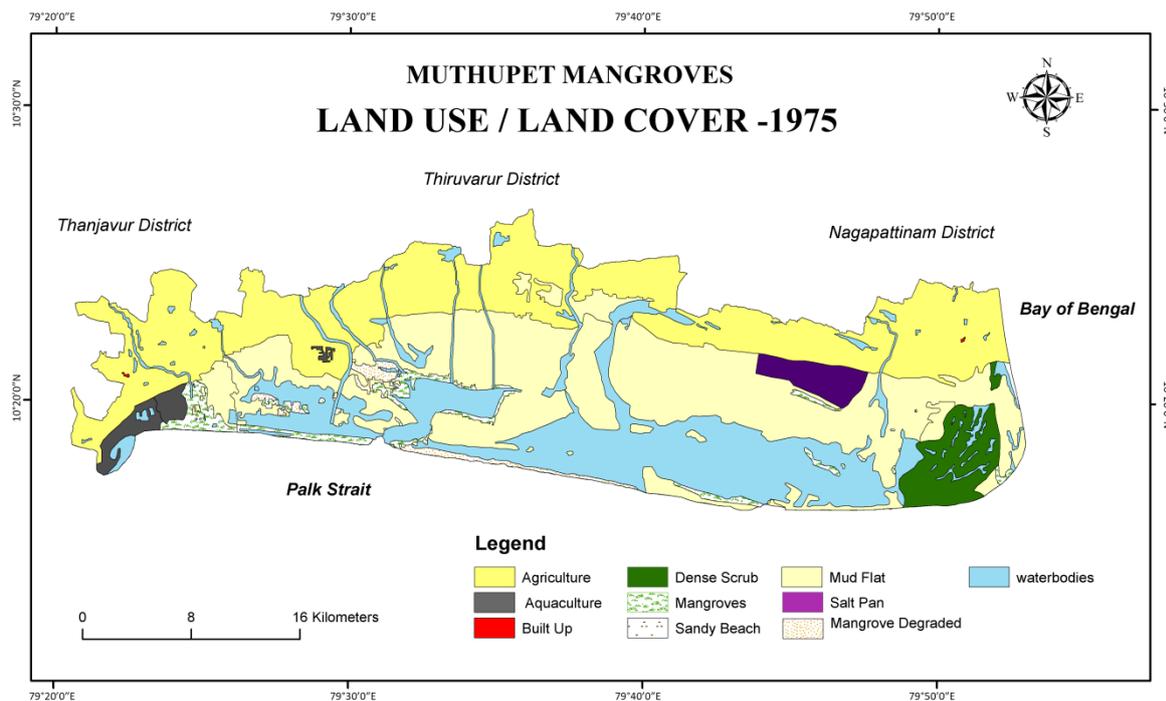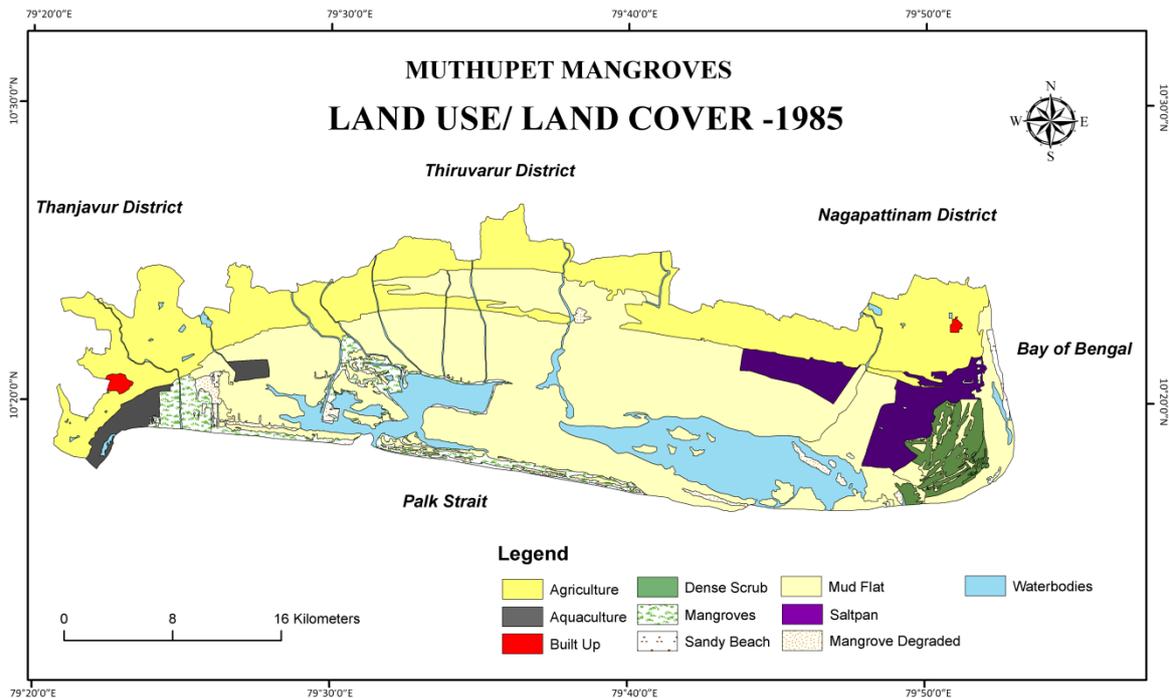

Figure 4. Land cover and Land use -1975

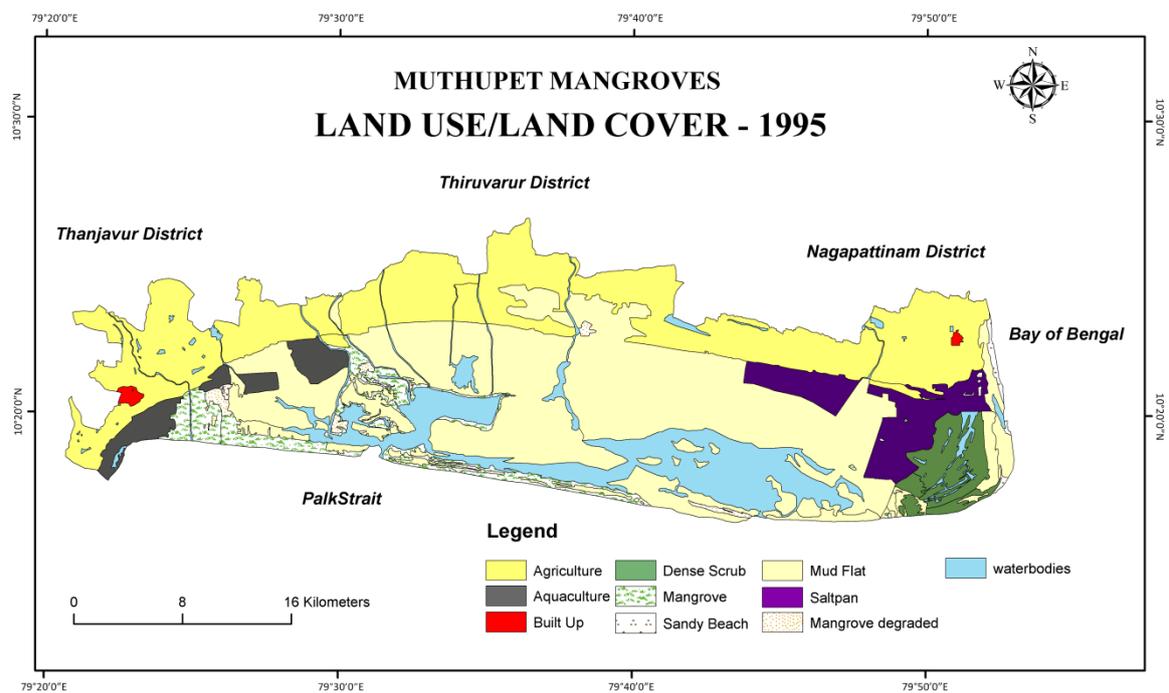Figure 5. Land cover and land use -1985
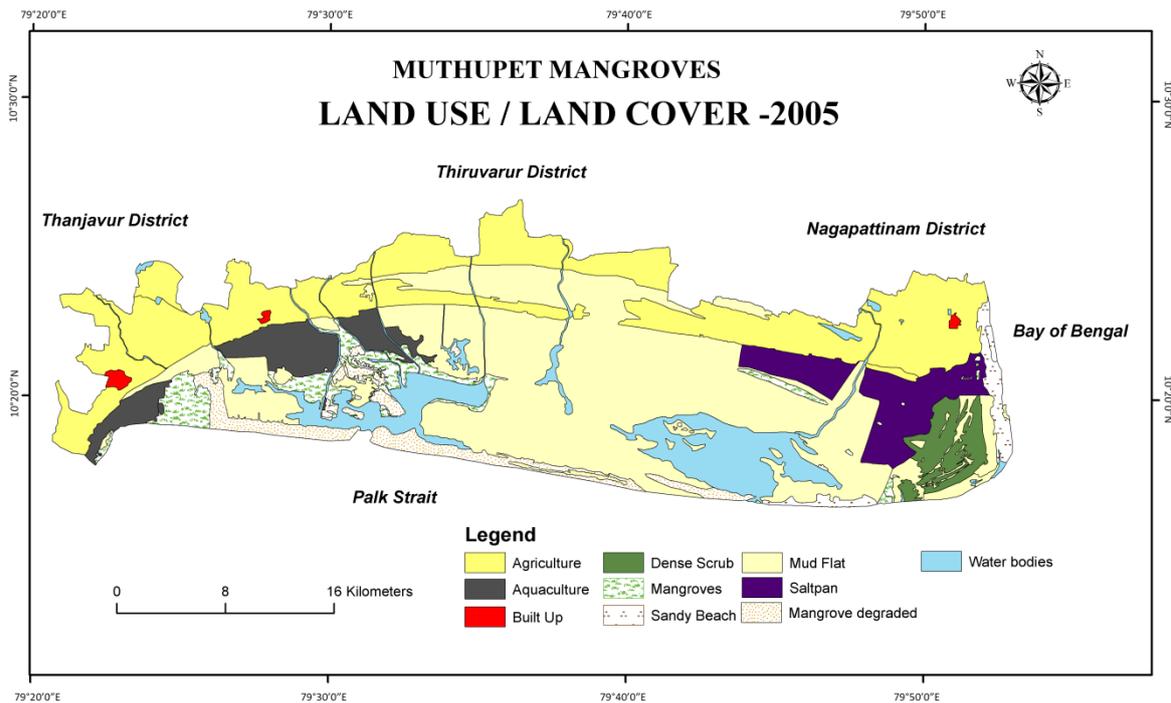

Figure 6. Land cover and Land use -1995
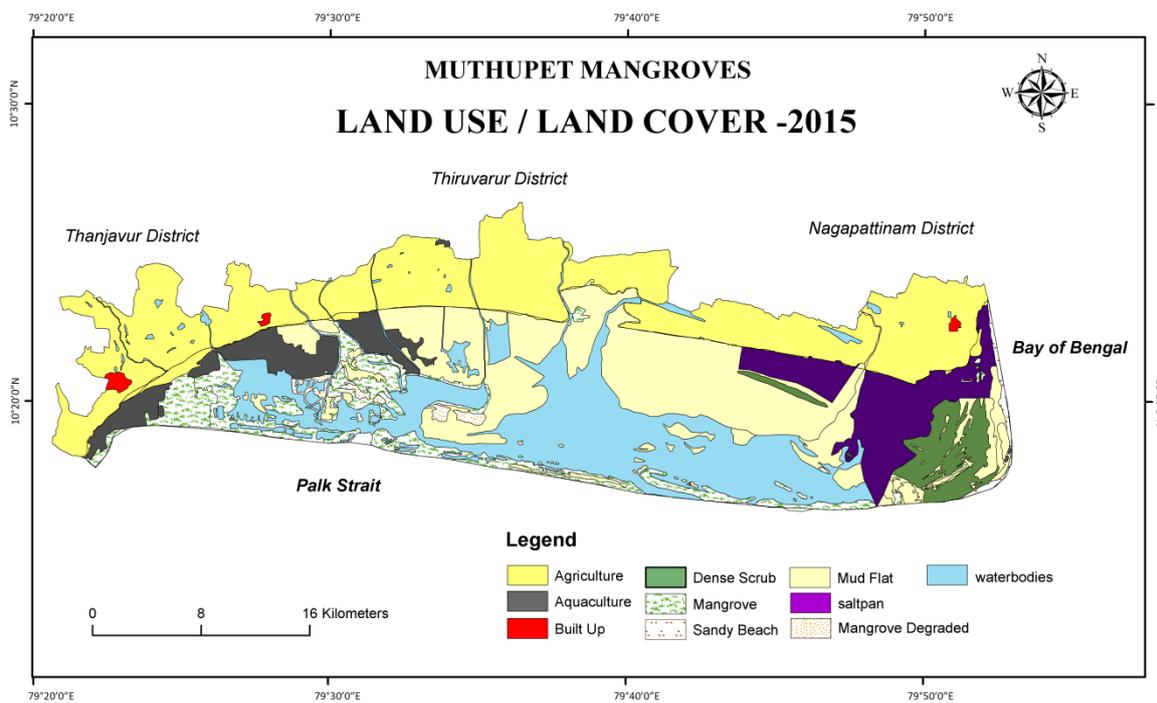
Figure 7. Land cover and Land use -2005

Figure 8. Land cover and Land use -2015

3.1 Accuracy Assessment of Change Detection

Several factors have been known to influence the accuracy such as precise geometric registration, Geometric correction, normalisation, ground reference data availability and quality, landscape and environment variability, techniques and methods employed in the analysis, and the analyst's abilities and experience (Hanafi et al, 2021; Widiawaty et al., 2020). Errors due to pre-processing activities, and change detection methods. The classification and data extraction errors are also possible. Besides, field survey errors (accuracy of ground position) also rectified the results.

Among the various appraisal methods, and most efficient index used the error matrix for image classification is used in the analysis. The accuracy of classification is enhanced by field verification (Table 3). Latest satellite data in the year 2015 has been considered for accuracy assessment. Therefore, overall, 203 sites are verified by the researcher, spreading over 30 places for agriculture and other uses along the coastal stretch of three districts. 17 places were visited for aquaculture, 28 for built up area, 27 sites for dense scrub, 23 places visited for mangrove forest. 9 sites are verified for saltpan which is found near Vedaranyam, 22 mud flats has been verified, and 24 Mangrove degraded places are verified, 4 places are considered for sandy area. 19 tanks are verified, based on the completion of the ground truth verification. The errors found are recorded and its modification on the classified imageries has been made.

The error matrix and Cohan's kappa (k) index have been calculated to measure the accuracy of classification. The error matrix has been performed based upon the square array of rows Cohmn's approach stated each row and each column represent a same habitat category of the classification. However, each cell comprises the number of sampling sites are given a exacting land use category (Meli Fokeng et al., 2020; Pitkänen et al., 2020). Usually, columns consist of reference data and rows from the source data.

Table 3. Ground truth verifications

Land Use/ Land covers	Agriculture	Aquaculture	Built Up	Dense Forest	Mangroves	Saltpan	Mud Flat	Mangrove degraded	Sandy Beaches	Water bodies	Total	User Accuracy
Agriculture	30			1	1						32	93.75
Aquaculture		17								1	18	94.44
Built Up			28				1	1			30	93.33
Dense Forest				27	1						28	96.43
Mangroves	2				23						25	92
Salt pan						9	1				10	90
Mud Flat						1	22				23	95.65
Mangrove Degraded					1		1	24			26	92.31
Sandy beaches							1		4		5	80
Water bodies										19	19	100
Total	32	17	28	29	25	10	26	25	4	20	216	
Producer Accuracy	93.75	100	100	93.10	92	90	84.62	96	100	95		

The confusion (error) matrix was used to calculate producer and user accuracy for each class (Table 3). The pixel classified as a given habitat on the image is truly that environment is known as user accuracy. The kappa index has been calculated to assess the accuracy of classification. Kappa index is played a major role to an appraisal of projected model and ground reality (Congalton, 1991) or this can

be an error matrix's values projected correctly then random (Temgoua et al., 2021; Tewabe & Fentahun, 2020) kappa is computed value shows user accuracy for land use categories (Meli Fokeng et al., 2020; Mishra et al., 2020; Pitkänen et al., 2020). The accuracy of agricultural land use is 93.75 percent and at the same time when considered the producer accuracy of agriculture is 90.91percent. Likewise, the user accuracy of aquaculture is 94.44 percent, while producer accuracy of aquaculture is 100 percent. Built-up Land comprises the user accuracy of 93.33 percent. While producer accuracy comprises 100 percent. Also, the dense forest user accuracy is 96.43 percent and producer accuracy of dense forest is also 96.43 percent. Mangroves comprise the user accuracy 92.00 percent and the producer accuracy is also 92.00 percentages. The salt pan user accuracy is 90.00 percentage as well as producer accuracy is 90.00 percent. Mud Flat user accuracy is 95.65m percentage and producer accuracy is 88.00 percentages. Mangrove degraded user accuracy of 92.31 percentages, and the producer accuracy of 96.00 percentages, the tanks user accuracy is 100.percentage and producer accuracy are 95.00 percentage. The overall accuracy has been calculated as 94.31 percent. Table 4 and Figure 9 shows the different land use categories for the years and changes over the years (1975-1895, 1985-1995, 1995-2005, 2005-2015).

Table 4. Land Use / Land Cover Changes

| Land use / Land Cover	Year wise Area in Sq. Km^2					Changes Area in Sq. Km^2			
	1975	1985	1995	2005	2015	1975-1985	1985-1995	1995-2005	2005-2015
Agriculture	227.5	192.1	215.5	171.3	211.5	-35.4	23.5	-44.2	40.2
Aquaculture	10.4	10.6	20	27.2	35.2	0.2	9.4	7.2	8
Built Up	3.1	3.9	4.9	5.2	6.6	0.8	1	0.3	1.4
Dense Scrub	26.5	18.6	26.2	18.1	25.5	-7.8	7.6	-8.1	7.4
Mangrove Degraded	7.8	7.8	8.1	31.5	6.3	0	0.3	23.5	-25.2
Mangroves	20.1	31.9	35.9	29.9	57.6	11.9	4	-6	27.8
Mud Flat	220.9	297.1	235.9	255.8	199.8	76.2	-61.2	19.9	-56
Salt Pan	11.8	33.4	35.7	31.7	48.9	21.6	2.3	-4	17.2
Sandy Beach	0.5	3.1	3.9	11.3	3.1	2.6	0.8	7.4	-8.2
Water bodies	156.1	86.3	98	102.1	89.8	-69.7	11.7	4	-12.2
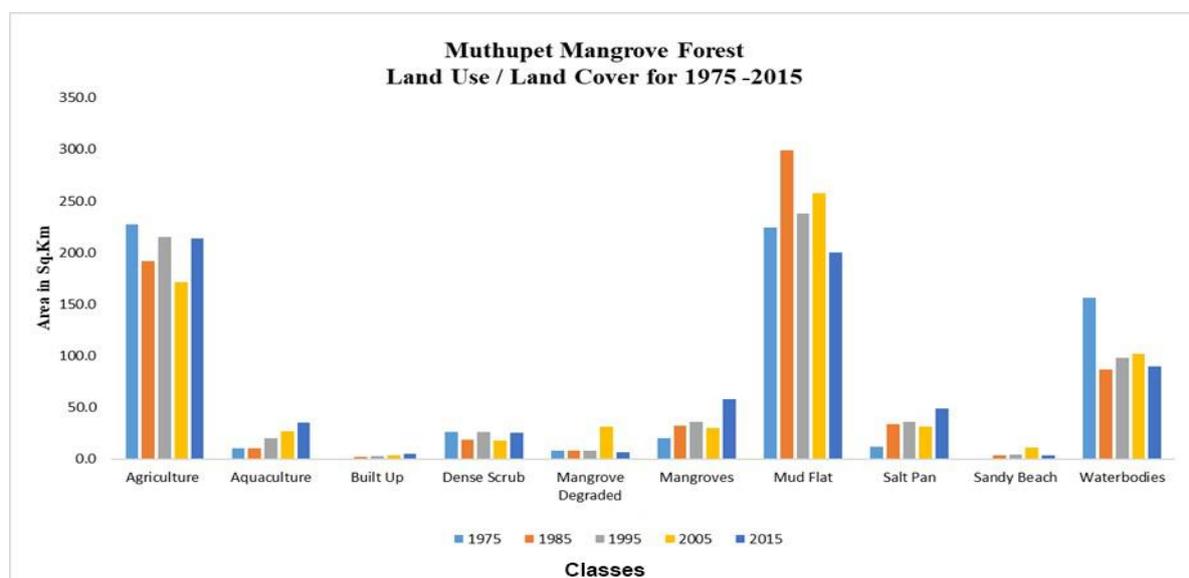
Figure 9. LULC temporal changes 1975 -2015

3.2 Land use Changes
Dense Scrub

The dense scrubs (Figure 9 and Table 5) found throughout year and it is easily identifiable on the satellite images. These are simply identified through tone texture and shape of the satellite imageries. It can be available Eastern part of the study area. Dense scrub covers about 26.5 km² (3.87 percent) in the year of 1975. While, 1985 the dense forest occupied an area of about 18.6 km² (2.72 percent), and third decade of the yeas in 1995 it has covered an area of about 26.2 km² (3.83 percent). Furthermore, in 2005 the dense forest has declined, and it covered an area of about 18.1 km² (2.65 percent) in 2005, and, in the year of 2015 it had improved an area of about 25.5 km² (3.73 percent). Therefore, the results show that fluctuated growth of scrubs between 1975 and 2015 (Ackom et al., 2020).

Mangrove Degradation

The degraded mangroves (Figure 9 and Table 5) can be found bordering of the mangrove forests, which might have declined due to the physical factors, and human interruption. In the year 1975 the mangrove degradation covered about 7.8 km² (1.14 percent). Where, in 1985 shown that the degraded mangrove covered an area of about 7.8 km² (1.14 percent) that means there has been no changes from 1975 to 1985. In 1995 had been occupied an area of about 8.1 km² (1.18 percent). In addition, the year 2005, degraded mangrove areas had highly increased which extended of 31.5 km² (4.60 percent), whereas, in the year 2015 shown the mangrove degraded area has occupied about 6.3 km² (0.92 percent). The overall result shows that fluctuated degraded mangrove forests are found in 1975-2015 (Temgoua et al., 2021). Specifically, during year of 2005 the degraded mangrove areas have increased. And it is due to tsunami disaster.
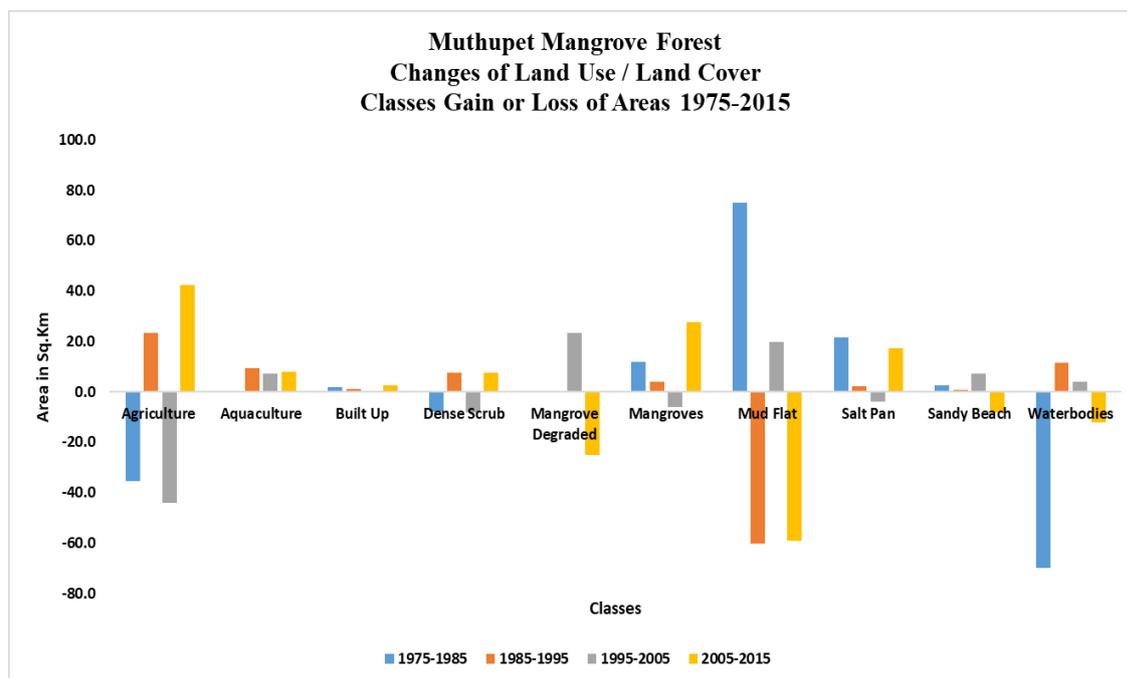

Figure 10. LULC gain and losses 1975-2015

Mangroves

This is generally associated with backwaters, where, fresh water and sea water mixed. The areas are suitable places for growing mangroves (Narmada & Annaidasan, 2019). In the year 1975 (Figure 9 and Table 5) mangrove status was very low and it covered an area of 20.1 km^2 (2.94 percent) and during the year 1985 it had increased to about 31.9 km^2 (4.66 percent). Whereas, in 1995 the mangrove forests has occupied an area of 35.9 km^2 (5.25 percent). During the year 2005 the mangrove forest has declined. Leftover's mangrove forests covered by tsunami disaster 29.9 km^2 (4.37 percent). In the year of 2015, it had increased because of strong mangrove management policy

Table 5. Land Use / Land Cover Changes in percentage Estimation of Area and its Changes 1975 – 2015

LULC Categories	LULC area in Percentage					Changes in percentage			
	1975	1985	1995	2005	2015	1975-1985	1985-1995	1995-2005	2005-2015
Agriculture	33.23	28.05	31.50	25.04	30.91	-5.17	3.45	-6.46	5.87
Aquaculture	1.52	1.55	2.92	3.98	5.14	0.03	1.38	1.05	1.17
Built Up	0.45	0.57	0.72	0.76	0.96	0.12	0.15	0.04	0.20
Dense Scrub	3.87	2.72	3.83	2.65	3.73	-1.15	1.11	-1.18	1.08
Mangrove Degraded	1.14	1.14	1.18	4.60	0.92	0.00	0.05	3.42	-3.68
Mangroves	2.94	4.66	5.25	4.37	8.42	1.72	0.59	-0.88	4.05
Mud Flat	32.26	43.38	34.78	37.39	29.20	11.12	-8.90	2.91	-8.19
Salt Pan	1.72	4.88	5.22	4.63	7.15	3.15	0.34	-0.58	2.51
Sandy Beach	0.07	0.45	0.57	1.65	0.45	0.38	0.12	1.08	-1.20
Water bodies	22.80	12.60	14.33	14.92	13.12	-10.20	1.72	0.60	-1.80

3.3 Human Activities

Agriculture

Muthupet and its surrounding area can be called as Muthupet forest where can be found agricultural areas across the top of the region (Figure 9 and Table 5), and it can be affected by the various natural calamities in every monsoon. The human interruption has been found very less and the local community has been following the coastal zone management policies. There are some coastal zone land uses found, such as plantation and large cemeteries. However, in the year 1975 the agricultural land area was 227.5 km2 (33.23 percent) whereas during the 1985 it had covered only of 192.1 km^2 (28.04 percent). In 1995, an agricultural area had been occupied 215.5 km^2 (31.50 percent), as well as in the year 2005 the agricultural land comprised of 171.3 km^2 (25.04 percent)(Mishra et al., 2020). In 2015 it increased about 211.5 km^2 (30.91 percent). Thus, the results show fluctuated distribution of agricultural land between 1975-2015.

Aquaculture

The present study has examined that the aquaculture has been practicing from 1975 onwards (Figure 9 and Table 5), and it seems that gradually, these are found to have positive changes near to brackish waterline. In the year 1975 the aquaculture area can be sited in the Western region of study area and it covered an area 10.4 km^2 (1.52 percent). In 1985, aquaculture covered an area 10.6 km^2 (1.55 percent), and during 1995 aquaculture has little increase in the area of 20.0 km^2 (2.92 percent) and in the year 2005 it has been found as 27.2 km^2 (3.98 percent). During the year 2015 the aquaculture has rapidly increased and it has covered a 35.2 km^2 area of (5.14 percent) it gradually increased during the period of 1975 – 2015 (Tewabe & Fentahun, 2020). The increased areas have been converted from mud flat areas.

Built Up

The built-up area naturally consists of places such as settlements, cemeteries, dumping areas, water-control structures and channels. New land developments occur, in one part of built-up area in the urban (Figure 9 and Table 5). Open land may be in intensively used are found as urban playgrounds (Bogale, 2020). However, In 1975 the urban built up land covers 3.1 km^2 (0.45 percent), In 1985 the urban built up land occupied an area of 3.9 km^2 (0.57 percent) and in 1995 it has covered 4.9 km^2 (0.72 percent). In the year 2005 the urban land increased and amounted to 5.2 km^2 (0.76 percent). In the year of 2015 the urban built-up land has increased to 6.6 km^2 (0.96 percent). The results revealed the urban built-up area increased gradually.

3.4 Landscape Features
Mud Flat

The mud flat is found along the seashore where the shore is protected from the waves. It has formed over the river entrance where a river and the ocean meet. An estuary is the name given to the entire area. Fine sediments are carried by the moderate movement of seawater towards the inland area, as well as by the slow movement of the river (Vivekananda et al., 2021). Mud flats can be assessed by land use and land cover analysis (Figure 9 and Table 5). Accordingly, 1975 comprises an area 220.9 km^2 (32.26 percent). During the year of 1985 the mud flat has highly increased due to deposition, which is about 297.1 km^2 (43.38 percent), and 1995 the mud flat has consisted an area of about 235.9 km^2 (34.48 percent). During the year of 2005 it shows that enormous sediment has occurred, it has covered an area of about 255.8 km^2 (37 .39 percent). In the year of 2015, it has little reduction is the overall assessment of mud flat shows that fluctuated growth has occurred at between 1975-2015.

Salt Pan

The salt pan expansions of ground cover increase salt and other minerals. It covers the Eastern part of Muthupet region, especially, it has been found near Vedaranyam coast. During the year 1975 the salt pan (Figure 9 and Table 5) covers an area of about 11.8 km^2 (1.72 percent). In the year of 1985, it covers an area of about 33.4 km^2 (4.88 percent). During the year of 1995 the salt pan comprises an area of 35.7 km^2 (5.22 percent); in the year of 2005 the salt pan shows that it has increased about 35.7 km^2 (5.22 percent), in the year 2015 the salt pan has increased enormously (Cleyndert et al., 2020).

Sandy Beaches

Generally, sand beaches are one of the most common aspects of a shoreline, which is composed of eroded material transported from elsewhere and deposited by the sea (Annaidasan, 2017). On beaches, effective waves would form. During the year of 1975 (Figure 9 and Table 5), the results show that sandy beaches cover an area of about 0.5 km^2 (0.07 percent) which compare with in the year of 1985 the sandy beaches have increased to 3.1 km^2 (0.45 percent) In the year of 1995 it has comprised of an area of about 3.9 km^2 (0.57 percent), In the year of 2005 the sandy beaches have little prolonged and it has area of 11.3 km^2 (1.65 percent). During the year 2015 it has covered an area of about 3.1 km^2 (0.45 percent). Therefore, overall results show that the Sandy beaches showed a fluctuated growth during 1975-2015.

Water Bodies

The term of water bodies (Figure 9 and Table 5) can be represented i.e. seas, and lakes, and it also consider the smaller pools of water such as ponds, wetlands, or more rarely, lakes. In 1975, the water bodies covered an area of about 156.1 km^2 (22.80 percent), and during the year 1985 it has comprised an area of about 86.3 km2 (12.60 percent) In the year 1995 the water bodies have covered an area of about 98.0 km^2 (14.33 percent), and, during the year of 2005 it has consisted of in 102.1 km^2 (14.92 percent)(Thakur et al., 2021). In 2015 it has comprised 89.8 km^2 (13.12 percent).

4. Conclusion

The study has exposed the land use changes from the 1975 to 2015, and it has examined for the past 40 years through every 10 years interval. There are 10 land use categories were considered, where an agricultural land use changes were occurred throughout the period. Furthermore, aquaculture practices gradually increasing since 1975 to 2015, and substantial changes were occurred 1985 to 1995, the study exposed the status of mangrove forest at Muthupet region. In addition to built up areas are covered lesser amount area since it has been locating at highly sensitive area i.e. coastal wetlands. The study helped to understand the land use and land cover categories and their change from 1975 to 2015 across the Muthupet region. Furthermore, ground truth verification were rectified the system errors. Consequently, increasing of mangrove forest with help of strong protection policy of the country. The study emphasis to the local authority dynamics of mangrove forest will effects of socioeconomic variables, and promote the environmental conservation for sustainable management plan.

Conflicts of Interest

The authors declare no conflict of interest.

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