Research Article

Application of post Classification in Landuse & Landcover Stratagies at north Chennai Industrial Area

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Abstract

Northern Chennai is highly urbanized due to rapid industrialization, in this Manuscript, we are present a comprehensive set of indicators and put forward a new evaluation method for measuring environmental impacts of urbanization. With the effective use of GIS tool in remote sensing data, the Land Use and Land Cover change strategies of north Chennai industrial area are analysed and discussed. Landsat TM images of this area is downloaded and processed in GIS tool for the year 1992, 2005 and 2015 to produce the LULC change maps. These maps are used to assess the area of four types of classes which are Water, Barren, Greenery and Builtup. From this analysis, it is concluded that the barren land is drastically occupied, constructed and converted into buildup lands from 1992 to 2015. The rapid urbanization due to industrial expansions in this area has maximized in the last two decades, some portions of water bodies and greenery land have been converted into buildup land. This leads to increase of livelihood demands and various types of pollution. Effortless use of remote sensing and GIS technique is helpful in understanding the situation that exists in this type of complex zones. The information derived from this type of studies can be utilized in future management of Urbanization and towards sustainable development.

Keywords: Remote sensing, GIS, Urbanization, Industrialization, Environmental Impact

Introduction

Consequence of human activities in the environment can be assessed using the LULC (Land Use Land Cover) change analysis and has become a fundamental tool. Land cover mapping serves as a basic inventory of land resources.Rate of deforestation and the most relevant transformation pathways of forested land also can be identified through a detailed analysis of landuse and land cover change (Sandoval et al 2007). Chennai is the capital of Tamilnadu and fifth most populated metropolitan city in India as per 2010 census, which has numerous industrial areas in its fringes (Brindha et al 2014). Over recent years, Chennai City has experienced a rapid increase in the extent of urbanization and the growth of population due to migration of the people to the city. This has increased the pressure on the livelihood demands of the metropolitan city.Increased population demands, additional urbanization and increase of industrial activities have burdened the ecosystem so much that it cannot rejuvenate itself.Generally,land use practices increase over a long period under different environmental, political, demographic, and social conditions.This has to be monitored and understood with the help of GIS Tools and Remote sensing knowledge (Cabral et al 2005). Remote sensing and GIS techniques are effective and reliable tools in mapping the land useand land cover of an area. The remote sensing data integrated with GIS gives a wide range of new perspectives and possibilities for the analysis, evaluation and interpretation of data,

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in combination with auxiliary digital information such as digitized maps(Keita and Zhang 2010). Land use and land cover information of landscape patterns, changes and interactions between human activities and natural phenomenon are important for proper land management, planning and decision improvement activities concerned with the surface of the earth(Boori et al 2015, Sharun et al 2011). To estimate temporal rates of changes or to model long term changes, the vector files of landuse classes that produced by remote sensing technique can be used in GIS (Jaunzeme et al 2015). This study is to analysesthe changes in land use and land coverof north Chennai industrial zone using remote sensing and GIS technique over the period from 1992 to 2015.The post classification analysis gives a better understanding of the landuse and landcover changes which may helps in urban management and developments.

Study Area

The study area is covers a part of the north most region of Chennai city (Fig1).The study area lies between latitudes13°09′ N & 13°14′ N and longitudes 80°16′ E & 80°20′ E.The total area of the selected region is around 60km^2 andhaving flat topography with very gentle slope towards east.The Land surfacealtitudes vary from 10 m above MSL in the west to sea level in the east.Meandering streams with small sand bars are there along the path of Kosastaliyar River.The ecological system is not more disturbed in around the forest area of the study area while the other areas arefully disturbed by built up area with large-scale anthropogenic interference and pollution. Variation of the overall surface area of the study area in different period is due to the extent of coastal landscape is rapidly changing because of coastal processes (Prabaharan et al 2010). Tropical climate condition of the area makes the weather hot most of the time in a year. The temperature ranges between 38˚C to 42˚C during May to June and varies from18˚C to 32˚C during December to January. In1200mm of average rainfall, 60% is contributed by Northeast (October to December) monsoon and 40% by Southwest (July to September) monsoon annually.Cyclones forms in the Bay of Bengal also give precipitation occasionally in this area (Brindha et al 2014). The area comprises backwaters and salt marshes. The fluvial cycle dominates the marine processes in these areas. The longitudinal sand dunes, is present near the coastal zone, were formed due to coastal progradation. This zone comprises lagoonfacies with salt marshes and backwaters which are submerged under water during high tide and form an arm of the sea with the opening to the sea at Ennore creek.Many petroleum industries and fertilizer manufacturing industries are situated in this region.

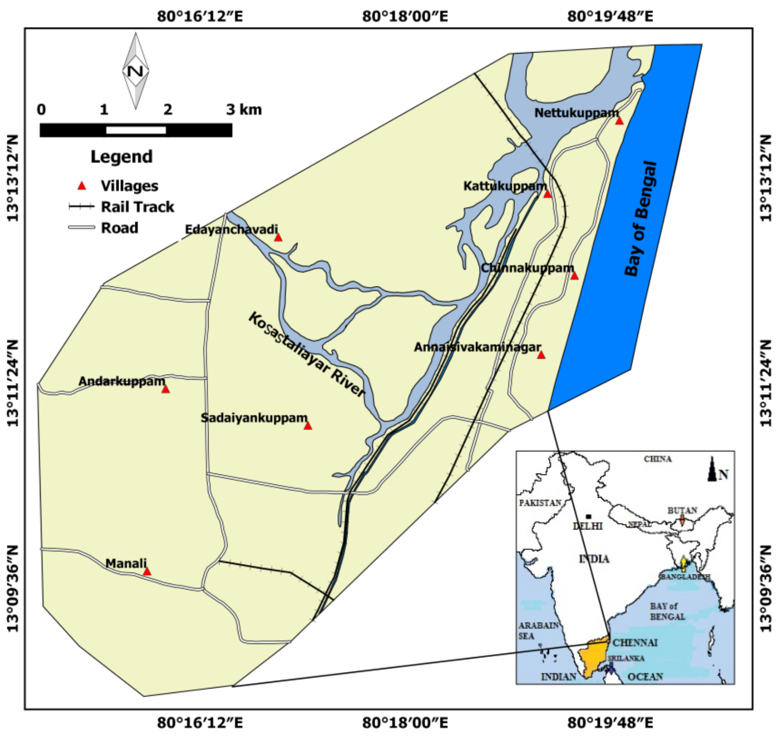


Figure 1.Study area map of the Manali region

Methodology

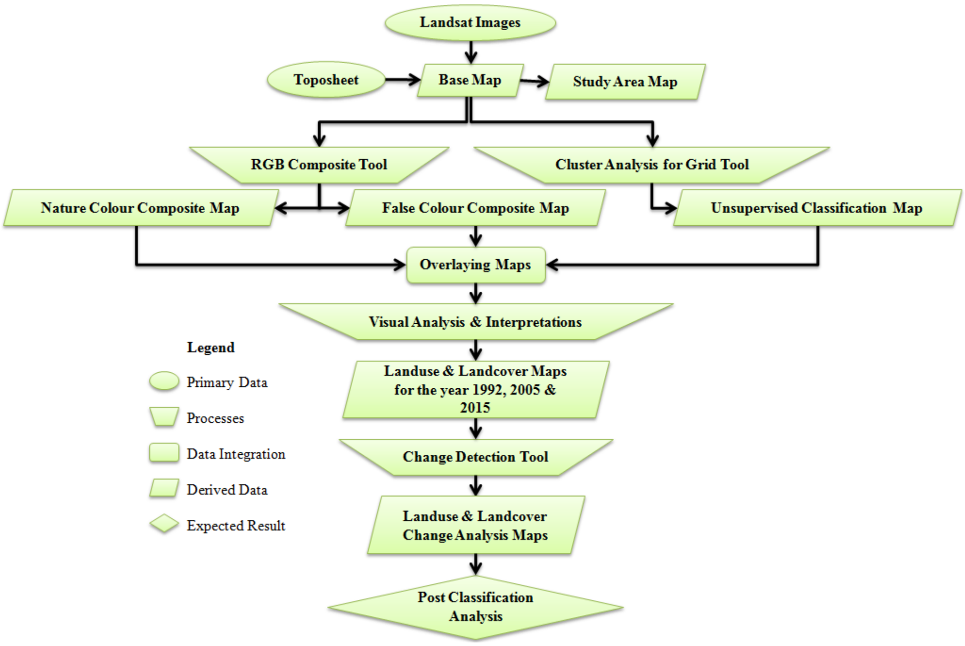


Figure 2.Methodology Flowchart

Survey of India toposheets of 1984 scaled 1:50,000 were used to prepare the base map for the study area. 1972 is marked as the beginning of satellite remote sensing for a renewable application which was the year Landsat-1launched (Bauer and Coppin 1996). Landsat TM cloud free images of 30m resolution (Ghosh et al 2015) from the USGS portal for the years 1992, 2005 and 2015 were downloaded and registered in the Qgisv.2.12 Lyon software. The imagery particulars are given in the Table1.

Table 1.Satellite Imagery Particulars

Sl.No.	Scene 1	Scene 2	Scene 3
Satellite	LANDSAT_5	LANDSAT_5	LANDSAT_8
Scene Identifier	LT51420511992016ISP00	LT51420512005259BKT00	LC81420512015287LGN00
Date Acquired	16-01-1992	16-09-2005	14-10-2015
Format	GEOTIFF	GEOTIFF	GEOTIFF
Sensor Mode	SAM	BUMPER	OLI_TIRS
Coordinate System	WGS84/UTM Zone 44N	WGS84/UTM Zone 44N	WGS84/UTM Zone 44N
WRS Path/Row	142/051	142/051	142/051

Preprocessed satellite images are loaded in to the Saga GIS (v.2.1.2) which is integrated and available within the Qgis platform (Jayaseelan et al 2014). Nature color or true color composite maps (Fig3) were produced using the red, green and blue bands (Sharun et al 2011) of the each scene in the module "RGB Composite". Subsequently false color maps (Fig4) using the bands green, red and infrared were produced in the same module "RGB Composite" for each scene (Hughes and Hayes 2014). These two composite maps are used later in assigning the classes for each cluster of classified images. The name of the classes which is set to classify the images is given in the (Table2) with their descriptions.

Table 2.Classes and its Descriptions

Sl.No.	Class	Description
1	Water	All the water logged areas
2	Barren	Unused lands, waste lands, uncultivated lands, open scrubs, sandbars and beaches
3	Greenery	Agriculture fields, forest, bushes and scrubs
4	Builtup	Residential areas, Industries and pavements

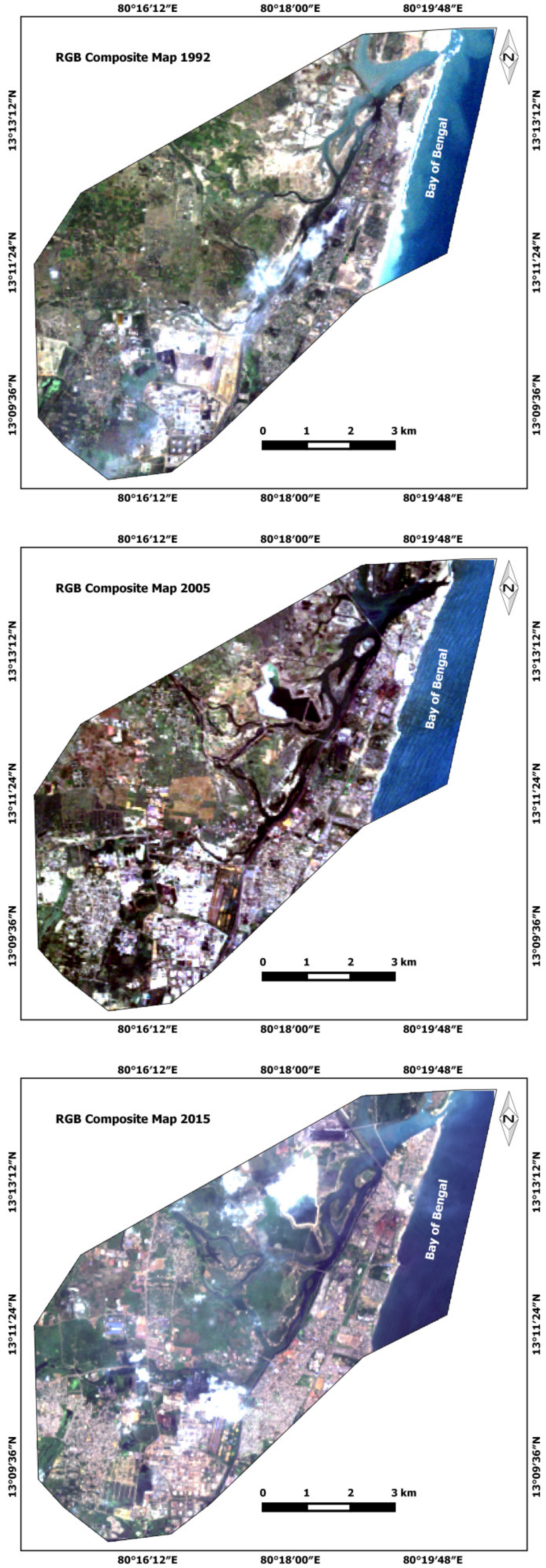


Figure 3.Nature Color or True Color Composite Maps (Red Green Blue)

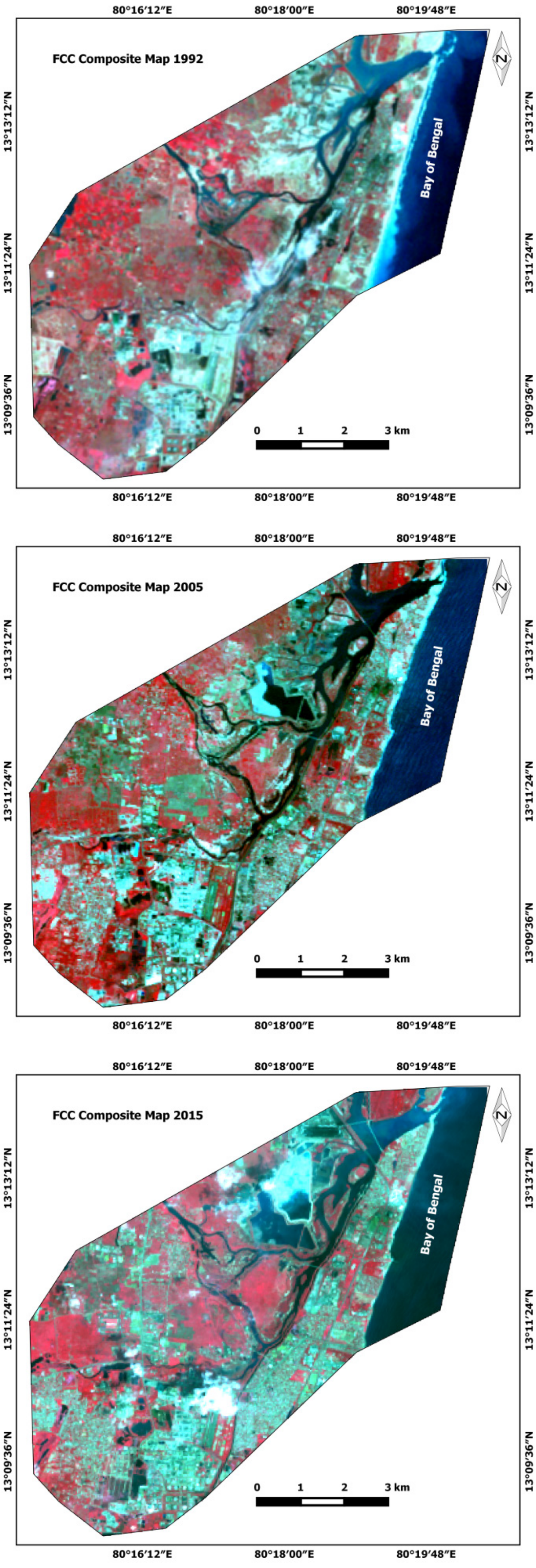
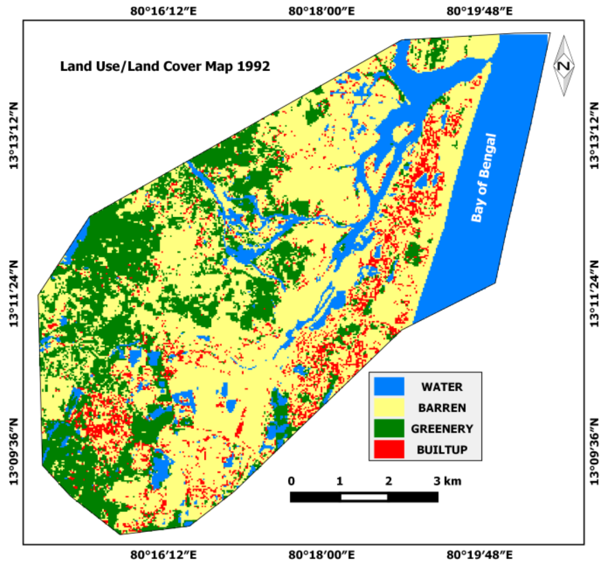
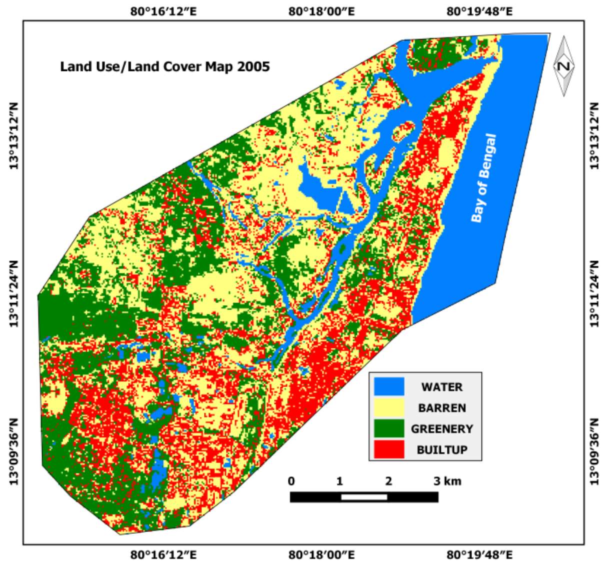


Figure 4.False Color (Green, Red & Infrared) Composite Maps

All the bands of each image are processed in the Saga module "Cluster analysis for grids" to produce unsupervised classification map. Generally known classification method are unsupervised and supervised Classification. However there are large number other classification methods also (Prabhakar and Tiwari. 2015).The method of classification is"Hill – climbing (Rubin. 1967)" and the number of clusteris 100. Later the classified layer has been overlayed on the RGB and False color layers of respective years. The pattern, tone or color, shadow, texture, shape, size, location, convergence of evidence and its association of each cluster were visually analysed and interpreted(Paine and Kiser. 2012) with integration of respective Nature color and false colour composite maps before assigning the classes.The assigned class values for Water, Barren, Greenery and Builtup is 1, 2, 3 & 4. The cluster values for the each map have been changed using the "change grid values" module from saga module library into assigned respective class values. The final output of landuselandcover map for the selected years is shown in the (Fig5). As per the changed cluster values of the classified maps, each classes has been vectorisied into single shape of multi polygon file and the area of classes has been calculated using the field calculator which is given in the Table3. To detect the changes and measure the area of changed classes from 1992 to 2005, 2005 to 2015 and 1992 to 2015, all the classified maps were processed in "change detection" module and resultant maps are shown in the (Fig6). The each changed classes are converted in to shape file format and the area is calculated using the field calculator and given in the (Table6).





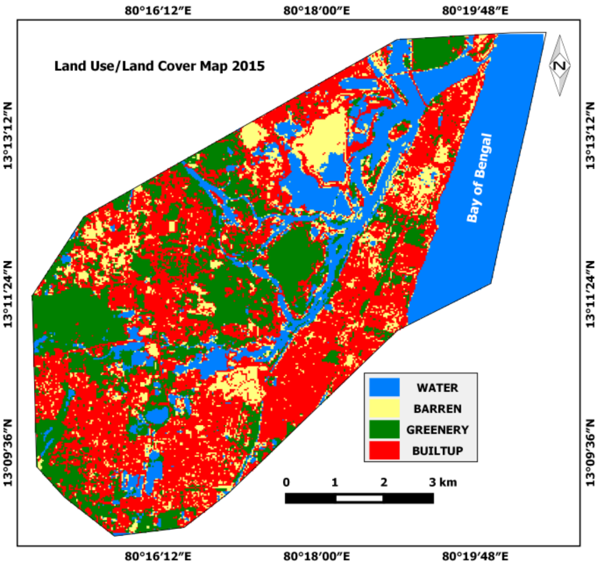
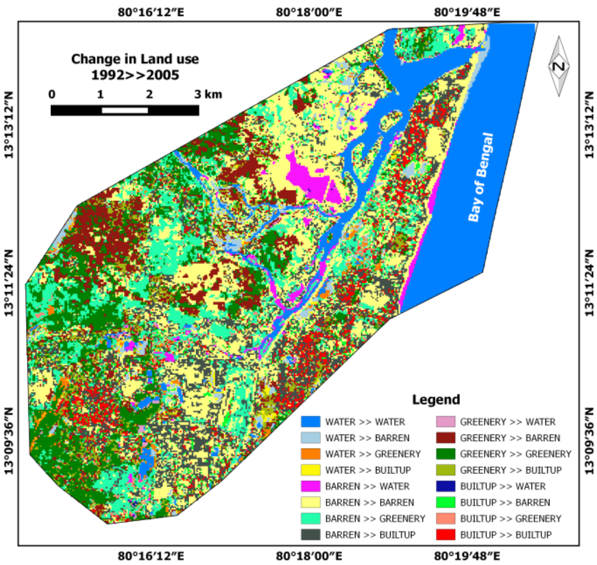
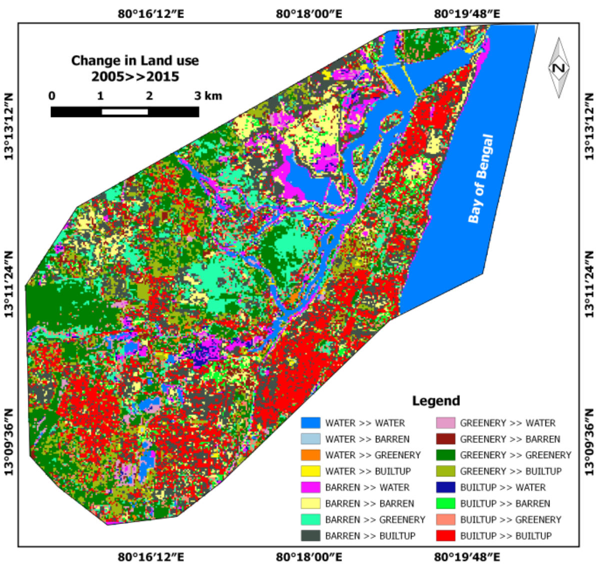


Figure 5.Land Use & Land Cover Classified Maps





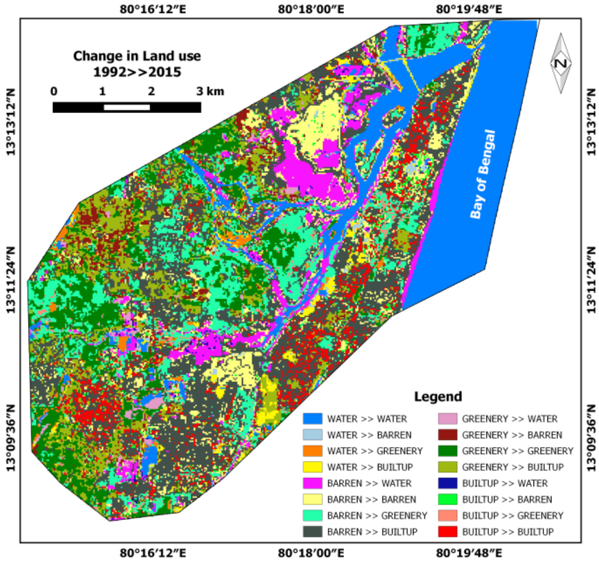


Figure 6.Land Use Land Cover Change Analysis Maps

Results and Discussions

According to the obtained results (Table3), the bar chart shows (Fig7) graphically the area of each classes in selected years and the overall percentage of classes which existed in the time of image taken is illustrated in the pie charts (Fig8). During 1992 barren land covered 56% of the total area followed by greenery land about 26% whereas water logged area and builtup area was 10% and 8%. In 2005 barren land decreased to 39% and the greenery land, builtup area increased to 28%, 24% respectively, whereas the water loglost 1% of its area in 2005. Builtup area in 2015 drastically increased to 47% and seems to be that rapid urbanization is maximum due to industrial expansions. Water logged area increased to 14%, barren land decreased to 13% whereas the greenery land remains same about 26% in 2015. Compared to 1992, the barren land use of 8.9 km^2 has been converted into other classes that is during 2005; in 2015 it is increased to 15.6 km^2 while comparing with 2005(Table4). The builtup land increased from 1992 to 2005 that is about 9.3 km^{2}and in 2005 to 2015 periods it was 14.2 km^2.Water and greenery land area did not alter that much when compared with barren and builtup lands. The rate change of class is calculated usingthe Formula 1. Rate of Change = (Difference in Class Area / Number of Year in a period) and the obtained results are given in the (Table5) and accordingly (Fig9) illustrates the difference in area of classes in different periods. Barren land decreased at a rate of 0.69, 1.56 and 1.07 km^{2}per year during the periods 1992-2005, 2005-2015 and 1992-2015,whereas the builtup increased at a rate of 0.71, 1.42 and 1.02 km^2 per year during the same period. However the water logged area and greenery lands did not increase or decrease at the rate above of 0.5 km^2/year;it is because these classes depend upon the rainfall. This shows that the growth of industrial activities led to occupation of the barren lands and converted it as constructed land surface. The (Fig7) illustrates the temporal variation of classes as bar chart and illustrates clearly the decreased trend of barren land and increased trend of builtup land during 1992, 2005 and 2015.

The change detected class map (Fig6) gives the information of the changed classes and the unchanged classes during the periods 1992 to 2005, 2005 to 2015 and 1992 to 2015. The (Table6)and (Fig9) shows the area of changed and unchanged classes during the period 1992 to 2005, 2005 to 2015 and 1992 to 2015. Unchanged area of water log, barren, greenery and builtup land from 1992 to 2005 is about 3.62, 14.72, 7.09 and 2.38 km^2(Grey shaded cells in the Table6 are the unchanged class area). About 8.63 and 8 km^2 of barren land was changed intobuiltup and greenery land. However 4.98 and 1.56 km^2 of greenery and builtup land changed in to barren land. In 2005 to 2015, the 4.27 , 4.51 , 8.85 and 10.7 km^2 area of water log, barren, greenery and builtup lands remains same, whereas barren land of about 10.93 and 4.51 km^2 has been changed in to builtup and greenery land respectively. The water logged area of about 0.9 km^2 area is changed into other landcover classes.

This result clearly shows that during 2005 to 2015 period barren land was highly occupied by various industrial buildings and it will increase the livelihood demands of the area rapidly. The ecosystem of the study area will get affected by various types of pollution due to rapid increase of industrialization and urbanization. Over all from 1992 to 2015 the 16.78 km^2 barren land was converted into buildup land is the maximum change of class while compared with other change of classes and it is followed by barren to greenery land: 7.38 km^{2}areas are changed. The ratio between the classes that changed is given in the (Table7). The ratio of change between barren to builtup and builtup to barren is 23.96:1 during the period from 1992 to 2015. It means that, if 1% of builtup land is changed into barren, 23.96% of the barren land is changed into buildup land from 1992 to 2015. Whereas the same changed classes ratio in 1992 to 2005 and 2005 to 2015 is 5.54 and 6.54:1. It is obtained that barren to buildup land change is predominant from 1992 to 2015(Fig10). All these results and discussions lead to conclude that study area experiences rapid urbanization as a result of Industrial expansions. Increase in industrial activities attracts lots of people who seek employments in those industries and settle in near the same industries which lead to the rapidness of urban growth in the study area.

Table 3. Calculated Area for each class in selected years

Id	Class	1992_Area (km²)	1992_Area (%)	2005_Area (km²)	2005_Area (%)	2015_Area (km²)	2015_Area (%)
1	Water	6.1	10	5.2	9	8.4	14
2	Barren	32.5	56	23.6	39	7.9	13
3	Greenery	14.9	26	17.0	28	15.8	26
4	Builtup	4.8	8	14.1	24	28.3	47
Total Area		58.4	100	59.8	100	60.4	100

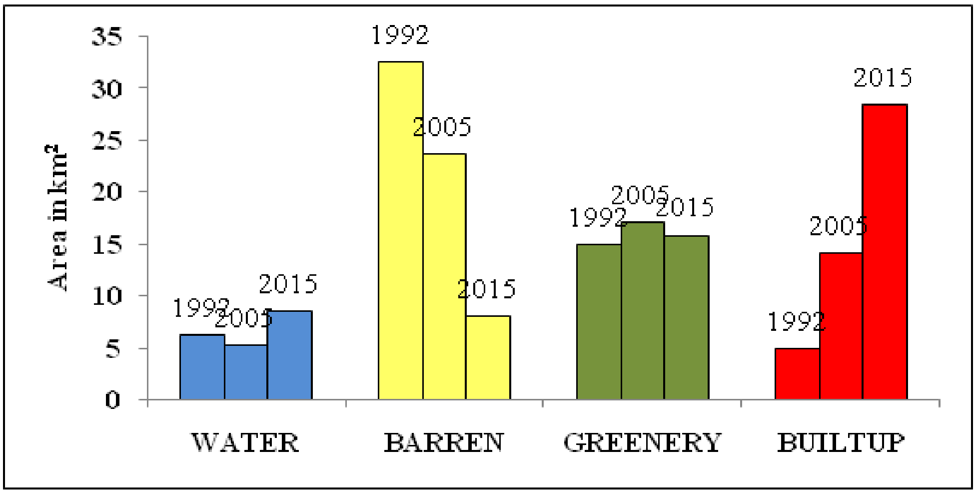
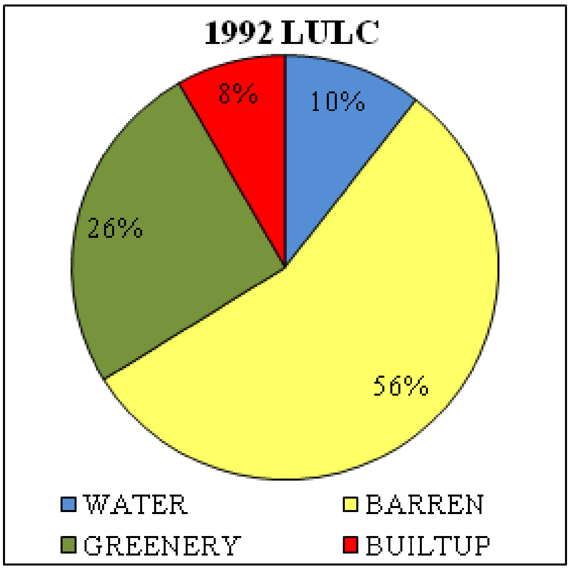
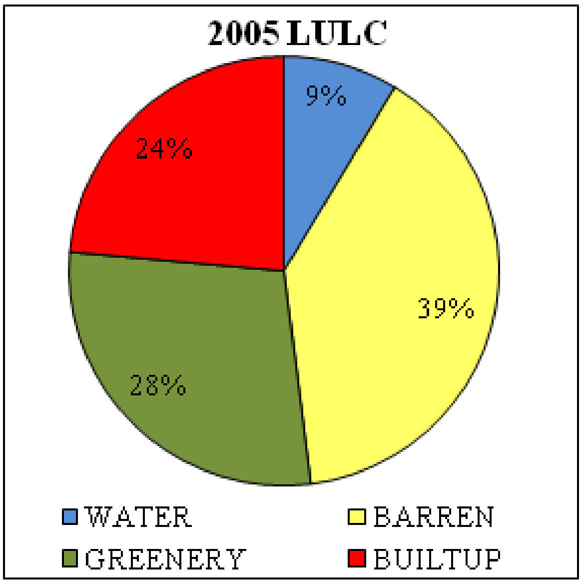


Figure 7.Bar-chart shows the area of classes in selected years





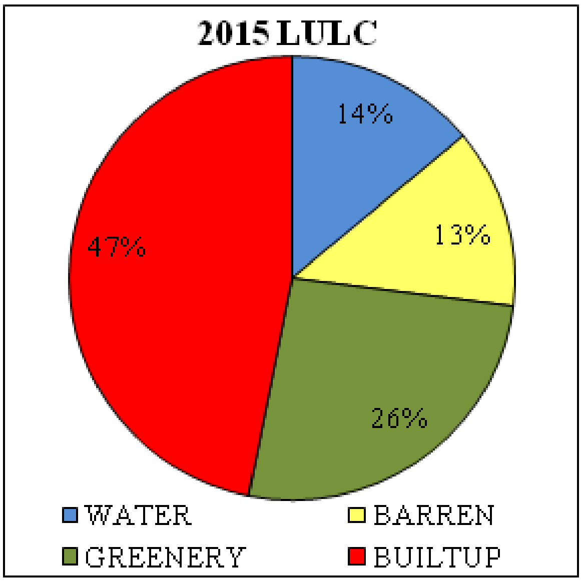


Figure 8.Pie-charts illustrates the percentage of each class in selected years

Table 4.Temporal difference of class area

Id	Class	1992-2005 (km²)	2005-2015 (km²)	1992-2015 (km²)
1	Water	-1.0	3.2	2.3
2	Barren	-8.9	-15.6	-24.6
3	Greenery	2.1	-1.2	0.9
4	Builtup	9.3	14.2	23.5
(-value decrease) (+value Increase)				

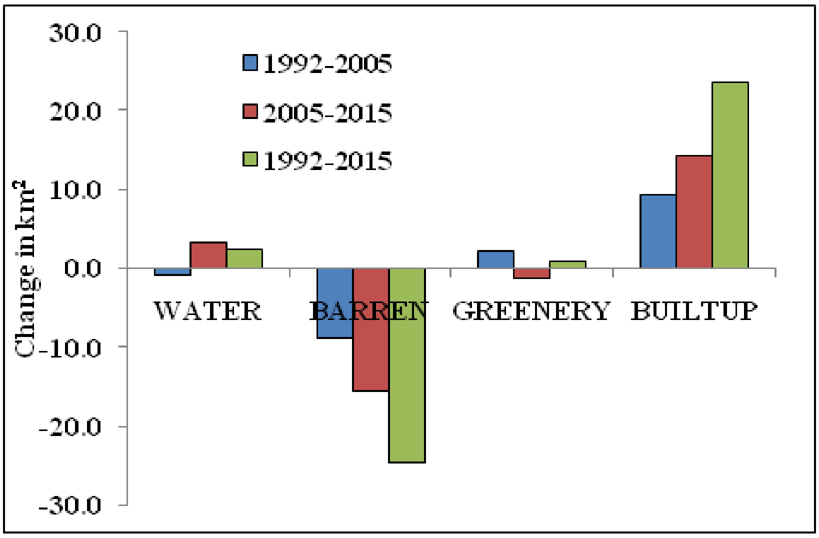


Figure 9.Difference in class area in different periods

Table 5.Rate of changes in each class for the periods

Period	No. of years	Water (km²/year)	Barren (km²/year)	Greenery (km²/year)	Builtup (km²/year)
1992-2005	13	-0.07	-0.69	0.16	0.71
2005-2015	10	0.32	-1.56	-0.12	1.42
1992-2015	23	0.10	-1.07	0.04	1.02
(-value decrease) (+value Increase)					

Table 6.Calculated area of changed classes in selected periods

Id	Class 1992>>2005	Water	Barren	Greenery	Builtup
1	Water	3.62	1.63	0.66	0.37
2	Barren	1.56	14.72	8.00	8.63
3	Greenery	0.16	4.98	7.09	2.15
4	Builtup	0.05	1.56	0.81	2.38
	Total	5.38	22.89	16.57	13.53
Id	Class 2005>>2015	Water	Barren	Greenery	Builtup
1	Water	3.76	0.53	0.72	1.17
2	Barren	4.04	5.19	7.38	16.78
3	Greenery	0.69	1.52	6.78	5.51
4	Builtup	0.23	0.70	0.75	3.13
	Total	8.59	7.98	15.61	26.46
Id	Class 1992>>2015	Water	Barren	Greenery	Builtup
1	Water	4.27	0.27	0.28	0.35
2	Barren	2.68	4.51	4.75	10.93
3	Greenery	1.08	1.52	8.85	5.10
4	Builtup	0.56	1.67	1.74	10.07
	Total	8.72	7.94	15.62	26.58
Column(Change(>>))Row		Area (km²)			

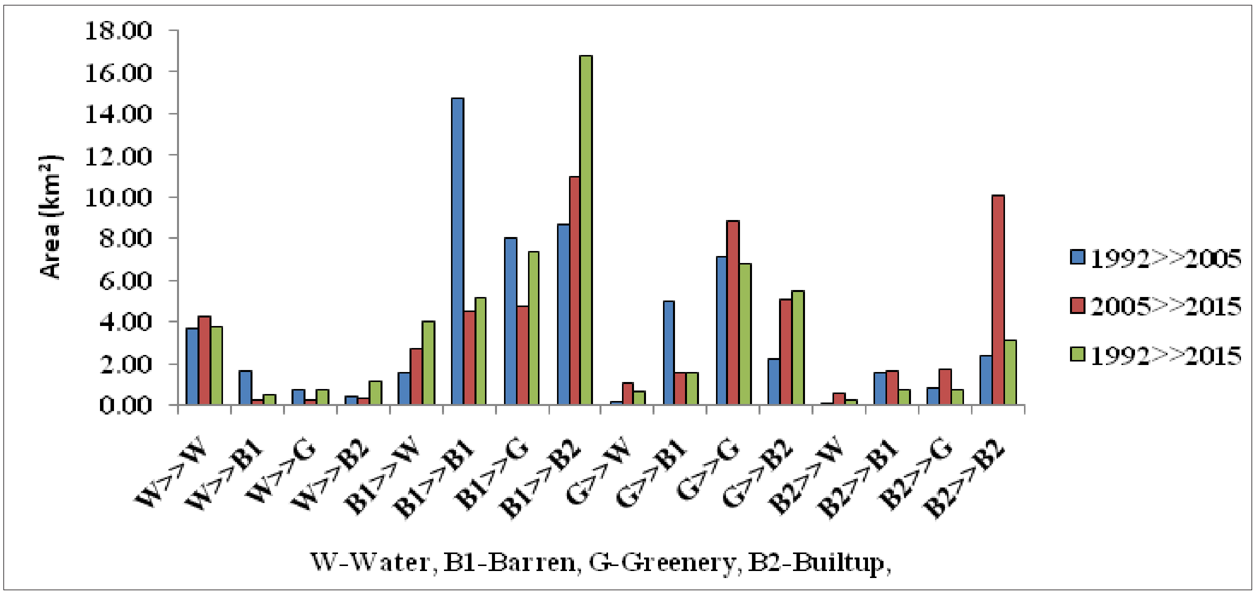


Figure 10.Bar-Chart shows the temporal variation changed classes

Table 7.Ratio between changed classes

Ratio	1992>>2005	2005>>2015	1992>>2015
(W>>B1)/(B1>>W)	1.05	-	-
(W>>G)/(G>>W)	4.14	-	1.04
(W>>B2)/(B2>>W)	8.22	-	5.18
(B1>>W)/(W>>B1)	-	9.98	7.64
(B1>>G)/(G>>B1)	1.61	3.12	4.85
(B1>>B2)/(B2>>B1)	5.54	6.54	23.96
(G>>W)/(W>>G)	-	3.91	-
(G>>B2)/(B2>>G)	2.65	2.93	7.38
(B2>>W)/(W>>B2)	-	1.60	-
W-Water, B1-Barren, G-Greenery, B2-Builtup			

Conclusions

The effective use of GIS tools in remote sensing data has been successfully utilized in this study area to come up with results that explains the various land use land cover changes from 1992 to 2015 and the interpretation of results shows that the barren land is altered rapidly during the selected period and is reduced from 32.5 to 7.9 km^2, whereas the buildup land drastically increased during the same period from 4.8 to 28.3 km^2. Water log and greenery land area seem not to be altered that much when compared with the barren and builtup land. In the temporal changes of classes, barren shows decreased trend and the builtup shows increased trend, this gives an idea that barren land is converted in to other land class in which builtup is maximum due to industrialization and urbanization. The rate of change of classes is doubled during the period 2005 to 2015 when compared with the 1992 to 2005. It is the key to realize that urbanization and industrialization increased from 2005 onwards. However some parts of the area of all the classes remain the same in 1992 to 2015. The change detection results clearly show that the change of barren land into builtup land is higher from 1992 to 2015. If it continues the ecosystem of this area will have highly threatened due to various types of pollution that triggered by industrialization and rapid urbanization. This type of studies and its valuable information can be utilized in proper planning to control the urban growth and site specific industrializations. This study also reveals that with the help of remote sensing and GIS tool land use and land cover change strategies can be effortlessly impact assessed.

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