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Cell : 9595 359 435, Ph No: 02172372010 Email: ayisrj@yahoo.in Website: www.aygrt.isrj.org



IMPACT OF URBANIZATION ON THE NATURAL ENVIRONMENT – A CASE STUDY OF SOUTH CHENNAI



Sunil Kumar Singh A¹ and V Madha Suresh²

¹Assistant Professor (Dept. of Geography, School of Earth Sciences, Central University of Karnataka, Kadangachi, Kalaburgai)

²Professor (Dept. of Geography, University of Madras, Chepauk, Chennai)

ABSTRACT:

Rapid Urbanization has induced a marked change in the land use dynamic of any urban area. This change is more rapid in the suburban areas of major metropolitan cities. The present study tries to evaluate the land use changes in the urban fringe of south Chennai city and measure the impact of urban expansion on the natural environment of South Chennai. Eleven wards of the Chennai Metropolitan Authority (Perungudi, Okkiyamthuraipakkam, Karapakkam, Solinganallur, Perumbakkam, Medavakkam, Pallikaranai, Kulathur, Jaladampetti, Madipakkam, Puzhuthivakkam) are chosen for the study. The land use changes are measured using satellite data for three decades. Level I, Land use classification listed devised by James Anderson (1976) have been used for the deduction of land use. The study has found that the area under settlement has increased rapidly at the cost of the Natural Environment, one of them being a wetland (Pallikaranai Wetlands), which are one of the most sensitive ecosystems.



KEY WORDS: Natural Environment , Urbanization , economic development.

INTRODUCTION:

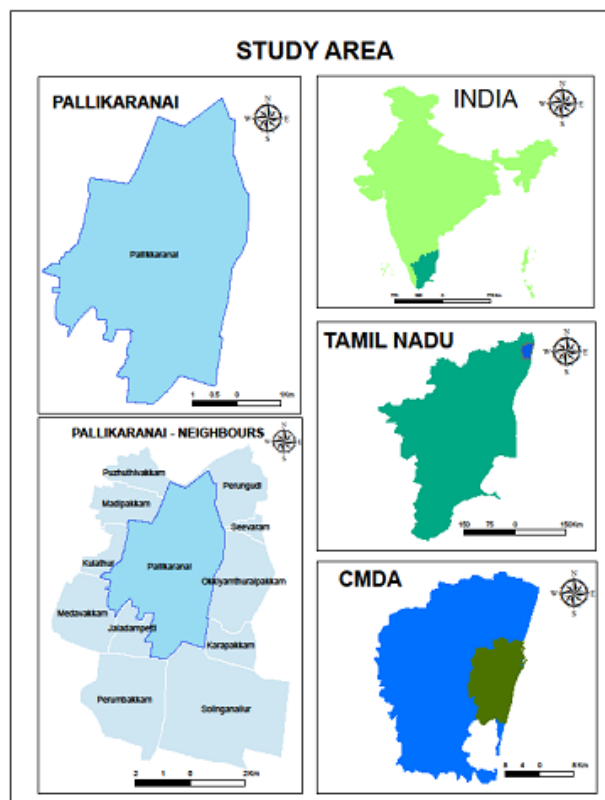
Urbanization is the process by which cities and towns develop and grow into larger areas.

It includes the movement of people from rural to urban areas as well as movements among towns and cities (UNHABITAT et al, 2002). Even though cities are considered as the 'engines' of economic development, failure to manage the impacts of rapid urbanization provides a threat to the health of human beings, as well as environmental quality and urban productivity (Leitmann et al, 1992). According to Drakakis Smith (2000) the increase in the number of urban residence basically the poor whose main aim is to mainly survive as best they can is at the cost of the environment. According to the United Nations Population Fund (2005), rapid and unplanned growth of cities caused by migration and natural increase has outpaced governments' abilities to provide basic services causing a crisis in living conditions. This clearly exacerbates the

problem of protecting the natural environment as a shortage of social facilities means that individuals have to find various means of survival, which frequently entails a compromise regarding the degradation of natural resources. Population increase and accompanying land-use activities are a threat to the natural environment (Rakodi and Treloar, 1997). A Land use and land cover change plays a major role in the study of changes in any natural environment. Land use or land cover changes by human and through natural means have resulted in deforestation, bio-diversity loss, global warming and increased natural disaster mainly flooding (Rogana and Chen, 2004). The present study tries to evaluate the impact of rapid urbanization in the sub urban area of Chennai. The study area consists of eleven wards of the Chennai Metropolitan Authority namely Perungudi, Okkiyamthuraipakkam, Karapakkam, Solinganallur, Perumbakkam, Medavakkam, Pallikaranai, Kulathur, Jaladampetti, Madipakkam and Puzhuthivakkam. Satellite image have been used to deduct the temporal changes in the land use from the year 1991 to 2011.

BACK GROUND OF THE STUDY AREA:

The study area falls in the southern part of Chennai city and is part of the Chennai Metropolitan Authority. It consists of eleven town Panchayats namely Perungudi, Okkiyamthuraipakkam, Karapakkam, Solinganallur, Perumbakkam, Medavakkam, Pallikaranai, Kulathur, Jaladampetti, Madipakkam and Puzhuthivakkam. The population density of these wards has increased from 378 people per square kilometer in 1971 to 8340 person per square kilometer in 2011. This area is dominated by new constructions with many Information and Technology Firm and residential apartments. This region was once part of the South Chennai flood plain and housed the famous Pallikaranai wetlands which have now reduced to fewer than 5 Sq. Km. Pallikaranai wetlands have great wealth of flora and fauna and is also visited by the migratory birds.



METHODOLOGY:

The study has used satellite imageries to classify land use data. Level-I classification listed devised by James Anderson (1976) has been used for the deduction of land use. The land use changes and the change deduction were determined using Thematic Mapper (TM) Image with 80m resolution, Enhanced Thematic Mapper (ETM) Image with 30m resolution and Linear Imaging Self Scanning Sensor (LISS III) Imageries from Indian Institute of Remote Sensing (IRS) having 24m resolution. Supervised Classification was done with reference to ground truth verification. Zhao Hui et al. (2010), Ester et al. (2012), Zhang et al. (2007), Tahir et al. (2013), Manju et al.(2005), Kuwari and Kaiser (2011), has used similar technique for land use analysis and change deduction. Satellite imageries were used for the year 1991, 2001, 2006, and 2011 for the present study to find out land use and change deduction in the study area. The year 1991 imagery was taken from LandSat 5 (L5) satellite with Thematic Mapper (TM) sensor of path 142 and row 51. The year 2001 data was taken from LandSat 7 (L7) satellite with Enhanced Thematic Mapper (ETM +) sensor of path 142 and row 51. The data for the year 2006 and 2011 were taken from Indian Remote Sensing Satellite (IRS P-6), Linear Image Scanning Sensor (LISS -3) having path 102 and row 64. The Satellite Imageries were Georeferenced using ERDAS IMAGING 9.8 version. The Imageries were processed and classified into 500 classes, using unsupervised classification these classes were re-coded after field verification. The coded unsupervised classified Images were digitized in the ARC GIS 9.3.1 and Land Use Maps were prepared using Level -I Classification. Based on this, eight classes have been devised for the study. They are Cropped Land, Dump Site, Settlement, Sewage Treatment Plant (Tp.), Vegetation, Waste Land, Water Bodies and Wetlands. The main aim of the study is to find the change in the extent of wetlands and natural vegetation and the land under other land use which has played a major role in bringing this change in the aerial extent of the natural environment. Vegetation, wetlands, water bodies and fallow lands are considered as natural environment.

Land Use of Pallikaranai -1991

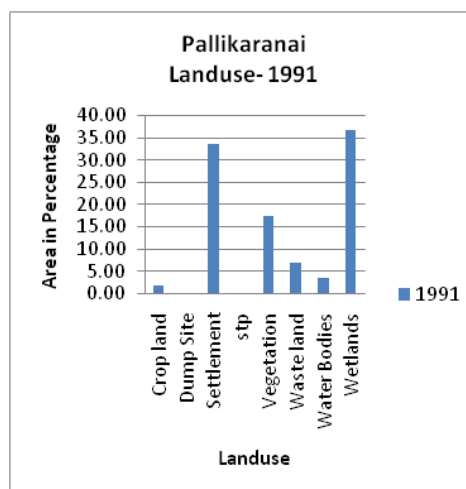
The land use data of the year 1991 shows large area under Settlement which accounts for around 33.44 percentage of the total area followed by Wetlands which occupies 36.51 percentage of the area. Water bodies cover 3.63 percentage of the area, whereas vegetation covers 17.43 percent of the area and waste land covers 7.06 percentage of the area. Cropland covers 1.77 percentage of the area. Sewage Treatment Plant was not established by this period of time (figure 7.1). The table 4.1 and Graph 4.1 clearly show that settlement and wetlands was the major land use, but wetlands dominated the aerial extent in the study area in the year 1991. Vegetation occupied the third position, thus it can be inferred that though anthropological activities had been established in the study area, it was not too alarming at that period of time.

Table 1 Land use – 1991

Year (1991)	Area in Sq. Km	Percentage
Cropped Land	1.24	1.77
Dump Site	0.11	0.16
Settlement	23.41	33.44
Swage Tp.	0.00	0.00
Vegetation	12.20	17.43
Waste land	4.94	7.06
Water bodies	2.54	3.63
Wetlands	25.56	36.51
Total	70	100.00

Source: TM Image

Graph 1 Land use - 1991



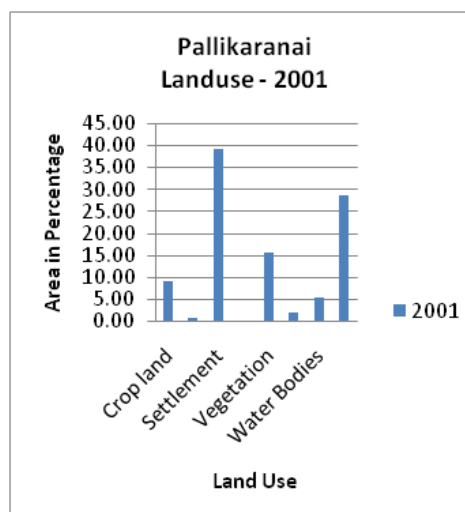
Source: Table 1

Table 2 Land use – 2001

2001	Area in Sq. Km	Percentage
Cropped Land	6.35	9.06
Dump Site	0.48	0.69
Settlement	27.30	39.00
Swage Tp.	0.00	0.00
Vegetation	10.88	15.55
Waste land	1.24	1.77
Water bodies	3.74	5.34
Wetlands	20.02	28.59
Total	70.00	100.00

Source: ETM Image

Graph 2 Land use - 2001



Source: Table 2

Land Use of Pallikaranai - 2001

The land use data of the year 2001 shows a large area under Settlement which accounts for around 39 percentage of the total area it is followed by Wetlands which occupies 28.59 percentage of the area. Water bodies cover 5.34 percentage of the area, where as vegetation covers 15.55 percentage of the area and waste land covers 1.77 percentage of the area. Cropland covers 9.06 percentage of the area (Table 2). In 2001 the area under crop land has increased, but a decrease in the area under waste land is noticed. See figure 2 and Graph 2. By the end of 1991 and in the year 2001, settlement had been established as the major land use in the area. Wetlands and vegetation had been remarkably been reduced. The land use of 2001 clearly indicated that the anthropological activity in the area had increased and it had now become a threat to the natural setting of the study area (Graph 2). The land

use of 2001 seems to be the beginning for the end of natural harmony in the study area (See Graph 1 and Graph 2).

Land Use of Pallikaranai -2006

The land use data of the year 2006 shows large area under Settlement which accounts for around 60.64 percentage of the total area it is followed by Wetlands which occupies 15.33 percentage of the area. Water bodies cover 4.07 percentage of the area, where as vegetation covers 7.1 percentage of the area and waste land covers 6.45 percentage of the area. Cropland covers 5.14 percentage of the area. In 2001 the area under cropland has decreased, large area under wetland has been reduced and area under settlement and wasteland has increased (Figure 3 and Table 3). The land use of 2006 shows an alarming growth of settlement at the cost of wetlands and vegetation of the study area. Nature seems to be at the mercy of the anthropological slaughter. Only one land use seems to dominate the study area, at the expense of nature (Graph 3).

Land Use of Pallikaranai -2011

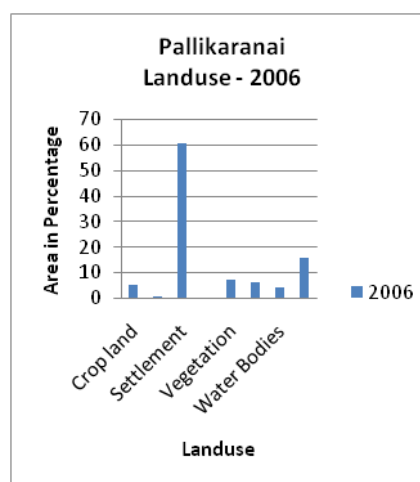
The land use data of the year 2011 shows large area under Settlement which accounts for around 64.78 percentage of the total area it is followed by Wetlands which occupies 8.5 percentage of the area. Water bodies cover 5.65 percentage of the area, where as vegetation covers 4.26 percentage of the area and waste land covers 7.87 percentage of the area.

Table 3 Land use -2006

2006	Area in Sq. Km	Percentage
Cropped Land	3.60	5.14
Dump Site	0.61	0.87
Settlement	42.45	60.64
Swage Tp.	0.14	0.2
Vegetation	4.97	7.1
Waste land	4.52	6.45
Water bodies	2.85	4.07
Wetlands	10.87	15.53
Total	70	100

Source: ETM Image

Graph 3 Land use - 2006



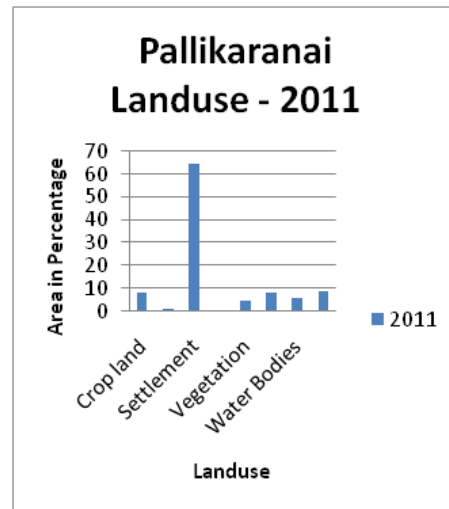
Source: Table 3

Table 4 Land use – 2011

2011	Area in Sq. Km	Percentage
Cropped Land	5.37	7.67
Dump Site	0.75	1.07
Settlement	45.35	64.78
Swage Tp.	0.14	0.2
Vegetation	2.98	4.26
Waste land	5.51	7.87
Water bodies	3.96	5.65
Wetlands	5.95	8.5
Total	70	100

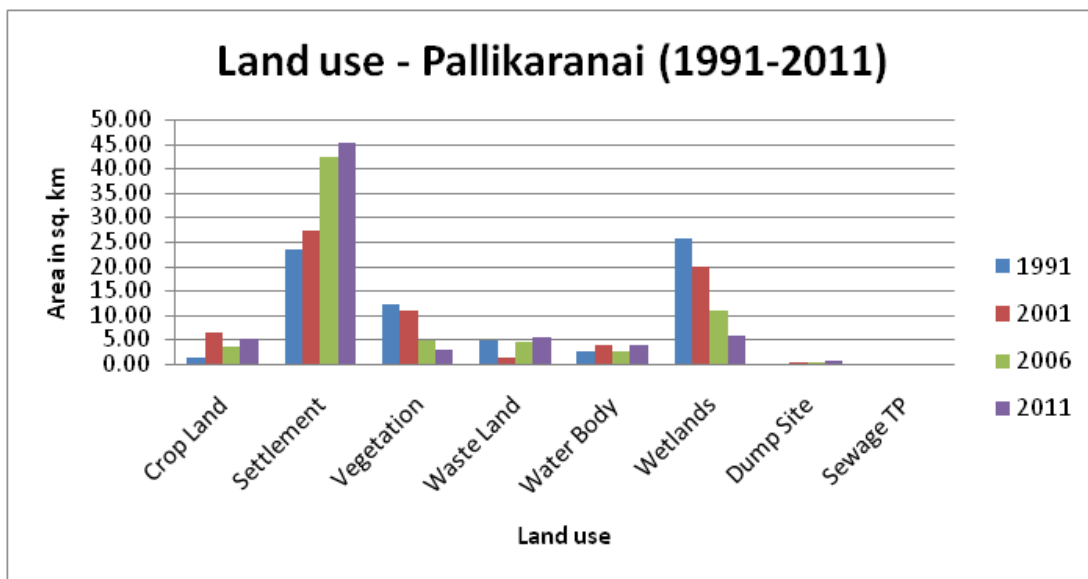
Source: IRS Image

Graph 4 Land use - 2011



Source: Table 4

Graph 5 Land use -1991-2011



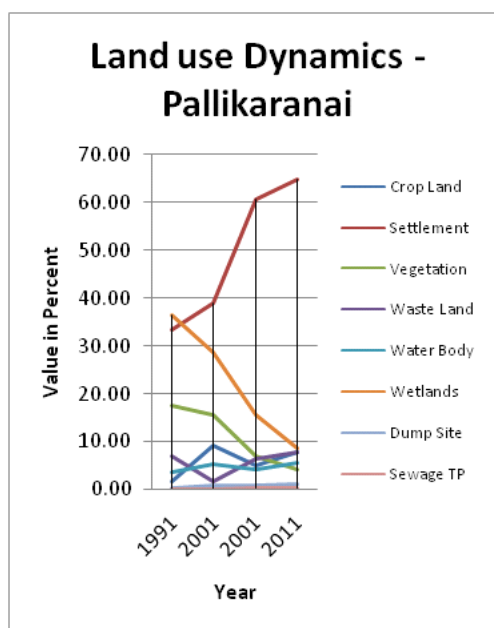
Source: Table 5

Table 5 Land use 1991-2011

Land use	1991 Sq. km	2001 Sq. km	2006 Sq. km	2011 Sq. km
Crop land	1.24	6.35	3.60	5.37
Settlement	23.41	27.30	42.45	45.35
Vegetation	12.20	10.88	4.97	2.98
Waste land	4.94	1.24	4.52	5.51
Water bodies	2.54	3.74	2.85	3.96
Wetlands	25.56	20.02	10.87	5.95
Dump Site	0.11	0.48	0.61	0.75
Sewage TP	0.00	0.00	0.14	0.14

Source: Table 1, 2, 3, 4

Graph 6 Land use – 1991-2011



Source: Table 5

Cropland covers 7.67 percentage of the area. It can be seen that the area under wetlands have been decreasing steadily where as the area under settlement and dump site has been constantly increasing (figure 4, table 4). The year 2006 had seen an alarming growth in the anthropological activity at the cost of nature. Wetlands and vegetation suffered the most, and the area under wetlands diminished the most during this period. The 2011 period the alarming rate of destruction of natural cover ceased a bit. The area under wetlands reached the minimum level.

In the Graph 1 and 2 we can easily infer the changes in the land use from 1991 to 2010. It can be seen that the area under settlement is on a continuous rise whereas the area under wetlands is on the decline. The area under crop land showed an increasing trend in the year 2001, which may be due to truck farming, but in the subsequent years it also declined rapidly to give way to settlement demands. The area under vegetation, increased marginally in the year 2010 from a consistent decline from 1991. The area used for dumping increased in the area 2001 and it has seen no increase in horizontal expand, but a field visit indicates vertical increase in the dump area, and also due to the growth of vegetation in the dump yard, some areas in the dump yard are covered by vegetation. All other land use are on the decline, but the area under wasteland has a fluctuating trend and is on the increase, and it may be due to speculation and real estate business which is on a sharp rise due to rapid industrialization of the area. Change Deduction

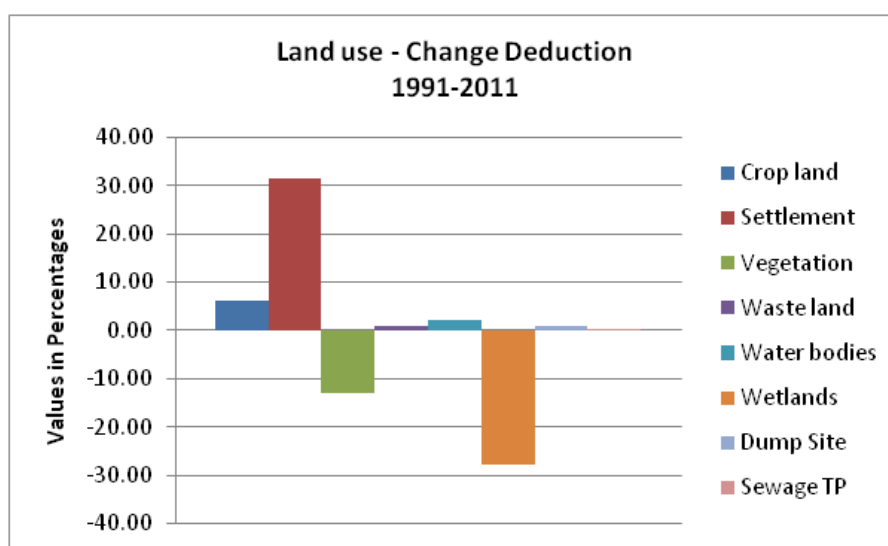
The change in the land use in 2011 when compared to that of 1991 shows marked reduction in area of Wetland and vegetation. Wetlands have reduced by 28.01 percentages whereas vegetation has reduced by 13.17 percentages. Cropland, waste land and area under water bodies have also shown a marked reduction in area. The reduction in area of other land use mentioned above is occupied by settlement which has increased by 31.34 percentages in the subsequent decade. The area under dump site and sewage treatment plant has also shown a marked increase. The area under dump site has increased by almost one percentage of the total area of the land use which is very large considering the area of the wetlands, which has just 8.5 percentage of the total area (graph 7 and table 6)

Table 6 Changes Deduction -1991-2011

Land Use	2011	1991	2011-1991
Cropped Land	7.67	1.77	5.90
Settlement	64.78	33.44	31.34
Vegetation	4.26	17.43	-13.17
Waste land	7.87	7.06	0.81
Water bodies	5.65	3.63	2.02
Wetlands	8.5	36.51	-28.01
Dump Site	1.07	0.16	0.91
Sewage Tp	0.2	0.00	0.20

Source: TM and IRS Image

Graph 7 Changes Deduction -1991-2011



Source: Table 6

CHANGE DEDUCTION-CROPPED LAND

The area under crop land has been fluctuating during the study period. In 1991, 1.77 percentage of the area was occupied by crop lands, which increased to 9.06 percentages in 2001. The increase in area under crop land was mainly due to wetland getting converted into crop land and waste land being bought to use. The utilization of waste land and conversion of waste land into cropped land was mainly due to population pressure. The year 2006, saw a decline, in the area under crop land. The expansion of Chennai city into the periphery resulted in the crop land getting converted for settlement. Another reason for the fall in the area under crop land was because, some areas which were under crop land, was left fallow for the purpose of speculation. Speculation was done mainly to increase the real estate

value to the land. The influx of population from the city to the periphery, led to an increase in the demand of land for settlement. The year 2011 saw a marginal increase in the land under cropped area. The increase in the cropped area was mainly due to fall in the area under wetlands and under vegetation (Fig. 5, Table 7 and Graph 8).

CHANGE DEDUCTION – SETTLEMENT

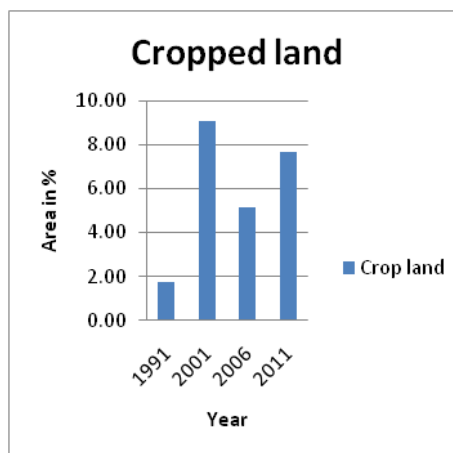
The area under study was sparsely populated during 1971, but the population in the area increased steadily and so did the area under settlement. In 1991, around 33.44 percentage of the area under study were occupied by settlement. The year 2001 saw a marginal increase of about 6 percentages, which is reasonable as the study area falls on the periphery of Chennai city. By the year 2006, a span of just five years saw a marked increase in area under settlement. The area under settlement increased from 39 percentages of the total area in 2001 to 60.64 percentages in 2006. The rapid expansion of the area under settlement was at the peril of the wetlands, and area under vegetation. Some area under crop land and some water bodies were also converted for settlement. This rapid increase in settlement was mainly due to the influx of industries in the area, and subsequent increase in the number of households. The increase in area under settlement was almost doubled and contributed about more than 20 percentages of area being converted for settlement. The next five year saw a marginal increase in the settlement area, and it increased to 64.78 percentages of the total area. The increase of about 5 percentages in the area under settlement was also at the cost of vegetation and wetlands (Fig. 6, 7, 8, 9, 10, Table 8, Graph 9).

Table 7 Cropped Land

Cropped Land		
Year	Area in Sq. Km	Area in Percentage
1991	1.24	1.77
2001	6.35	9.06
2006	3.60	5.14
2011	5.37	7.67

Source: Table 5

Graph 8 Cropped Land



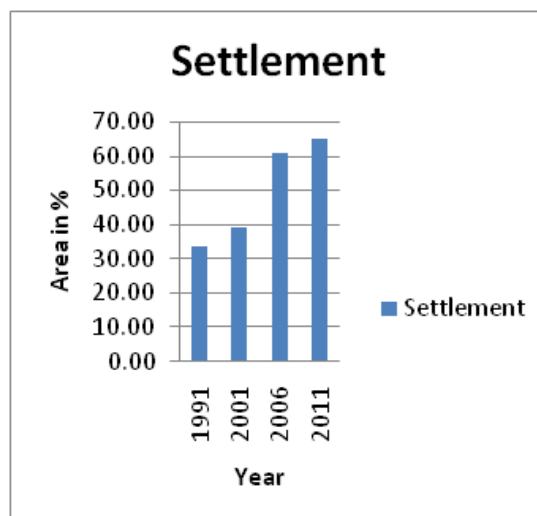
Source: Table 7

Table 4.8 Settlement

Settlement		
Year	Area in Sq. Km	Area in Percentage
1991	23.41	33.44
2001	27.30	39.00
2006	42.45	60.64
2011	45.35	64.78

Source: Table 5

Graph 4.9 Settlement



Source: Table 8

CHANGE DEDUCTION – VEGETATION

It is a universal truth that, from the time of growth of civilization, man has cleared forest to use it for growing crops and for settlement. Forest has also been indiscriminately been destroyed for timber and other resources. The fate of vegetation has been the same in the study area too. Though, the study area does not have thick strands of trees, yet it had a rich variety of grass, shrubs and trees. In the period of study that is, from 1991 to 2011 the study area has seen a steady decline in the area under vegetation. The decline was more prominent in period between 2001 and 2006. In the year 1991, 17.43 percentages of the area under study, was occupied by vegetation. A decline of 2 percentages was noticed between the years 1991 to 2001. The most alarming decline in vegetation was between the years 2001 to 2006, which saw the area under vegetation decline by almost 50 percentages within a span of five year, from 15.55 percentages in 2001 to 7.10 percentages by 2006. This decline was mainly due to the expansion of the city into the periphery and a rapid increase in the total number of household in the study area. The decline in the trend of vegetation continued even in the year 2011, though the decline was marginal. The area under vegetation in 2011 declined from 7.10 percentages in 2006 to 4.26 percentages by 2011. The decrease in vegetation is a matter of concern and the authorities should step in to increase the area under vegetation to maintain sustainability (Fig. 11, Table 9, Graph 10).

CHANGE DEDUCTION – WASTE LAND

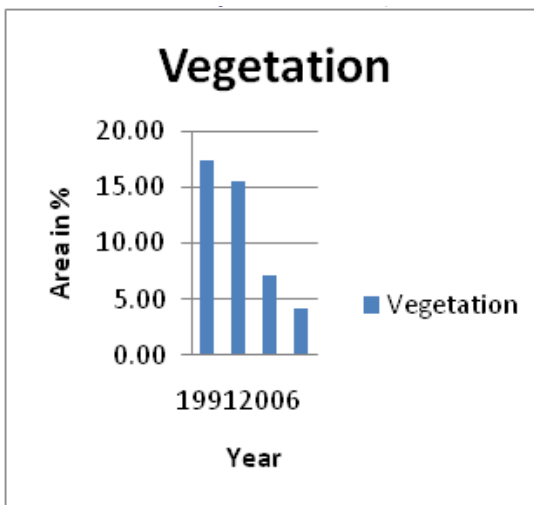
Fallow land and the vacant area not categorized into any of the land use in the present classification have been termed as waste land in the present study. The area under study has seen an increase in the total waste land area during the study period, though it has been fluctuation between the periods of study. It is important to mention that, the study area falls under the South Chennai flood plains, and a large area under study has been categorized as wetlands. It can be seen that the area under waste land in the year 1991 was just 7.06 percentages of the total area, and this rapidly fell to 1.77 percentages by the year 2001. The fall in the area under waste land was mainly due to the conversion of waste land into cropped land and for settlement. The area under waste land increased

from 1.77 percentages in the year 2001 to 6.45 percentages due to speculation and encroachment on the wetlands.

Table 9 Vegetation

Vegetation		
Year	Area in Sq. Km	Area in Percentage
1991	12.20	17.43
2001	10.88	15.55
2006	4.97	7.10
2011	2.98	4.26

Source: Table 5



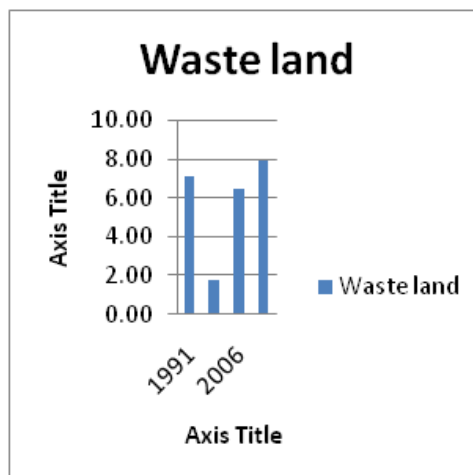
Source: Table 9

Table 10 Waste Land

Waste Land		
Year	Area in Sq. Km	Area in Percentage
1991	4.94	7.06
2001	1.24	1.77
2006	4.52	6.45
2011	5.51	7.87

Source: Table 5

Graph 11 Waste Land



Source: Table 10

The increase in waste land saw an increasing trend even in the year 2011. The area under waste land increased from 6.45 percentages in the year 2006 to 7.87 percentages in the year 2011. From the land use change deduction map in can be seen that, though waste land has been continuously used for the purpose of settlement, the area under wetlands and vegetation are continuously being converted into waste land (Fig. 12, Table10, Graph 11).

CHANGE DEDUCTION – WATER BODIES

The study area is present in the South Chennai flood Plain, and large portions in the flood plain are categorized as wetlands, thus the area under water bodies is comparatively less. Only those areas other than the Pallikaranai wetlands have been marked as water bodies in the present land use classification. It can be seen that the area under water bodies has been fluctuating during the study

period. The area under water bodies increased from 3.63 percentages in the year 1991 to 5.34 percentage in 2001. This increase has been mainly due to the initiative of the Government to clean the sources of water to meet the need of Chennai city, and it is the result of de-silting of the lakes. In the year 2006, a small decline in the area under water bodies can be noted, as it fell from 5.34 percentages in 2001 to 4.07 percent in the year 2006. This is the period when the study area saw a rapid increase in the settlement and the population pressure and demand for water might have been a reason for the shrink in the area under water body in the year 2006. The year 2011 saw a marginal increase in the area under water bodies; it increased to 5.65 percentages. This increase in the area under water bodies may be due to increasing the source of water to be supplied to the growing needs of the city (Fig.13 Table 11, Graph 12).

CHANGE DEDUCTION – WETLANDS

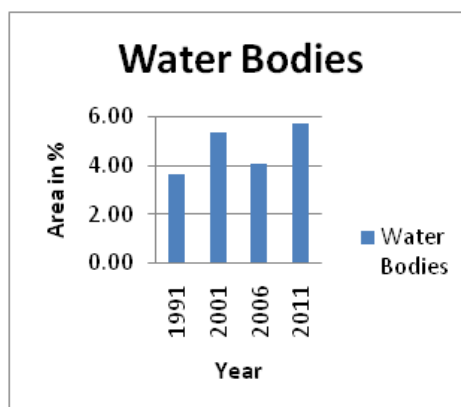
Wetlands have been diminishing all over the world, and the rate of wetland loss all over the world, and in India has already been discussed in Chapter one. The Pallikaranai wetlands have suffered from the impact of urbanization. This wetland has been diminishing continuously. In the period of study, the wetland has been reduced to 8.5 percentages from 36.51 percentages of the total area. In the year 1991, it occupied 25.56 sq.km which constituted 36.51 percentage of the total area under study. In the year 2001, the area under wetland declined by 8 percentages compared to the previous decade. The most remarkable

Table 11 Water Bodies

Water Bodies		
Year	Area in Sq. Km	Area in Percentage
1991	2.54	3.63
2001	3.74	5.34
2006	2.85	4.07
2011	3.96	5.65

Source: Table 5

Graph 12 Water Bodies

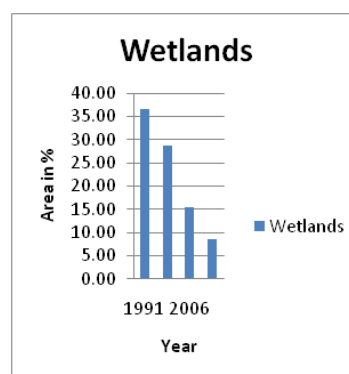


Source: Table 11

Table 12 Wetlands

Wetlands		
Year	Area in Sq. Km	Area in Percentage
1991	25.56	36.51
2001	20.02	28.59
2006	10.87	15.53
2011	5.95	8.50

Graph 13 Wetlands



Source: Table 5

Source: Table 12

decline in the wetland was in a small period of 5 years between 2001 and 2006. The wetland declined by almost 50 percentages of the previous area under wetland. It diminished from 28.59 percentages in the year 2001 to 15.53 percentages in the year 2006. The rapid decline in the wetland in this period was due to rapid increase in the settlement which also had a steep increase in the same period. In the year 2011, the area under wetland fell to a single digit, and it further declined from 15.53 percentages in 2006 to 8.50 percentage in the year 2011. It should be also noted that a portion of the wetlands was being dumped by MSW, and it played its own role in diminishing the area extent of the wetland (Fig. 14, 15, 16, 17, 18 Table 12, and Graph 13).

CHANGE DEDUCTION – DUMP SITE

The area under dump site saw a consistent increase from the year 1991 to 2011. The wetlands in the north eastern section had been continuously used by the Chennai Municipality for dumping Municipal Solid Waste (MSW) being generated in the city. The dumping of MSW has not only led to the reduction in the area under wetland but it has also polluted the water of the wetland. Fire consistently breaks in the dump yard, releasing thick poisonous smoke in the surrounding. The poisonous air is not only harmful to the rich diversity of fauna but also to humans living in the vicinity of the wetlands. During rainy season, the lechates from the dump site flow into the wetlands and release harmful chemicals into it. These chemicals pollute the wetlands and are a serious threat for the survival of the living organism which finds its shelter in the wetland. The water quality of the adjacent area has also been polluted due to the mingling of the polluted water with the underground water table wetland (Fig.19, 20, 21, 22, 23 Table 13, and Graph 14).

CHANGE DEDUCTION- SEWAGE TREATMENT PLANT (STP)

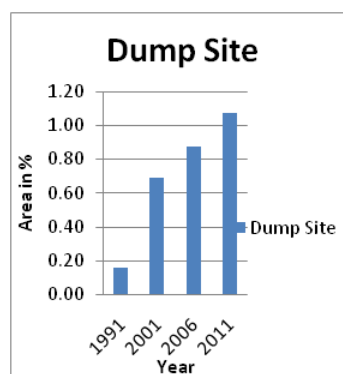
No remarkable change in the area under STP was noted. It can be only stated that; from the time of inception of the STP it has not been extended. The STP was not noticed in the satellite image of the year 1991 and the year 2001. The reason for not deducting the STP in those images may be due to the low spatial resolution of the images (TM and ETM) or, STP might not have existed during that period. The total area under STP covered about 0.20 percentage of the total area under study (Table 14, and Graph 15).

Table 13

Dump Site		
Year	Area in Sq. Km	Area in Percentage
1991	0.11	0.16
2001	0.48	0.69
2006	0.61	0.87
2011	0.75	1.07

Source: Table 5

Graph 14



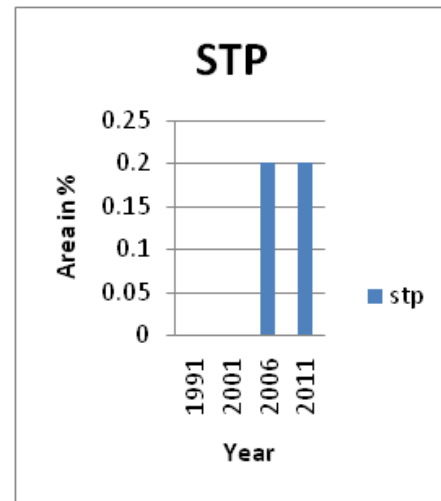
Source: Table 13

Table 14

Sewage Treatment Plant (stp)		
Year	Area in - /Sq. Km	Area in Percentage
1991	0.00	0.00
2001	0.00	0.00
2006	0.14	0.20
2011	0.14	0.20

Source: Table 5

Graph 15



Source: Table 14

Fig. 1 Land use -1991

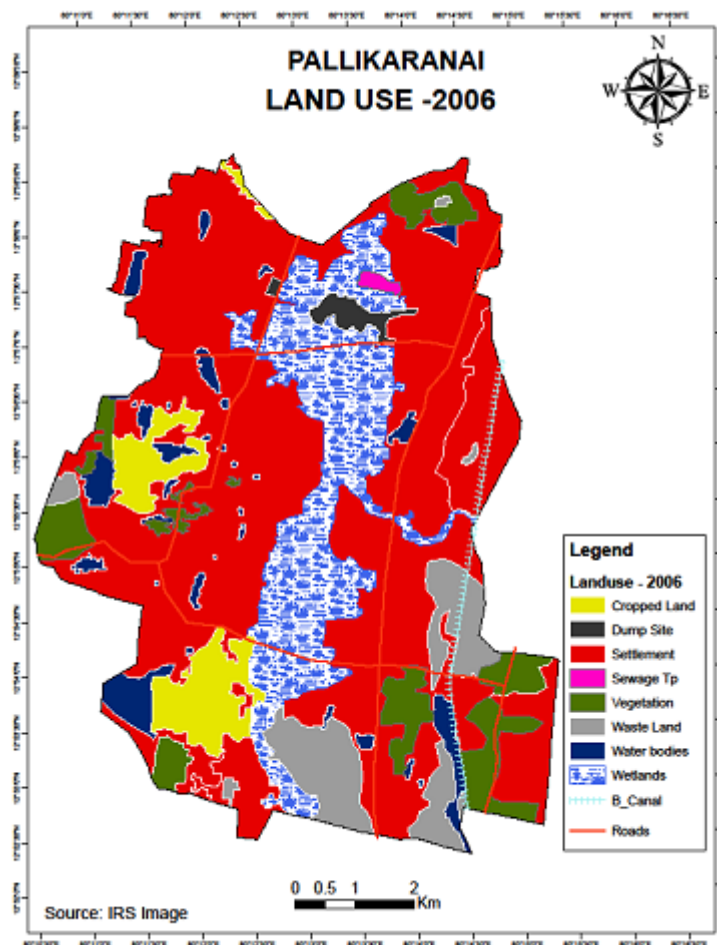


Fig. 4 Land Use – 2011

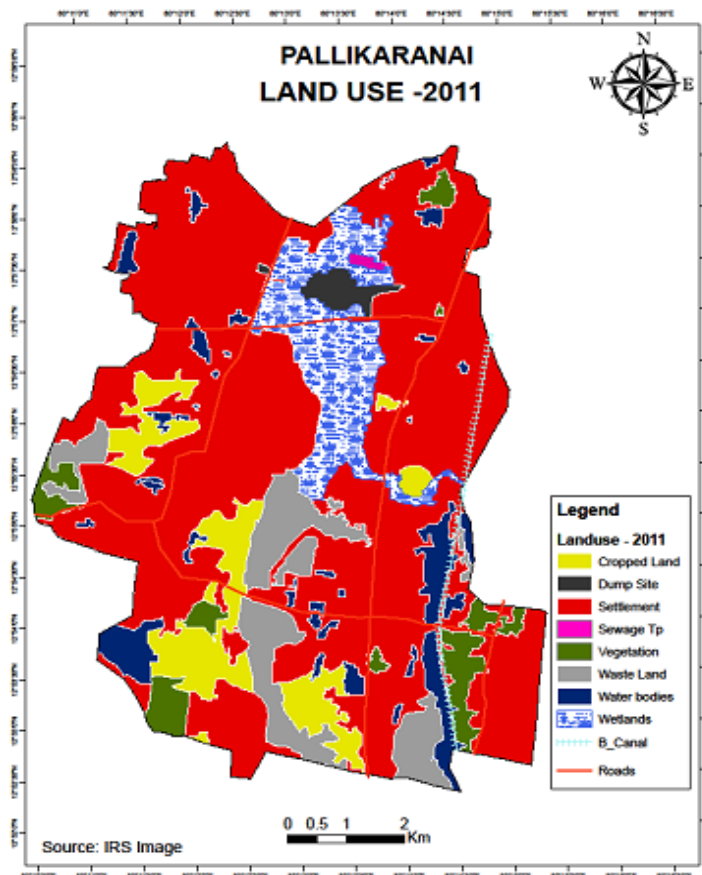


Fig. 5 Cropped Land -1991-2011

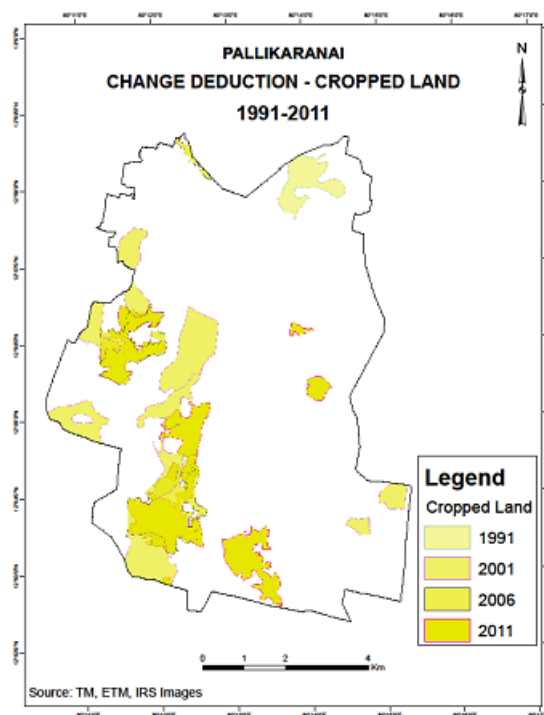


Fig. 6 Settlement -1991

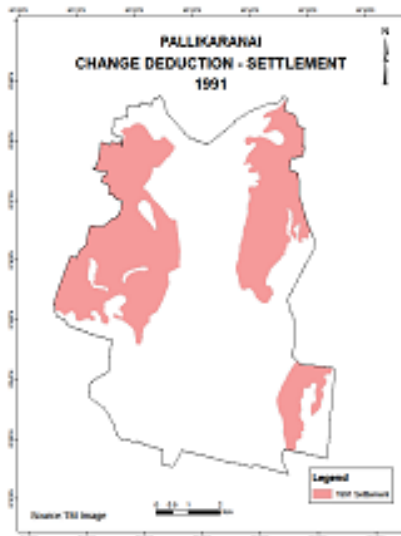


Fig. 7 Settlement -2001

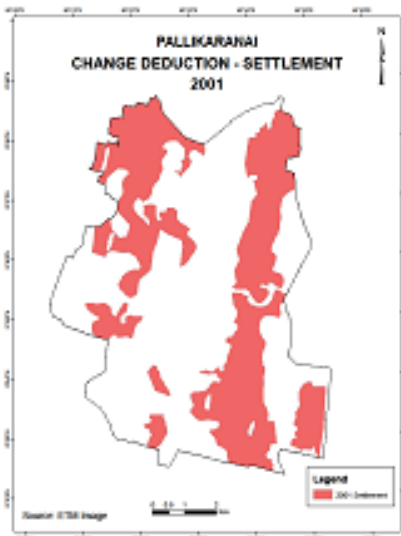


Fig. 8 Settlement -2006

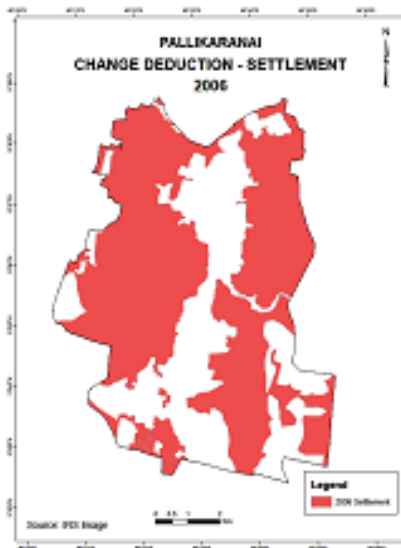


Fig. 9 Settlement -2011

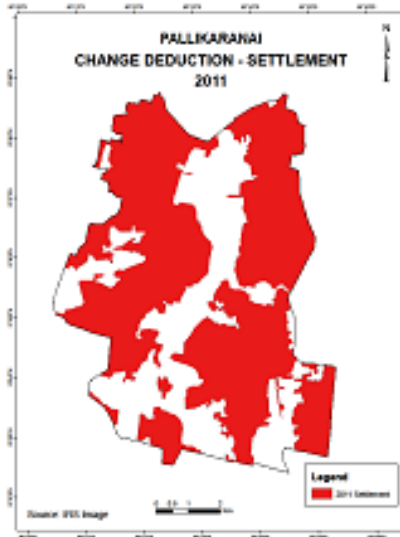


Fig. 10 Settlement -1991-2011

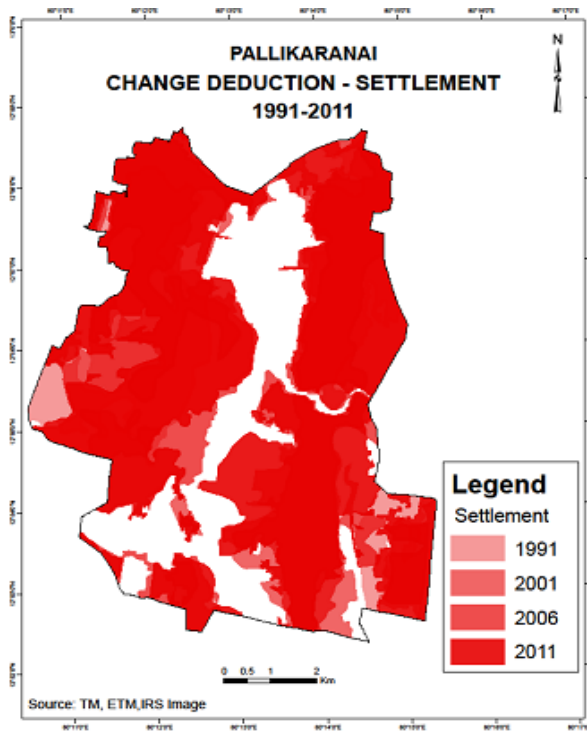


Fig. 11 Vegetation -1991-2011

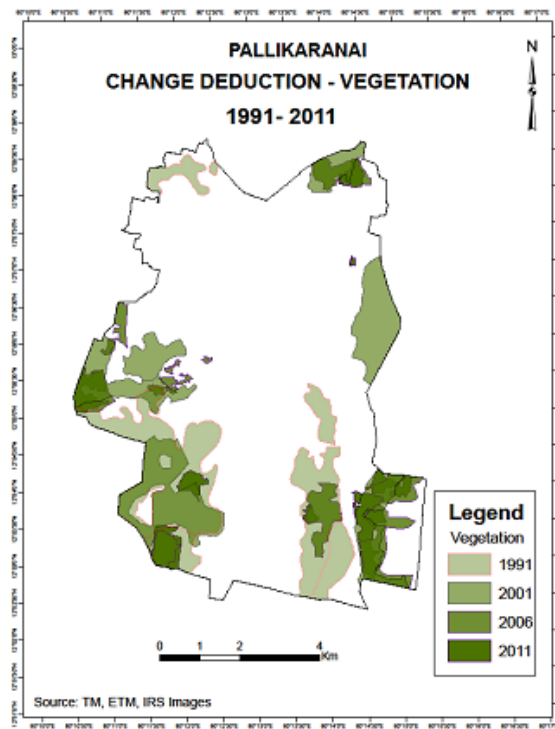


Fig. 12 Waste land -1991-2011

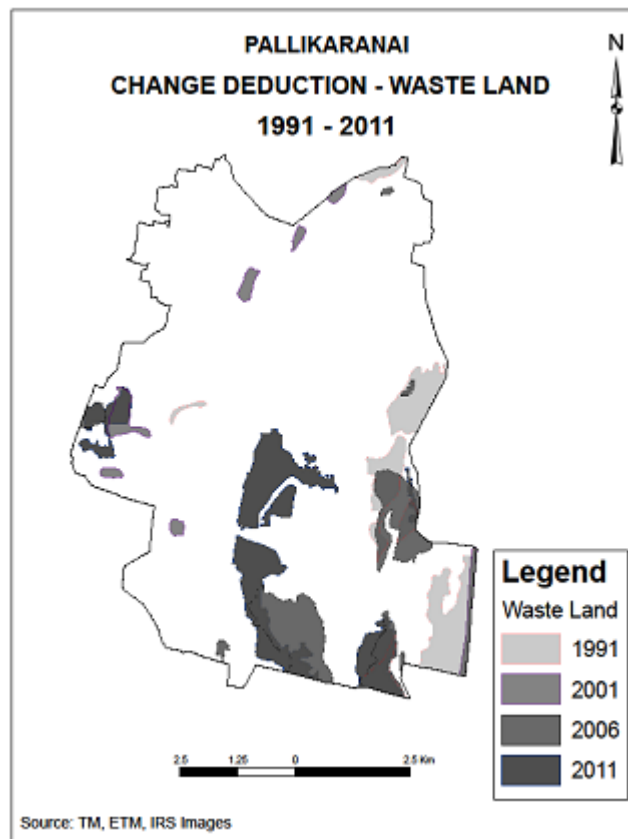


Fig. 13 Water Bodies -1991-2011

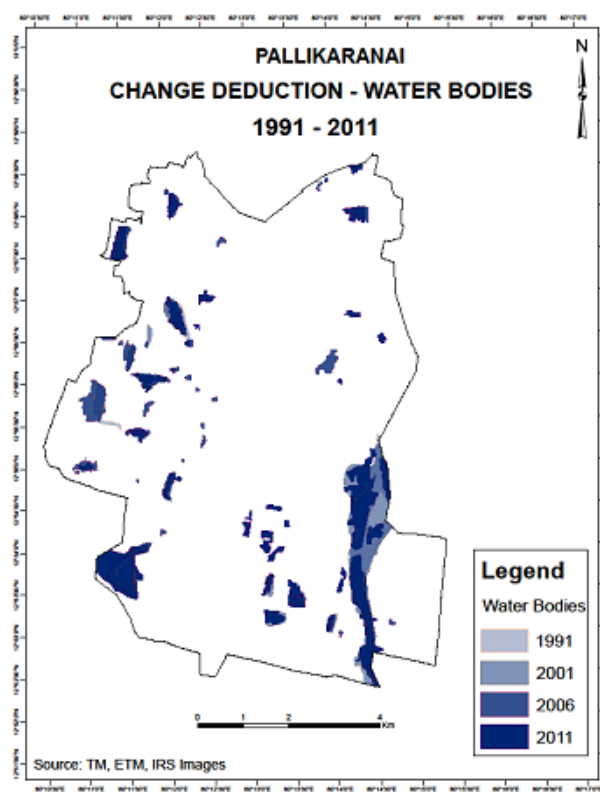


Fig. 14 Wetlands- 1991

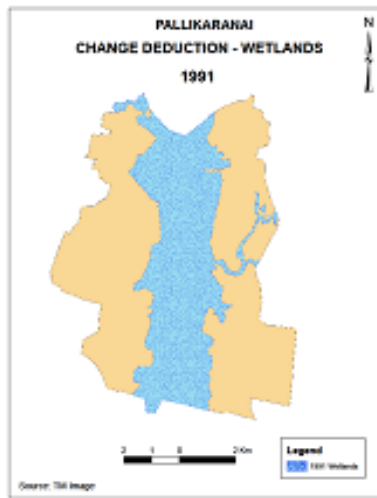


Fig.15 Wetlands - 2001

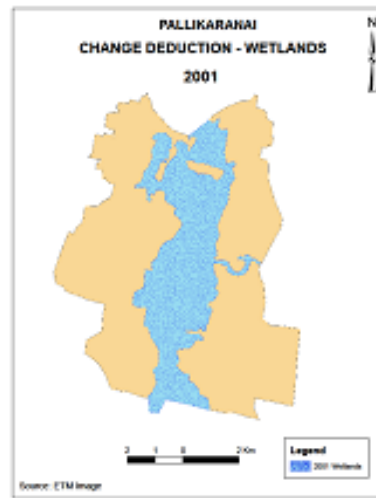


Fig 16 Wetlands -2006

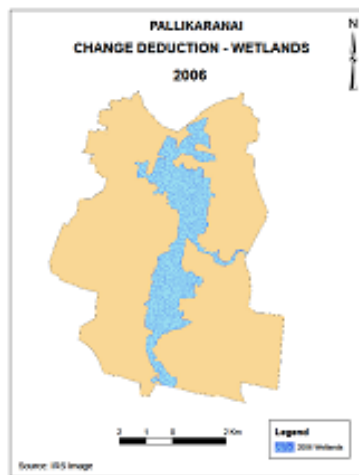


Fig 17 Wetlands -2011

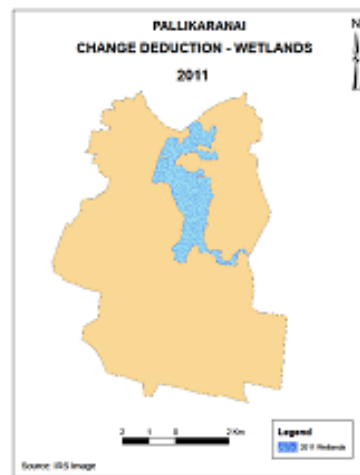


Fig. 18 Wetlands -1991 -2011

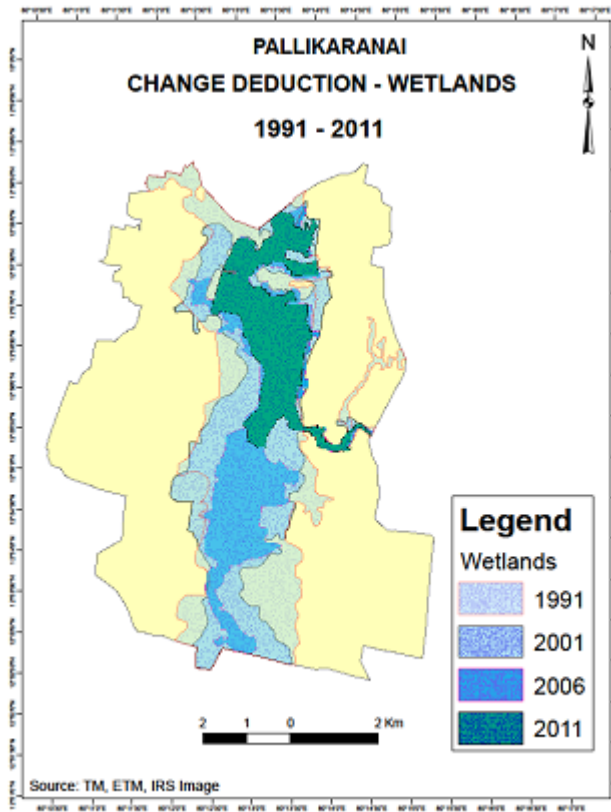


Fig.19 Dump Site -1991

Fig. 20 Dump Site -2001

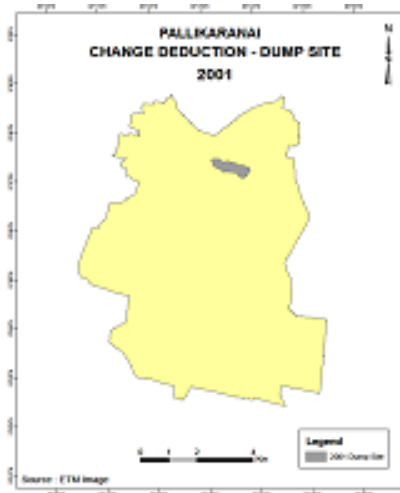
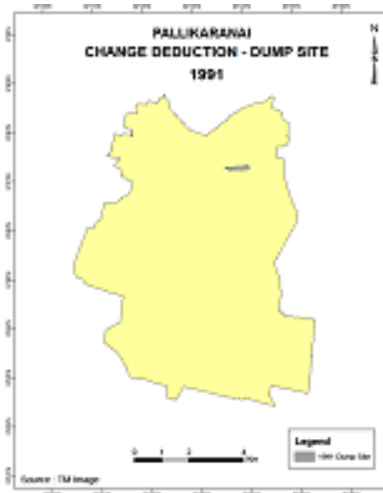


Fig. 21 Dump Site -2006

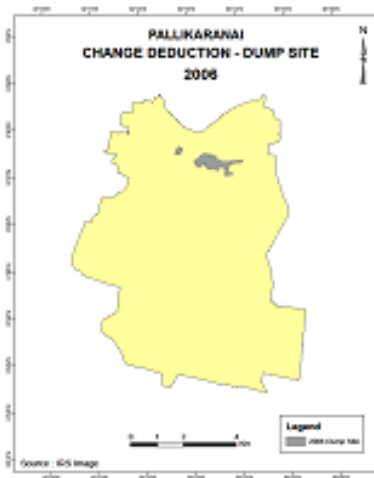


Fig. 22 Dump Site -2011

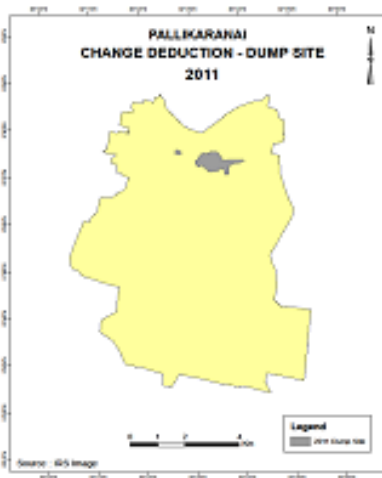
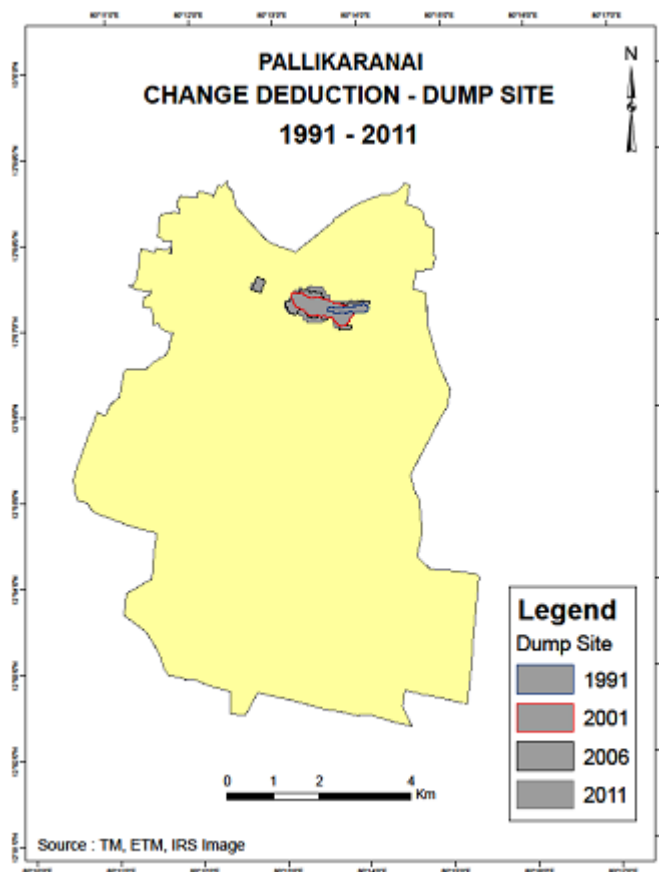


Fig. 23 Dump Site -1991-2011



CONCLUSION

The land use changes are one of the most important factors in determining the impact on the environment and its bio-diversity. To understand the impact of different factors relating to the land use

dynamics on the natural environment the pattern of land use was calculated using Satellite Imageries with the help of Image processing software and GIS software. This software was used to determine and map the land use changes. From the data obtained from the satellite imageries, it can be seen that the area under settlement is on the rise and the area under natural environment that is wetlands, vegetation, and water bodies are declining. The area under solid waste disposal site is also on the increase, though the rise in the area of the solid waste disposal site has been restricted due to steps taken by different organizations. The area under crop land has been changing and has reduced to a meager level, same is the fate of vegetation and water bodies which have seen a steady decline, though the area under waste lands is fluctuating and this may be due to speculation in the real estate market, wherein, large area of land are left fallow for the speculation of price and are later converted into settlement sights. The change deduction graph clearly shows negative growth of all types of land use except that of settlement and dump site area, when compared with the land use of the year 1991 with that of year 2011. The change deduction graph clearly shows that major change in the land use took place between 2001 and 2006, where in settlement increase rapidly at the peril of the natural environment.

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