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Urban Landuse Changes in Sri Lanka with Special Reference to Kaduwela Town from 1975 to 2016

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Abstract:

The study of land use/land cover changes is very important to have proper planning and utilization of natural resources and their management. Traditional methods for gathering demographic, censuses data and analysis of environmental situation are not adequate for multi complex environmental studies since many problems often presented in environmental issues and great complexity of handling the multidisciplinary data set. Therefore, it does require new technologies like satellite remote sensing and Geographical Information Systems.

The objective of the study is to identify the changing pattern of land use in Kaduwela Municipal Council from 1970's to 2016. Primary and secondary data are to be used for the analysis. The secondary data from the UDA, Survey Department and land sat 5 images in 1975, 1980, 1997 and 2016. The primary data was collect using field checking and discussion held with offices and residence.

The Land use of the urban sprawl in Kaduwela Municipal Council is change very fast. Specially most of the land uses are residential, commercial and service infrastructure facilities. The paddy, marshy or inland cultivation lands (Homestead) are the alternative land for use of residential, commercial and other urban activates. In addition, the land price of the area is increase very rapidly and fragmentation is increase and the size of the land plots is very small.

Keywords: Land Use Changes, GIS, Remote Sensing, Temporal Pattern, Urbanization and suburbanization

1. Introduction

The land use changes in large city areas is a complicated process; several factors have influences on this process, including both physical aspects and human aspects. On one hand, accelerated urban expansion is usually associated with and driven by the socio-economic factors; on the other hand, the process of urbanization has a considerable impact on the economies of the society in that area (He, 2006). According to Oduwaye (2001) the urban land is used variously for different purposes such as residential (low, medium, and high densities) commercial and central areas (offices, banks, markets, shops), industrial (factories, warehouses) public (schools, hospitals, police and post offices, cemeteries), semi –public (churches, temples, mosques), circulation (roads, railways, walkways, bicycle tracks) and recreational (parks, playgrounds, open spaces). However, Hill (1989) says the land use change is a complex phenomenon differing greatly from place to place. According to him, the causes of change include personal choices, legislations, government policies and plans, decision of developers or transportation entrepreneurs, the nature of the land itself or the availability of technology to develop the land.

Land use change is influenced directly by infrastructural development, where all types of human facilities are concentrated. Migration, globalization, government plan and policies, and political condition are the other factors of urban development and land use change of cities (Bhagawat, 2011).

The urban centers are concentrated mainly in costal belt, especially in the Western and Southern part of Sri Lanka. The Colombo metropolitan region of the country has high growth rate of the urbanization. The commercial and administrative capital and 1st, 2nd, 3rd and 4th place urban centres in urban hierarchy at national level are situated in Colombo and suburbs.

Suburbanization process is very fast in surrounding areas of Colombo city. Especially, be more than two rings of suburbs could be identified surrounding the main urban centres in the Western part of the country. Older suburban ring represents the adjoining urban centres in the Colombo City. The new ring represents the newly established urban centres such as Maharagama, Kaduwela, Kesbewa etc.

The nearest urban centres surrounding the Colombo City shows high growth rate from 1970s upto 1980s. At present high urbanized centers are visible in newly developed areas outside Colombo. In this process, the rural land uses are rapidly converted into urban activities. Therefore, this study focuses to identify the changes of the land use in Kaduwela town as a result of close relationship with

the Colombo Municipal Council and the adjoining areas of the Sri Jayewardenepura Kotte Municipal Council in Sri Lanka. In addition to these new suburban areas are faster growing centres in the country.

The objective of the study is to identify the temporal pattern of the land use changes in urban areas in Sri Lanka. The data are collected by the use of primary and secondary sources. Primary data are collected through interviews, observations and case studies. The secondary data are collected from the use of published and unpublished printed materials and institutional sources. The data analysis is done by use of analytical software, Geographic Information Systems and Remote Sensing Technologies.

1.1. The Factors that Affect the Change of Land Use in Kaduwela

The total land area covered by the administrative boundary of Kaduwela Municipal Council (MC) is 8770 hectares or 87.7 sq.km. The city consists of 3 regions, namely Battaramulla, Kaduwela and Athurugiriya (Fig: 4.1). Kaduwela MC situated in the Western Province in Colombo District and 17.5 km away from Colombo city of Sri Lanka. It is a junction settlement developed gradually connecting Colombo - Awissawella main road and Kotte - Gampaha road. It creates a beneficial relationship between other areas, such as Colombo, Kotte, kolonnawa, Maharagama, Homagama, Kesbewa, Biyagama, Gampaha, Kandy, Badulla, Ambilipitiya, and Awissawella. The land -locked areas in Northern Kelani river in Southern Homagama Pradeshiya Sabha and Maharagama Urban Council, in Eastern Homagama Pradeshiya Sabha and in Western Kolonnawa UC and Kotte MC. It comprised 57 Grama Niladhari Divisions and the Kaduwela MC is promoted as a MC in 1998 and its take 5th place in the urban hierarchy of Sri Lanka.

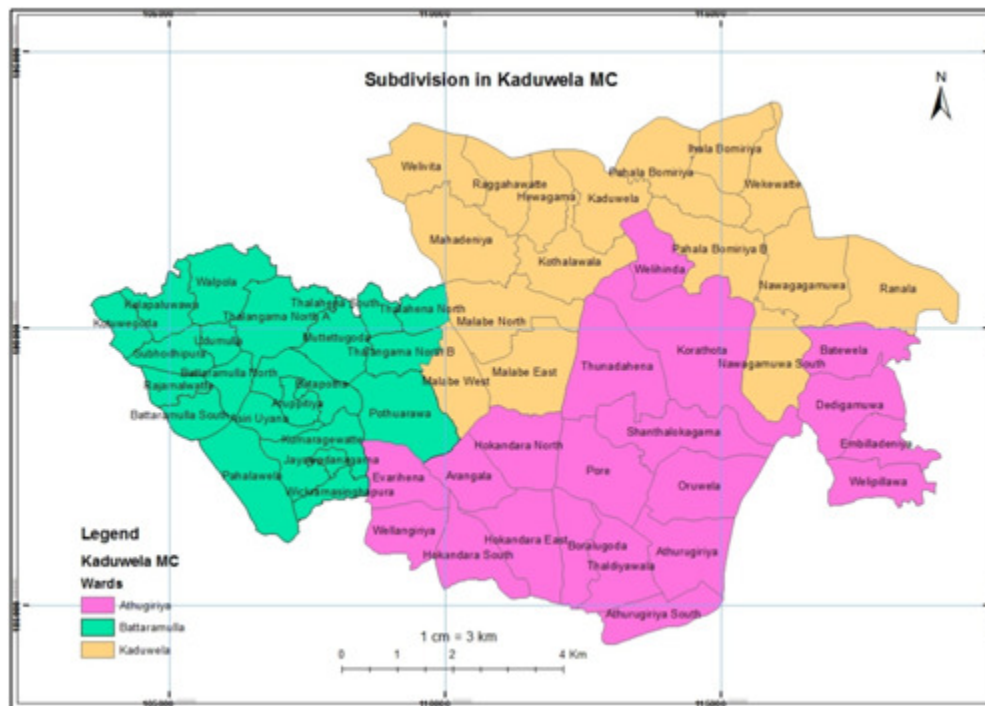


Figure 1: Administrative Divisions of the Kaduwela
Source: Based on Survey Department, 1985

In addition to this so many government institutions are established in Kaduwela MC as a result of decentralization of the Capital city of Sri Jayawardenepura Kotte. They are Ministry of Land, Sethsiripaya Ministerial Complex, Isurupaya (Education Department), Examination Department, and Institution of International Water Management, Central Environment Authority, Centre of Housing and Building, Western Provincial Council, Media Centres, Foreign Ministry etc. The private educational zone of Malabe is one of the most attracting place for investors in the country.

The total population of Colombo District is 1,699,241 in 1981 and 2,251,274 in 2001. According to the Department of Census and Statistics 2001 the Kaduwela population is 209,741. Nine percent out of the total population of the Colombo district. 9% are living in Kaduwela area. Administrative unit wise the population is as follows:

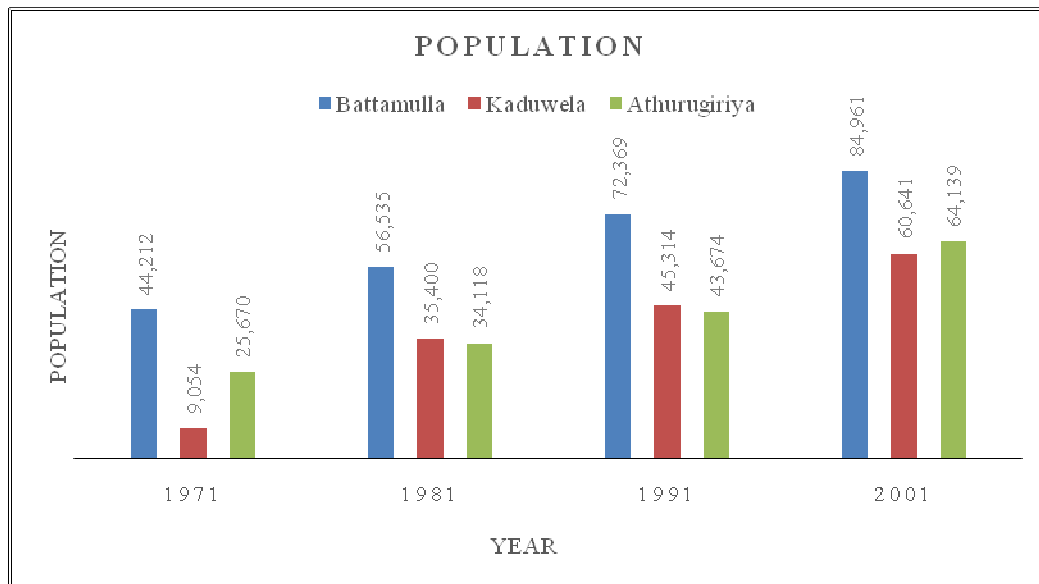


Figure 2: Administrative Division Wise Population in Kaduwela (1971 - 2001)

Source: Department of Census and Statistics, 2001

According to the above figures within 30 years the population in Kaduwela doubled in average. But compared to the other two regions, Kaduwela region population increased ten times from 1971 to 2001. The population in Battaramulla administrative region has increased nearly twice during that time and the increment rate of Athurugiriya area nearly 2.5. The reason of the growth of population is the low price of land market compared to other areas in surrounding areas and higher demand residences. The other reasons of the concentration of the population in this area are the introduction of housing schemes, development of higher level infrastructure facilities and the relationships with other regional centres.

According to the figures in table 1, nearly 61% out of the total land is used for residential purpose. In addition, this, another 21% of land reserve is for agricultural purposes and the rest land is utilized for other activities including mainly commercial activities in 2005 (Figure 4.5).

Utilization	Extent of Hectare	Percentage
Residential	5356.4	61.1
Commercial	351.0	4.0
Industrial	171.0	1.9
Government and Semi Government	163.0	1.9
Road and Transport	9.0	0.1
Religious	40.0	0.5
Play Grounds	23.5	0.2
Paddy fields	1233.0	14.0
Marshy Land	200.0	2.3
High elevation land	57.0	0.65
Agricultural Land		
Coconut	244.6	2.8
Rubber	344.3	3.9
Other	32.0	0.3
Vacant Land	146.0	1.7
Cemeteries	20.0	0.23
Water	375.2	4.3
Total	8772.0	100.0

Table 1: Land Use in Kaduwela - 2005

Source: UDA, 2005

The commercial activities in Kaduwela are in leaner type along the Battaramulla – Kaduwela, Malabe – Athurugiriya and Avissawella – Colombo road. Within the Kaduwela MC limit, four commercial clusters can be identified, such as Battaramulla, Malabe, Kaduwela and Athurugiriya. According to the result from image analysis, commercial land comprises nearly 4% of the total land area in Kaduwela MC. In addition to this, main industries are located in Oruwala, Ranala, Athurugiriya, Korathota, Arangala, Pittugala,

Dedigamuwa and Bomoriya. The total industrial land utilization is nearly 2% out of the total land extent of the area. The contribution of residential land use is 52% in 1998 and it increased to 61.1% in 2005.

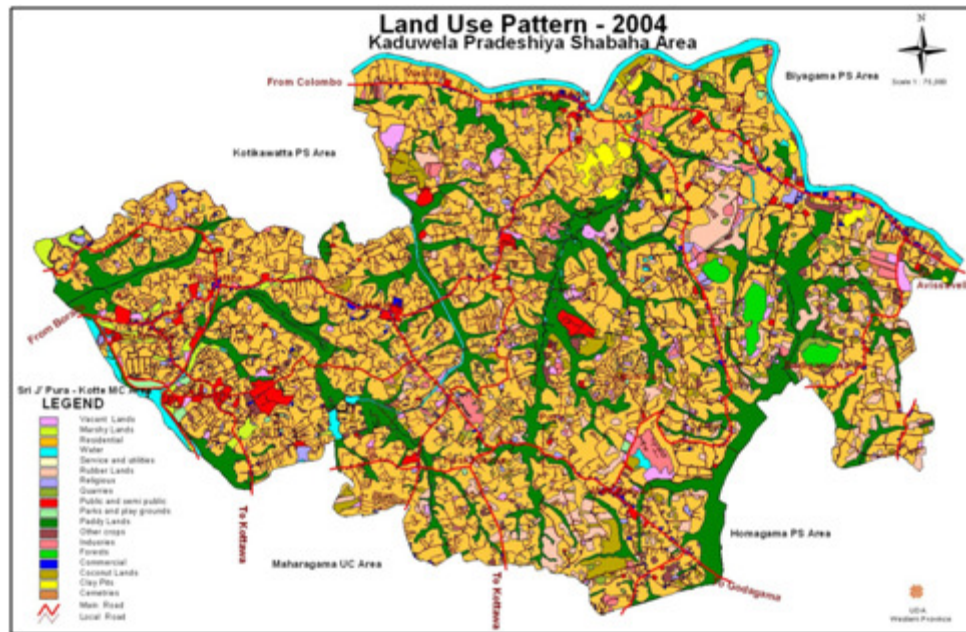


Figure 3: Landuse in Kaduwela Municipality Council of Sri Lanka, 2004
Source: UDA, 2005

The land use of the Kaduwela MC dramatically changed in recent years. Because of the rapid change of rural area into urban area surrounding the Sri jayewardanepura Kotte administrative capital. However, land use changes and high rate of suburbanization are the main causes of the rapid change of the land use in Kaduwela. Using landsat5 images in 1975, 1980, 1997 and 2016 are classified based on four categories of land use such as water, built-up areas, paddfielde and vegetation including homestead or other crops. The images were analyzed using ERDAS and ArcGIS software. The results of the analysis of the landsat5 images are as follows.

Type	1975	1980	1997	2016
Water	13.6*	2.2	2.1	2.1
Vegetation (Home garden & other cultivation)	24.6	38.9	38.9	38.9
Paddy	41.0	32.1	28.6	23.9
Built-up area	8.6	14.6	16.5	22.9
Total	87.8	87.8	87.8	87.8

Table 2: Land Use Changes from 1975 to 2016 in Kaduwela in KM²

Source: Output Data from GIS Analysis, 2016

*There is an error records because many paddy lands are calculated as water

The paddy land is decreasing rapidly and those lands are used for other activities. It is clearly shown when compare the other land uses are compared in various times (See4,5,6 and 7). Especially the residential/commercial land uses are increasing dramatically within the 41 years between 1975 to 2016.

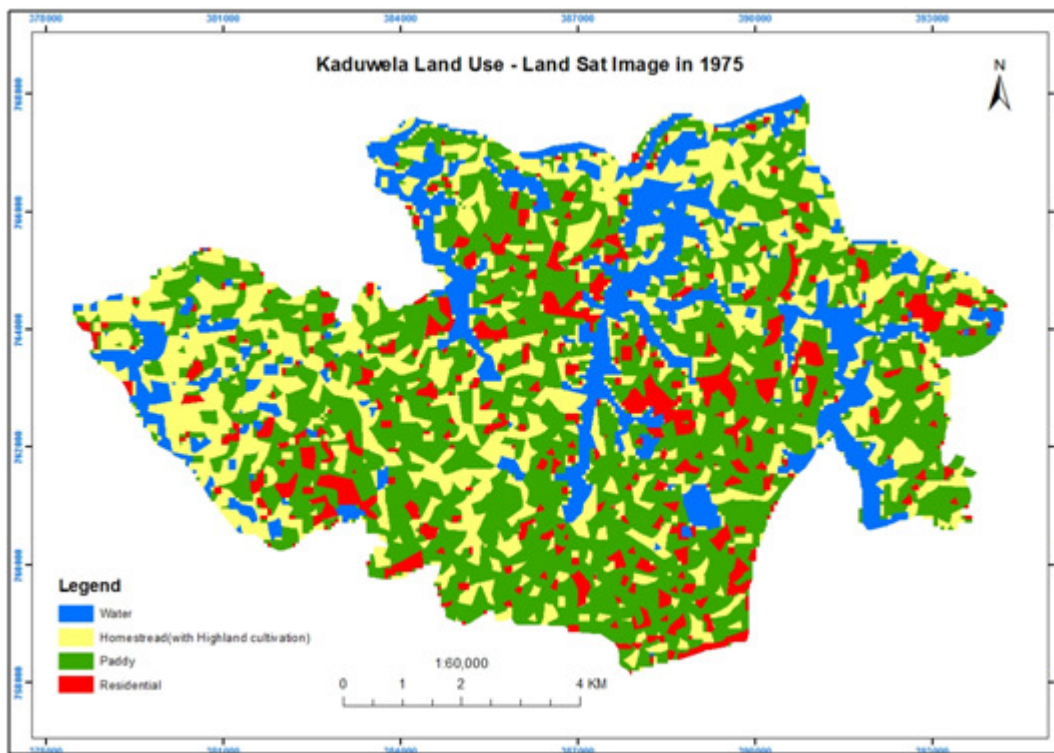


Figure 4: Classified Image in 1975
Source: Based on LandSat4 Image in 1975

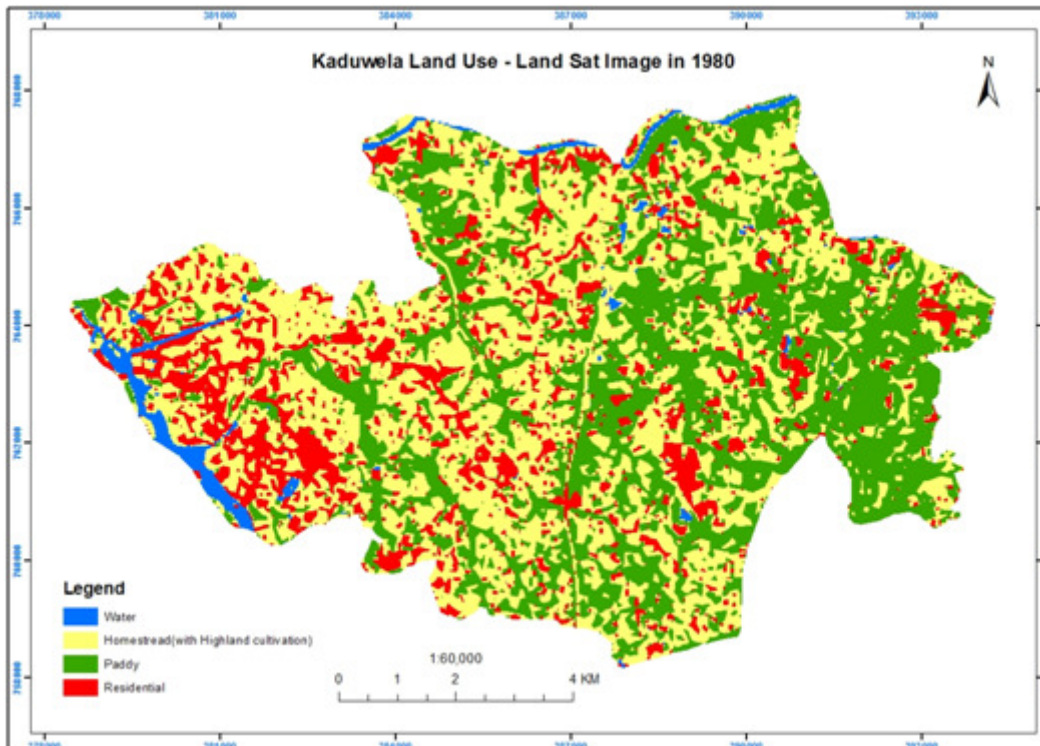


Figure 5: Classified Image in 1980
Source: Based on LandSat5 Image in 1980

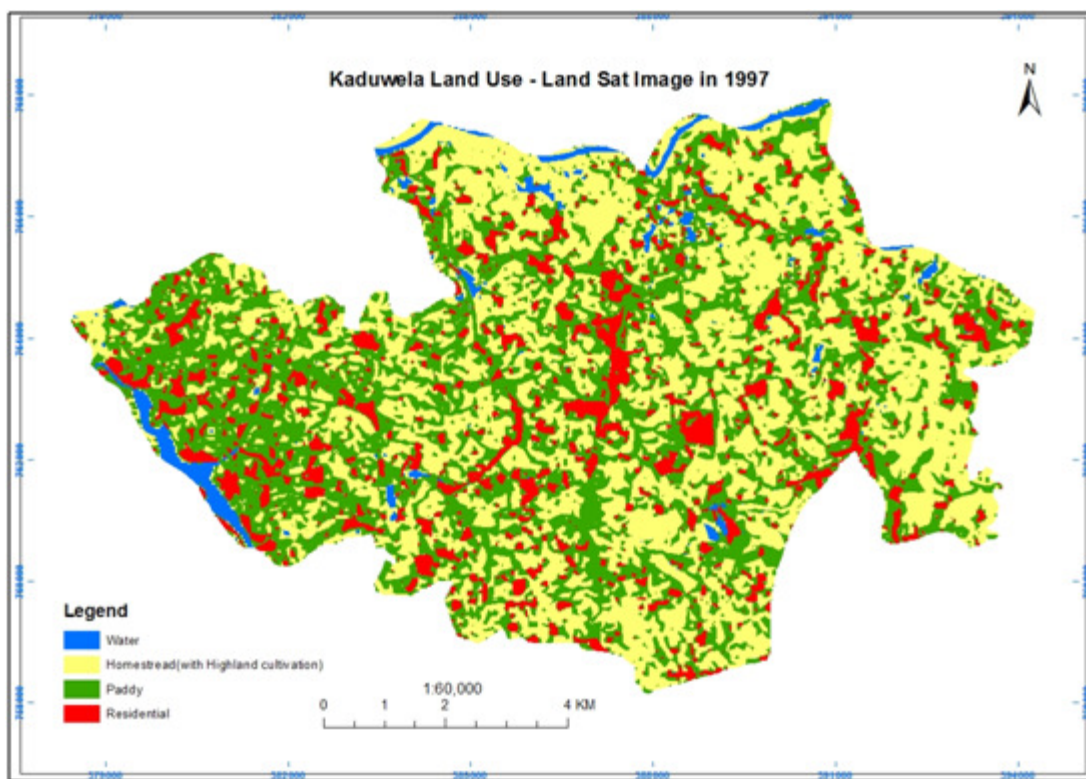


Figure 6: Classified Image in 1997
Source: Based on LandSat5 Image in 1997

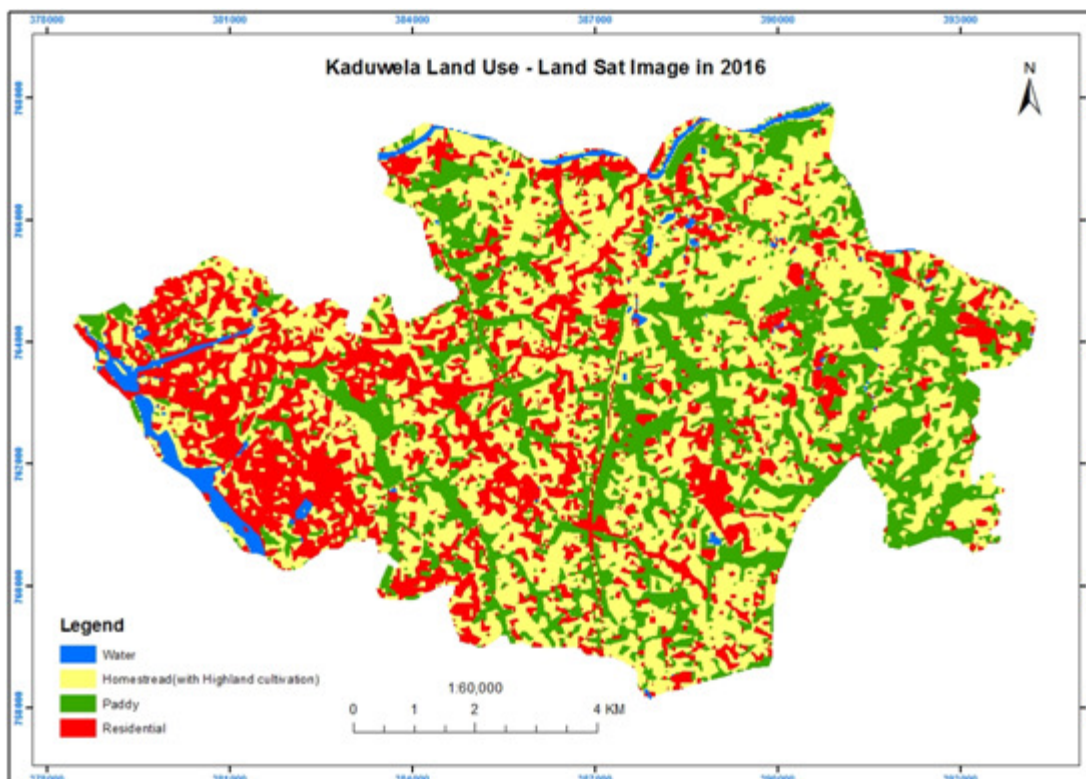


Figure 7: Classified Image in 2016
Source: Based on LandSat5 Image in 2016

Type	1975/1980	1980/1997	1997/2016	1975/2016
Water	-	-3.20	-0.94	-2.26
Vegetation (home garden & other cultivation)	57.98	-0.05	-0.03	57.86
Paddy	-21.76	-10.91	-16.24	-41.6
Built-up area	69.64	12.91	38.48	165.23

Table 3: Changes of Landuse from 1975 to 2016
 Source: Output Data from GIS Analysis, 2016

According to the table 3, the vegetation cover (home garden and other cultivation) increased but the value has not much changed (Figure 8). But the paddy lands decreased very rapidly in Kaduwela, from 1975 to 2016. In 1980 the paddy areas are shifted from West to East gradually (Figure 9). Compared to 2016, the paddy areas in Eastern part also decreased and at present some paddy lands are appearers in the Western part of the image. Compared to the other land uses built-up areas are growing up very fast. It, very clearly compares to the land use. Especially the Battaramulla region of the Kaduwela MC is a rapid changing area. Most of the suitable lands for residences is already used in Battaramulla and other land uses are gradually decreasing. Some of the other lands are engaging in commercial and industrial activities (Figure 10). According to the results from image analysis in 1975, 1980, 1997 and 2016 gradually increases are seen in that residential sector. Compared to 1975 and 1980 image, the residential areas have increased in Battaramulla area. In addition to this compared to 2016 not only Battaramulla region, but also Kaduwela and Athurugiriya region shown an increase in residential areas. The demand of office and market complex is very high. In addition, most of the vacant land use for recreational purposes. Compare to the 41 years data from image analysis the water and paddy areas are decrease and residential and commercial land uses are increase in rate of 165%.

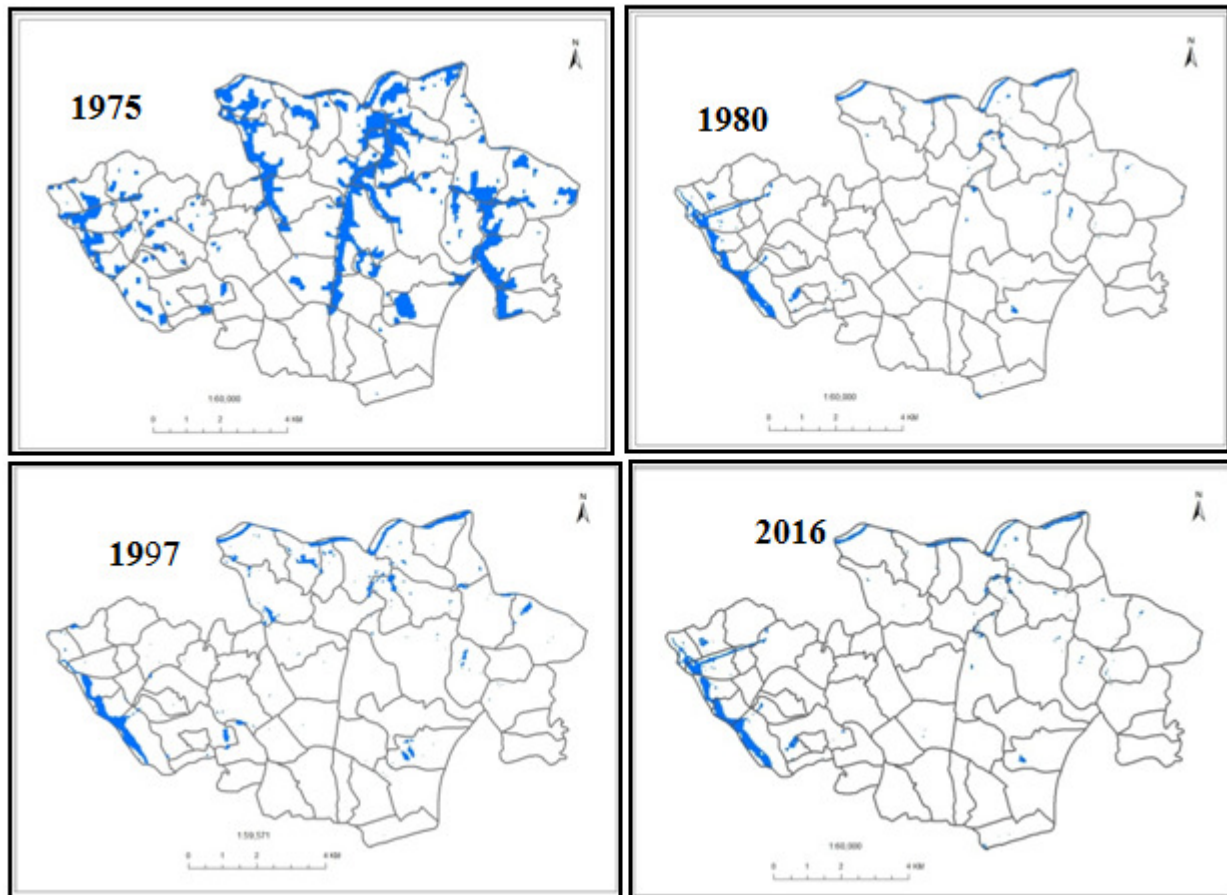


Figure 8: Changing pattern of the water areas from 1975-2016
 Source: Based on Land Sat Image, 1975, 1980, 1997 & 2016

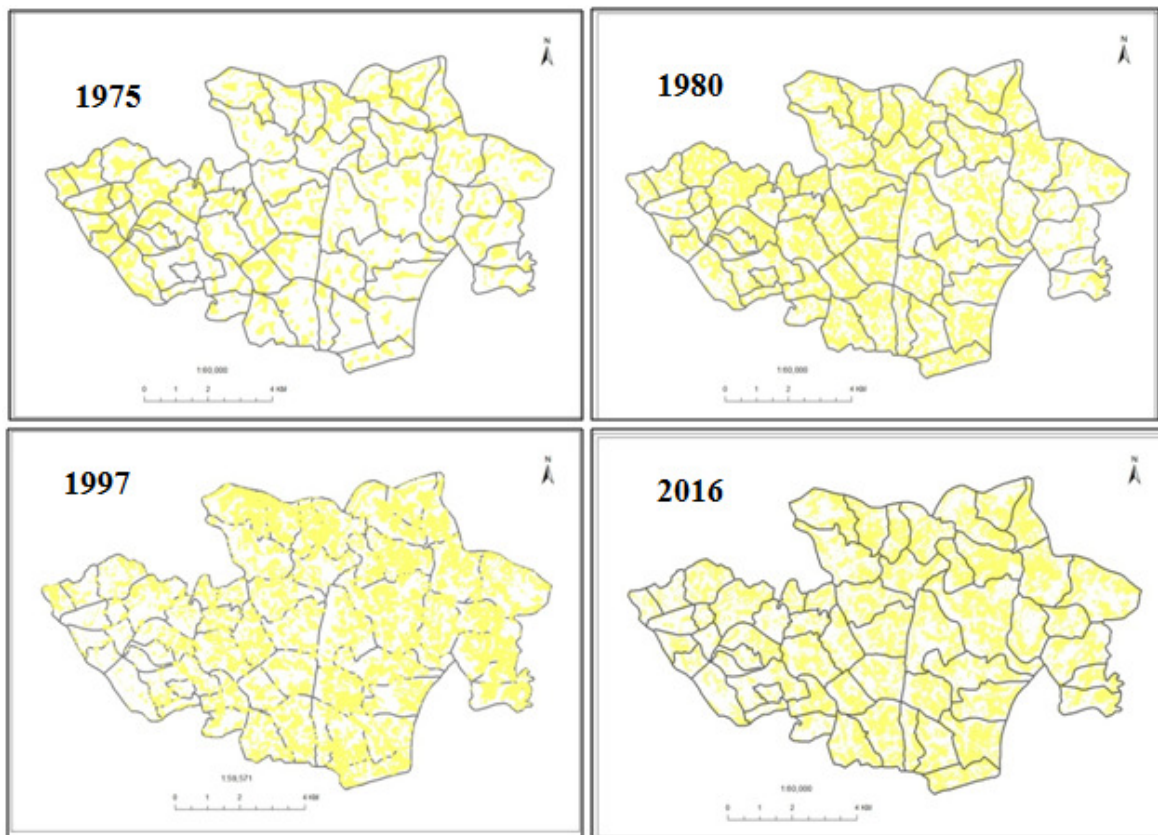


Figure 9: Changes in vegetation and other crops from 1975-2016
Source: Based on Land Sat Image, 1975, 1980, 1997 & 2016

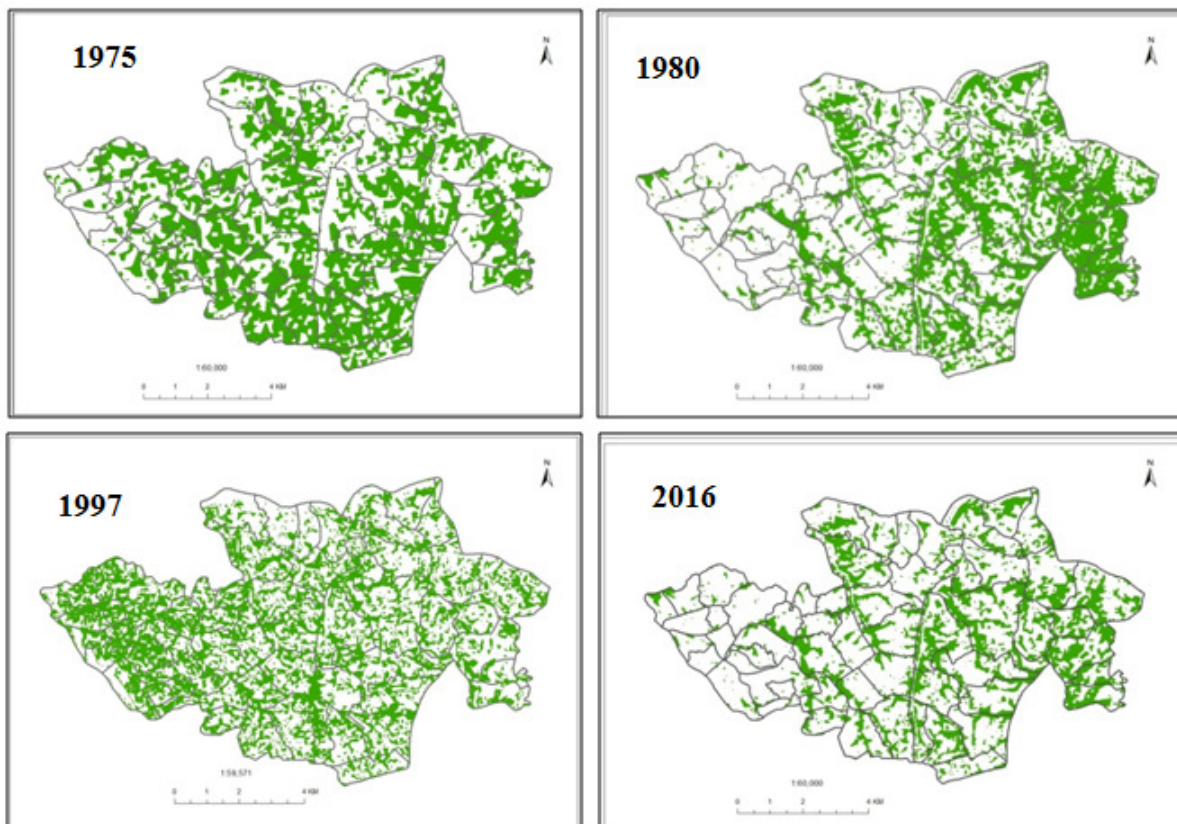


Figure 10: The Changing pattern of the Paddy land from 1975-2016
Source: Based on Land Sat Image, 1975, 1980, 1997 & 2016

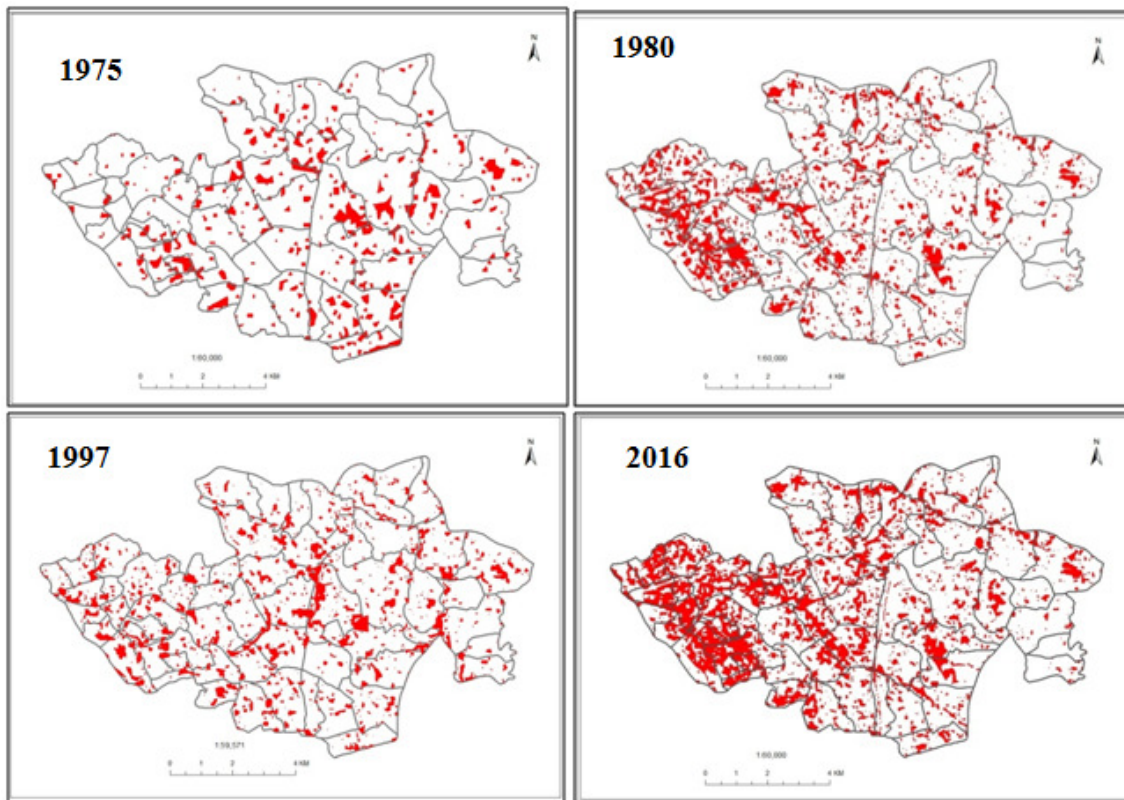


Figure 11: Changing pattern of Built-up areas in Kaduwela from 1975-2016
 Source: Based on Land Sat Image, 1975, 1980, 1997 & 2016

Type	1980	1997	2016
Water	219	212	210
Vegetation (Home garden and other Crop)	3888	3886	3885
Paddy	3208	2858	2394
Built-up Area	1464	1953	2289

Table 4: Extent of land utilization for Kaduwela MC
 Source: Output Data from GIS Analysis, 2016

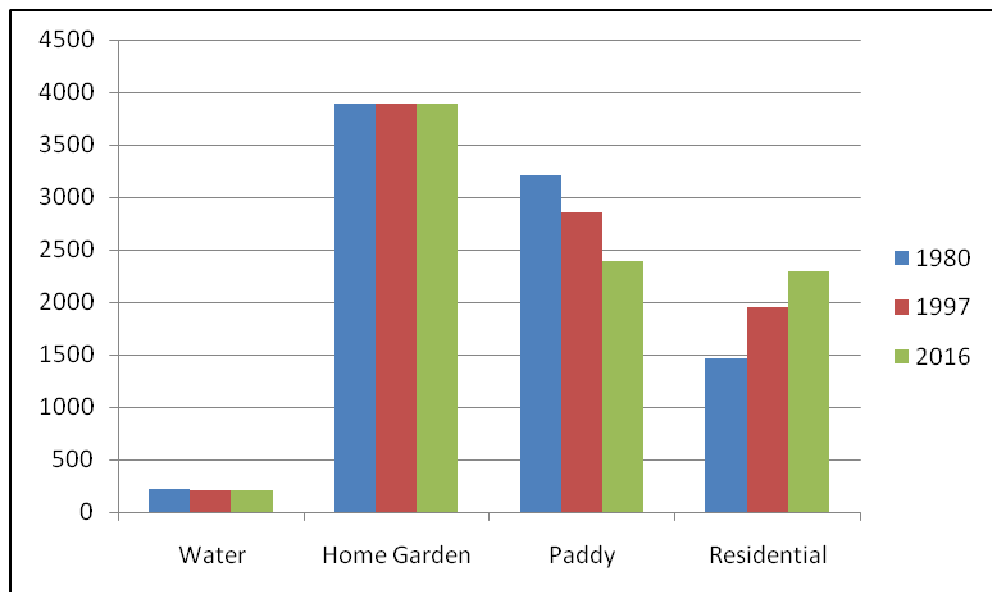


Figure 12: Extent of land utilization for Kaduwela MC
 Source: Output Data from GIS Analysis, 2016

According to the above table the, largest portion of the land is comprised of home gardens. The lower portion is water and second lowest area is residential. In 2016 also same hierarchy can be seen but the residential land area has increase from 1464 hectares in 1998 to 2289 hectares in 2016. The paddy land has decrease nearly to 900 hectares. Within 36 years the water and vegetation cover has decreased in a little but this has produced a high demand for land.

According to the topological sheets of 1956s, 1985s and 1990's result of the land use changes ware same in sat images.

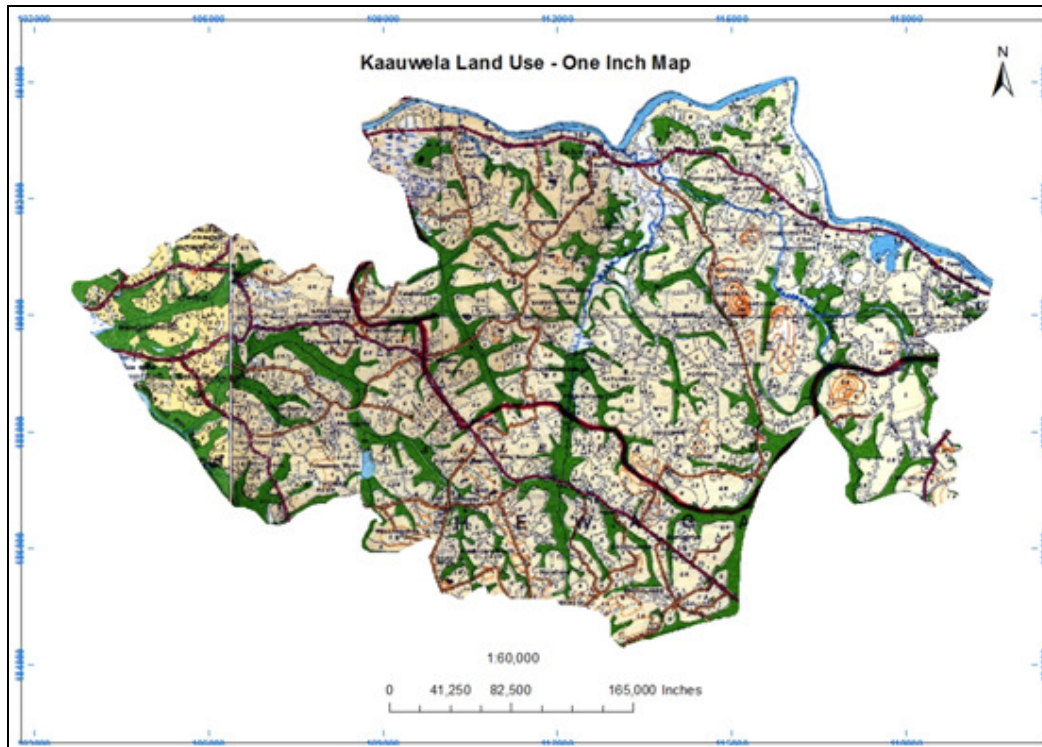


Figure 13: One Inch map of Land use in Kaduwela DSD (Topography Sheet) in 1956
Source: Based on Survey Department, 1956

According to above image lot of paddy lands, water areas and marshy lands in Battaramulla region and upper part of the Kaduwela region can be seen. At present those lands are used for residential and commercial purposes. It is clearly shown in the 1: 50,000 maps. In addition, some of the plantation areas are also converted for residential purpose. Specially, rubber and coconut plantation areas disappeared from 1980 to 2016.

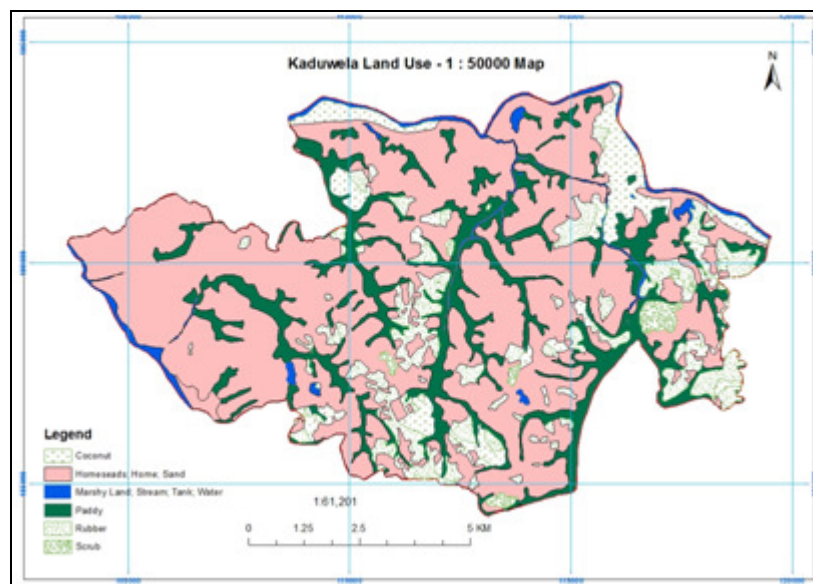


Figure 14: Land use Map of Kaduwela According to 1: 50,000 in 1985
Source: Based on Survey Department, 1985

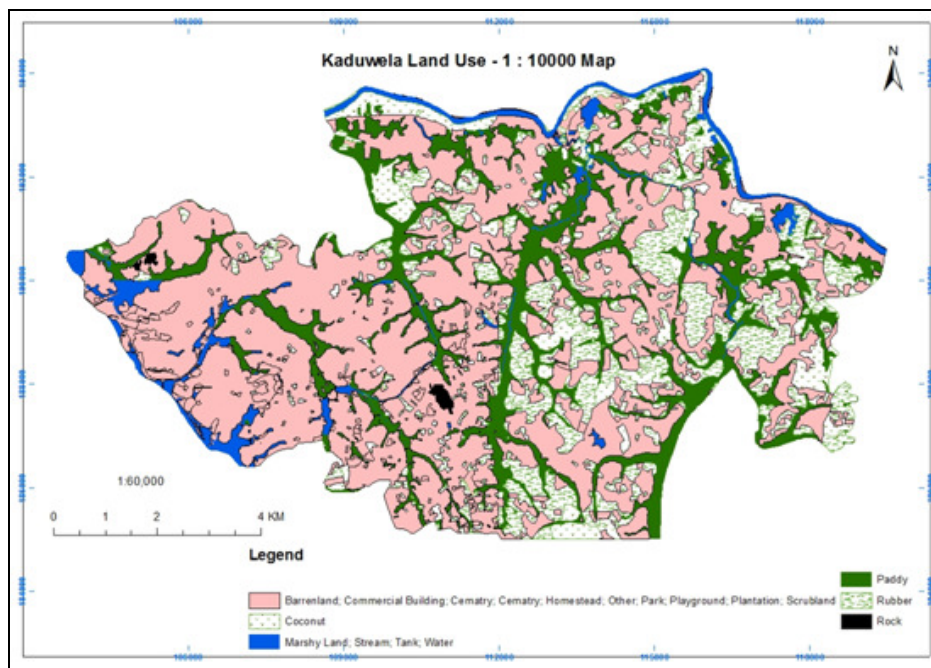


Figure 15: Land use Map of Kaduwela According to 1: 10,000 in 2001
 Source: Based on Survey Department, 1985

1.2. Trends in Land Use Change

The promotion of Kaduwela Pradeshiya Sabha to MC thereafter has influenced the land prices. There are no vacant lands as most of the existing developed land has undergone sub divisions to meet the demand for housing, and for commercial development along the main roads. Due to the scarcity of land within the city limits the adjacent areas of the municipality Homagama, Biyagama, Hanwella areas have accommodated the expansion of Kaduwela especially in residential use. Low lying areas have also been filled to meet the demand for land. Land prices in main commercial centres at Battaramulla, Kaduwela, Malabe, Athurugiriya, Thalawathugoda are very high ranging from Rs.600, 000 to 1,000,000 a perch along the main roads. Land values in residential areas outside the commercial clusters such as Athurugiriya, Malabe, and Thalawathugoda range from 200,000 to Rs.300, 000 a perch (Figure 16). The land prices are gradually increasing within a short period of time, because of the high demand of the land and more concentration of the services, commercial clusters and administration functions.

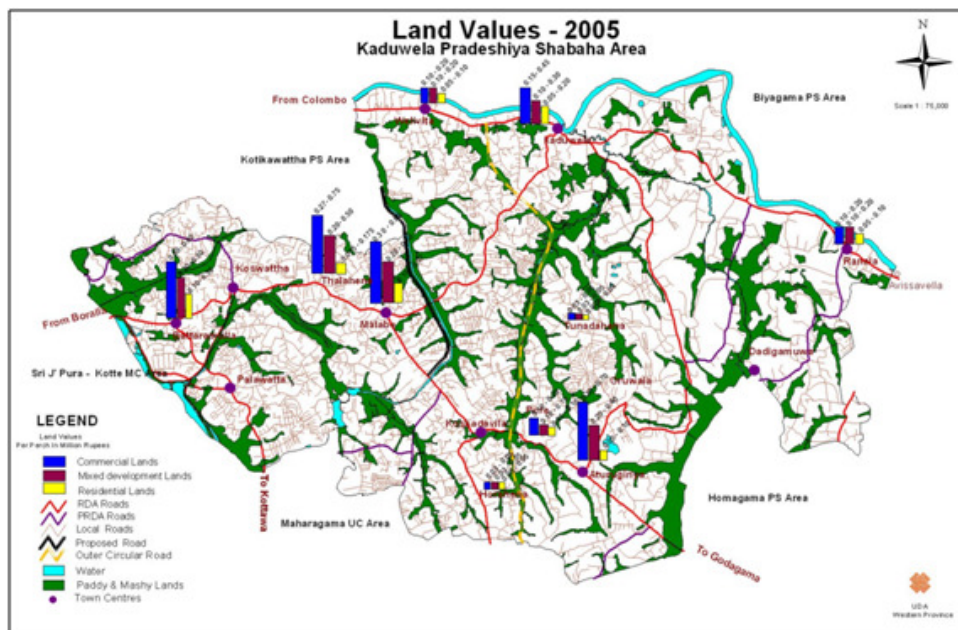


Figure 16: Land Value of Kaduwela MC
 Source: UDA, 2015

The sale of land divided into small blocks is very high in the area, specially, the Malabe educational zone and the Athurugiriya millennium housing complex, recently developed recreational facilities around the parliamentary complex and surrounding areas. Most important factors are the demand of the walking tracks, children parks, Diyatha Uyana open market and high levels of other infrastructure facilities. The other valuable factor is the major factories situated in the MC area Biyagama BOI project is also situated on the other side of the Kelani Ganga. Lot of factory workers are living around the area and they also come to Kaduwela for their needs. This is also the reason of the fast development of the commercial and other services in the Kaduwela MC.

A sample location based on Google image interpretation of 2004 to 2015 images can be identified about the changes of the land use in Kaduwela. According to the analysis the transformation of the land use within 11 years can be identified. For this analysis 50 locations are selected for checking. Out of 50 locations 36 locations have completely changed the land use. Other 14 locations are not completely change but their boundaries are reduced (figure 17). This figure shows the rapid changes of the land use in the area. Especially, the land use changes in Battaramulla region is very fast compared to other two administrative regions. On the other hand, development of the road network within the MC area is the major reason for the changes of land use. Most of the land is situated within 300 Meters from the main roads and the sub divisions are converting residences to commercial and administrative purpose (figure 17)

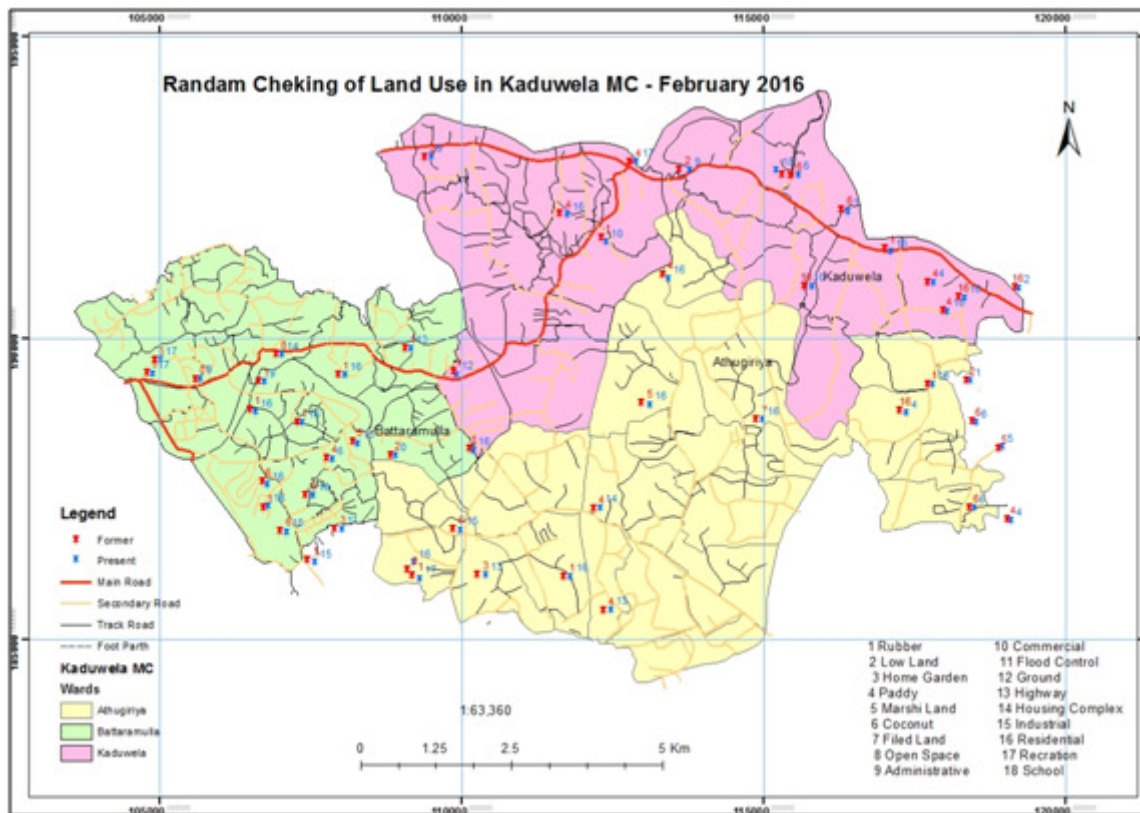


Figure 17: The changes of the land use according to the Sample from 2004 to 2015 in Google images
 Source: Result of Sample Point analysis, 2016

Former Land Use (2004)	Present Land Use (2015)	Percentage of the changes
Rubber	Administration (1), Residential (6), Industrial (1), Home Garden (1), Ground (1), Recreational (1), Commercial (1), School (1)	40.6
Low Land	Administration (2)	6.3
Home Garden	Tank (1), Highway (1)	6.3
Paddy	Coconut (1), Highway (1), Housing Complex (1), Residential (1), Recreational (1)	15.6
Marshy Land	Residential (1), Recreational (1)	6.3
Coconut	Residential (1), Commercial (1), Industrial (1),	9.4
Open Land	Residential (1), Housing Complex (1)	6.3
Residential	Commercial (3)	9.4

Table 5: The changes of the land use according to the Sample from 2004 to 2015
 Source: Result of Sample Point analysis, 2016

The table 5 shows the result of the analyzed sample points from 2004 to 2015. According to the figures, rubber and paddy land are rapidly changed into commercial and residential purposes. Out of the total land use 40.6% were mainly converted into residential purposes. Those lands are used in rubber cultivations in 2004 and now they are converted to another use. In addition to residential purpose, others are converted into administrative, commercial, recreational etc. Nearly 15.6% of the paddy lands in the area converted into of roads and residential and recreational areas. The coconut lands of the area are converted into residential, commercial and industrial purposes and it amounts to 9.4%. Similarly, another 9.4% of residential areas in the Kaduwela converted into commercial activities. In addition, low land, marshy land, home gardens and open lands are also converted into other land uses in representing the same amount according to the table 5. Those lands are also converted into residential, recreational, road development, housing complex and administration purposes. The same results of the area are shown not only for the sample point analysis of the Kaduwela but also the satellite image interpretation. (table 5).

2. Findings

The Land use of the urban sprawl in Kaduwela Municipal Council has changed very fast. Specially most of the land is used for residential, commercial and infrastructure facilities. The paddy, marshy or inland cultivation lands are the alternative land used for residential, commercial and other urban activates. The land prices of the area have increase very rapidly and land block out has increase and the size of the land plots are very small.

The nearby land of the main road is utilized for the commercial and entrepreneurial purposes. The density of the buildings is also high in surrounding areas. In addition, the changes of the land uses are very high and a vertical development can be identified.

The land use changes of the Kaduwela MC are directly influenced by the current developments, because it is near by the Colombo commercial capita and the administrative capital of the country. The other important factor is that it is situated in second crest of the suburbanization zone.

According to image analysis from 1975 to 2016 the main fault can be identified as the different types of land sat images taken and their DN values being different. Therefore, the land cover must be different and vary the types of images. The other reason is time period of the satellite image. Therefore, the land cover must be changed accordingly to represent different time period and the result of the analysis would be different.

Final conclusion is that after significantly identifying the suburbanization process and spread of surrounding areas of the main urban centres in Colombo the directs influence for the rapid changes of the land use are to be seen. It does clearly identify the urban settlement nearby the urban centres in Sri Lanka.

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