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Maximum Likelihood for Land-Use/Land-Cover Mapping and Change Detection Using Landsat Satellite Images: A Case Study "South Of Johor"

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ABSTRACT:

Land cover change has become a central component in current strategies for managing natural resources and monitoring environmental changes. Urban expansion has brought serious losses of agriculture land, vegetation land and water bodies. Urban sprawl is responsible for a variety of urban environmental issues like decreased air quality, increased local temperature and deterioration of water quality. In this study we have taken South of Johor as a case study to study the urban expansion and land cover change that took place in a period of time about of 16 years from 1995 to 2011. Remote sensing methodology is adopted to study the geographical land cover changes occur during the study period. Landsat TM and 7 ETM+ images of Johor are collected from the USGS Earth Explorer website. After image pre-processing, supervised classification has been performed to classify the images in different land cover categories. The study area classified into five classes: urban area, water bodies, vegetative area, barren land and unknown area (clouds). Classification accuracy is also estimated using the field knowledge obtained from using a topographic map and Google earth. The obtained accuracy is about 90.11% and 94.14%. Change detection analysis shows that built-up area has been increased by 3%, in the other side the vegetative area has been decreased by 12%. Information on urban growth, land use and land cover change is very useful to local government and urban planners for the betterment of future plans of sustainable development of the city.

KEYWORDS: *Remote sensing, Maximum likelihood classification, Change detection, land use/land cover, Landsat TM and 7 ETM+ images, Urban growth.*

I. INTRODUCTION

There are many factors should care about that relate to social and environmental problems in omega cities, and the growth of population, economic and urbanization development are the most affects factors. Urbanization area going to expand over the time [7], [13]. Most of these problems related to the expansion of urban area [6], these problems for instance: water and air pollution, climate change, decrease the vegetation productions, harm the animals and reduce the resources of human being (wood and food). These factors to gather will reduce the quality of life in different kind of societies. On the other hand the human being should care and protect about their natural resource [28]. Nowadays remote sensing sensors provide mass of geo-spatial data covers wide areas and it has the capability to update all these information temporally and low cost if compare with other techniques, with using the satellites imageries for manage and monitor the sprawl of the urban area and the negative effects of that expansion [9], [10], [11].

II. LITERATURE REVIEW

The environment and human health, and quality of life standards, all could be affected by poor urban planning developments, or urban sprawl. After providing several alternative definitions of sprawl, we conclude that there is no single definition that would satisfy the person's in charge. According to Jaeger, Bertiller, Schwick, and Kienast (in press) Urban Sprawl shows the extent to which the built area (urban area) and the amount of dispersion in the scene. Almost majority of the cities occupied by buildings, structures and higher degree of urban sprawl spread. The Term "urban sprawl" can be used to describe (sprawl degree in landscape) and the process (spread out in the landscape over time).

Characteristics, causes and consequences are discriminated. from the phenomenon of urban area. According to [14], [27] remote sensing based on multiple times for land-use, change data can be used to evaluate the structural variation of land cover/use patterns. The results are useful for planners who are looking for avoid cumulative effects of urbanization and promoting the allocation of urban services [3]. What is more, such information are essential to assess and evaluate strategies for sustainable environmental and urban planning [1].

Recently, many researches have been done based on the use of satellite data and geographic information systems to measure the growth of the city and development of sprawl patterns. Herold [7], [8] carried out an extensive study on the dynamics of ground cover in urban areas using remote sensing data to develop landscape measurement analysis and interpretation in conjunction with spatial modeling results for urban growth. Their study showed that the approach combines remote sensing measurements and analysis of landscape and urban modeling could be a promising way to understanding spatiotemporal patterns of urbanization.

Built up area generally is accepted as a key feature to estimate urban sprawl [4], [5], [24]. Cover urban area can be obtained from surveys of physical ground or remotely sensed data. [19] Confirms that economic and population growth on the natural and human resources are the main causes of urban sprawl. The study covered the period 1972-1999 and used aerial photographs and maps available, and IRS (Indian remote sensing satellite) images Mangalore, India. Researchers showed that while built area has increased by 145%, the population grew by 55%. This is due to unplanned development and renovation of low population density. Similarly [25] using SPOT (Satellite pour observation de la Terre) imageries from the period between 1986 and 1996, identified the amount and the patterns of expansion of the city of Tunis. They discussed the benefit of remote sensing is the ability to find out the city limits and illegal settlements around cities, which are often the main cause of damage to environmental resources. [15] The statistical model designed to assist planning and decision-making process is part of Beijing with using Landsat images of five dates between 1986 and 1997 concluded that the images provide a reliable solution for quantitative studies of the city.

There are few studies or research for the Middle East and Iraq. One that is [26], which focused on the Al-Ain in the U.A.E. In another study, [3] used available maps, aerial photographs, and satellite images for the period (1950 – 2003) to study city of Muscat in the Sultanate of Oman. The results of the study showed that the 1970-2003, accumulated by the region has grown 650%, or an annual growth rate of 20%. Findings revealed that although the built-up by nine times and population increased seven times its original size, a large amount of farmland was constructed land. According to [4] growth occurs when the amount of construction in urban areas in excess of population growth rates. Therefore, studies [19], [20], [16] to provide concrete examples of the land growth. From all previous studies there are many techniques have been used for detection of urban sprawl some of these studies used classification approaches and other used statistical models. In this paper we try to identify the patterns of urban growth in south of Johor using Maximum likelihood classification with using the Landsat TM and 7 ETM+ images.

III. MATERIALS AND MATHODS

3.1. STUDY AREA

Johor is a Malaysian state, located in the southern portion of West Malaysia. Johor is one of the higheat developed states in Peninsular Malaysia. The state royal city and capital city of Johor is Johor Bahru, formerly known as Tanjung Puteri (Malay for Princess's Cape). The old state capital is Johor Lama. Johor boundaries are surrounded by Pahang from the north, Malacca and Negeri Sembilan from Northwest and the straits of Johor separates Johor and the Republic of Singapore in the south. Johor is also known by its Arabic honorific, Darul Ta'zim, or "Abode of Dignity", and as Johore in English. Geography Districts of Johor is the 5th largest state by land area and 3rd most populated state in Malaysia, with a total land area of 19,210 km^2 (7,420 sq. Mi) and a population about 3,233,434 as of 2010 based on the census of 2000 and 2.75 million was the population of Johor with 54% Malays, 35% Chinese, 7% Indians and 4% others. It is the most southern state in Peninsular Malaysia, and is located between the 1°20"N and 2°35"N latitudes. Gunung Ledang is known as the highest point in Johor (1276 m) over mean sea level. Gunung Ledang is also known as Mount Ophir. Johor also has 400 km shoreline in the both of east and the eest coast. It has 8 large islands with numerous smaller ones, namely Pulau Besar, Pulau Aur, Pulau Lima, Pulau Dayang, Pulau Pemanggil, Pulau Sibu, Pulau Tengah, Pulau Rawa and Pulau Tinggi. REFERENCESFigure (1) shows the study area in southern of Johor state.

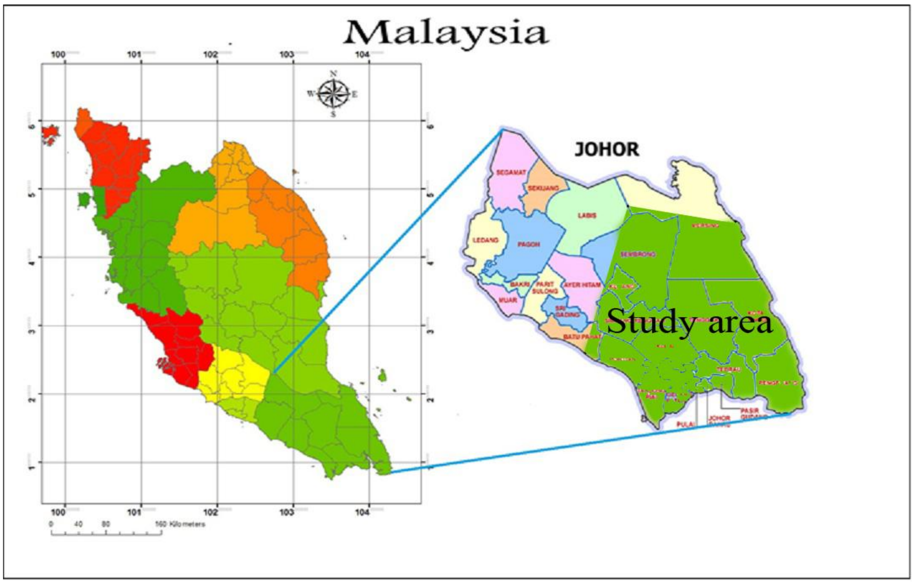

Fig. 1. The study area in south of Johor state, Malaysia

The methodology that follows to achieve our result as indicates in flow chart below in figure 2.

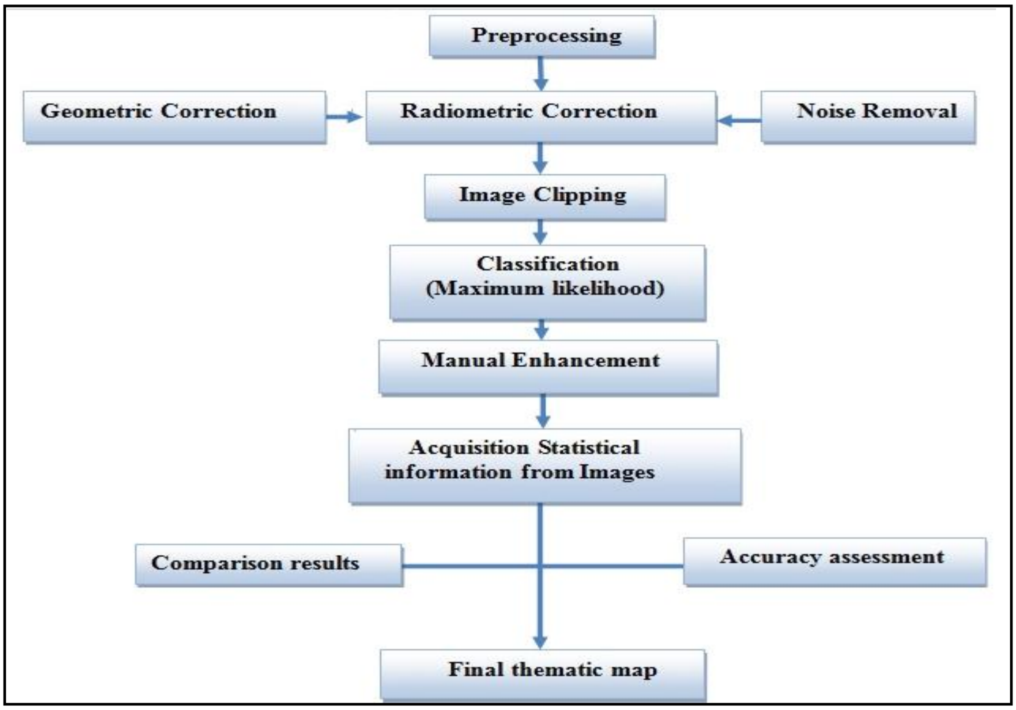

Fig. 2. Flow chart of methodology

3.2. DATA

Multi- temporal satellite data have been applied for this research. The data that has been used was Landsat data from different sensors (TM for 1995 and Landsat7 ETM+ for 2011) and it was from level 1and the datum was WGS84 for the acquisition date. Both images have spatial resolution of 30m. Then by using the topographic map of Johor to be familiar with the land cover in the study area and to collect some testing sites to use in the next stages to perform the accuracy assessment of the classification of (1995 and 2011) years, the scale of the topographic map is 1:50,000.

3.3 Training and Testing Sites Selection

The training sites collected from both imageries by selecting the region of interest (ROIs) using Envi software, the study area classified into five categories: urban area, vegetation area, bare land, water bodies and unknown area (cloud), therefore, five ROIs were collected for Landsat data and the testing sites collecting using the topographic map and Google earth from the historical database of Google earth (archive), testing sites selected and it represented the truth samples that represent these classes. Selection testing sites very important to do the accuracy assessment of classification result, then study area was classified into five classes using maximum likelihood classifier (MLC) to conduct the land cover thematic map of each Landsat data of the study area.

IV. RESULT AND DISCUSSION

4.1. IMAGE PROCESSING

The main goal of this study is to detect the urban area and vegetation changes from 1995 until 2011 using multi- temporal satellite data, in order to monitoring the changes. ENVI software has been used for performing the digital image processing and analyzing such as geometric correction, radiometric correction, atmospheric, noise removal, image clipping, classification and enhancement. Figure 3 shows the result of radiometric correction histogram. For image classification, maximum likelihood algorithm was applied to classify the area of interest into five classes including vegetation area, water bodies, urban area, bare land and unknown area which is considered as cloud. In this study Landsat images were used satisfactorily for the identification of area.The pre-processing for this case study start with radiometric correction, after that remove the noise (Stripped lines) from both of the Landsat images. The geometric correction of the images was perform using the topographic map of south Johor with help of Ground control points (GCPs) which obtained using topographic map and then the images were rectified with GCPs to remove the distortion from the images, which come from differences in orientation sensor parameters and noise from the platform itself. According to the rectification process the total RMS errors for 1995 and 2011 images were 0.44 and 0.50 respectively. The next stage was clipping the images to make the processing inside the area of interest in our imageries.Figure 3 shows the result of radiometric correction of Landsat TM that was captured in 1995 and it is obvious the different from compare the data value in x-axis in both of the histograms. Figure 4 demonstrates the result of remove the noise from the image, and from read the Cursor location/ value we can see the difference between the two images before and after removing the striped lines.

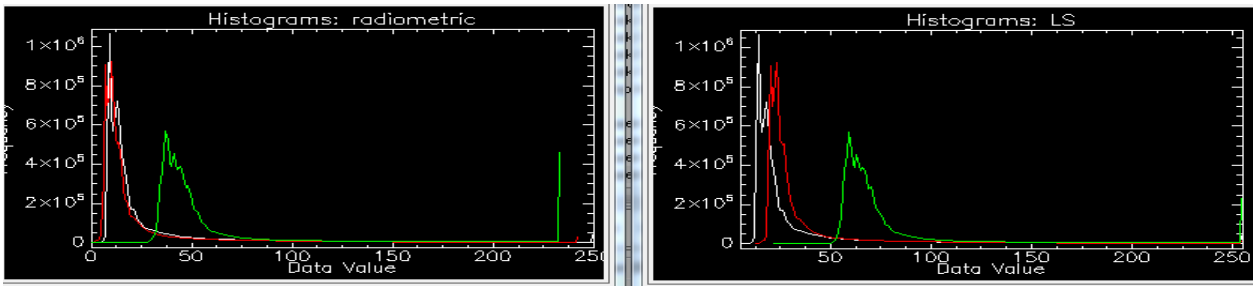

Fig. 1. Radiometric correction for image of 1995.

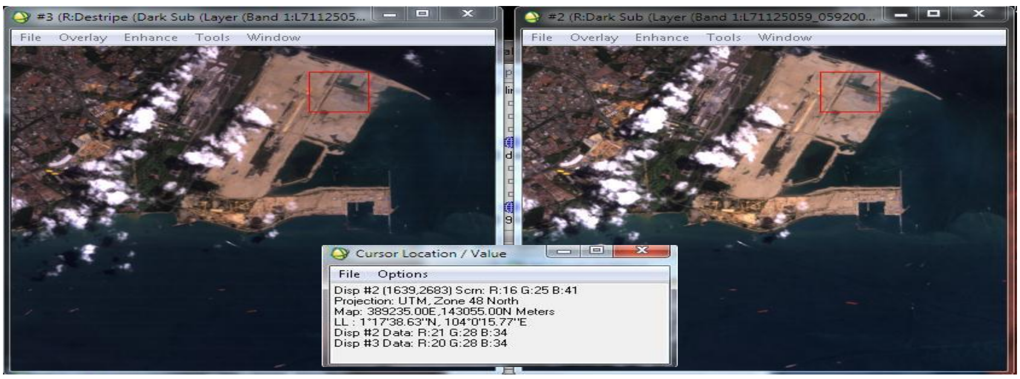

Fig. 4. Stripped line correction

4.2. CLASSIFICATION

Five classes of region of interest (ROIs) for the two images were generated; we applied Maximum likelihood approach for classification stage for each imagery to generate the thematic map of Land cover and to find out the changing that occurred between (1995-2011). The classification conducted with Envi software. There are more than 50 training sites collected for each class. For post classification stage the confusion matrix was used to find out the accuracy assessment of the classifications selecting, truth samples sites have been collected to use in the accuracy assessment. Here below figure 5 reveals the thematic maps of land cover for both years 1995 and 2011.

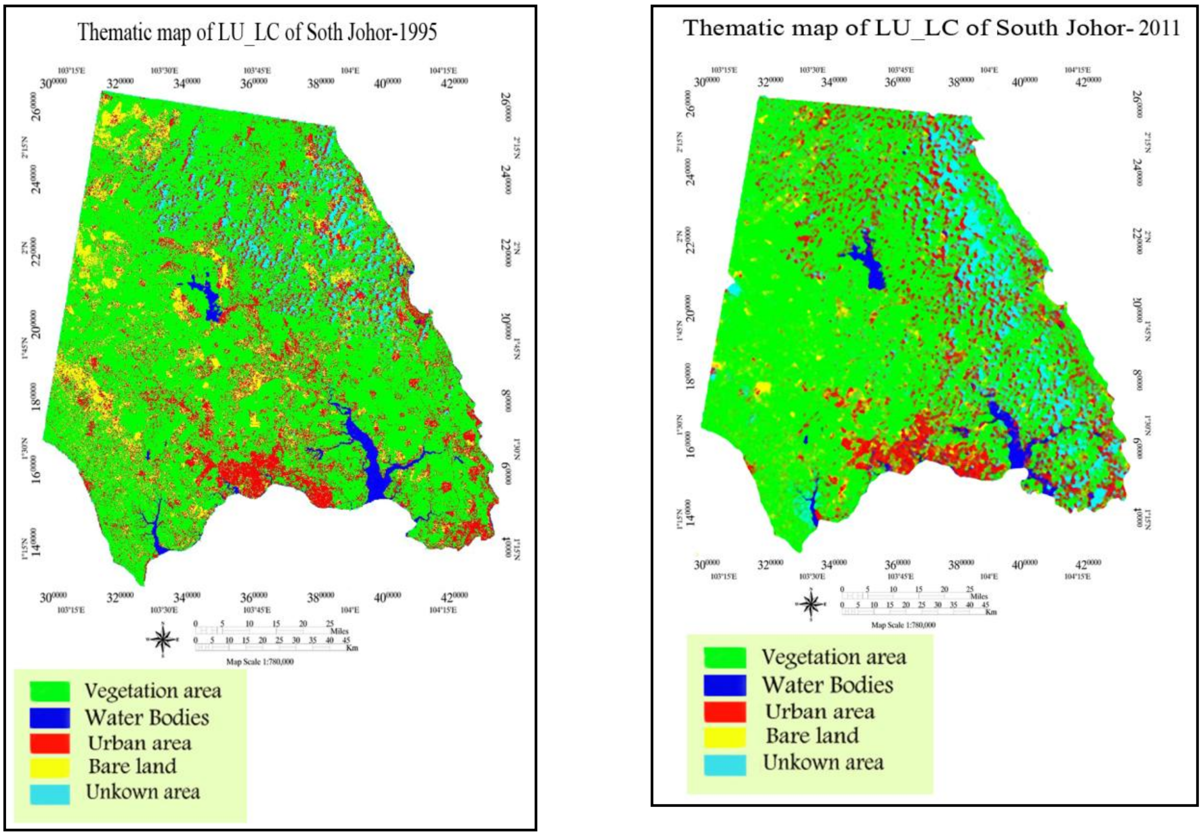

Fig. 5. Thematic maps of Land use/land cove between 1995 and 2011 in south part of Johor

4.3 ACCURACY ASSESSMENT OF CLASSIFICATION

Each of the land use / land cover map was compared to the reference data to assess the accuracy of the classification. The reference data was prepared by considering random sample points from the topographic map and historical data of Google earth. So, the ground truth samples were used to verify the classification accuracy. Over all classification accuracy for 1995, 2011 are 90.11% and 94.14% respectively. It is obvious that the accuracy assessment of Landsat TM images less than that for 2011 and that may be because the need of collecting more of reference samples to get better result than what we have and, on the other hand, it could be the area that covered with cloud reduce this accuracy, simply because no one can predict the types of features that covered these area, fortunately that area that covered with cloud less that 14% and that allow to us to use the image with acceptance results.

4.4. IMAGE ANALYZING

The changes in urban area presented in this paper were based on the statistics extracted from the two land use / land cover thematic maps of the South Johor city. The changes in land cover during the study period (1995 to 2011) can be observed clearly from the pie diagrams shown in figure 6.

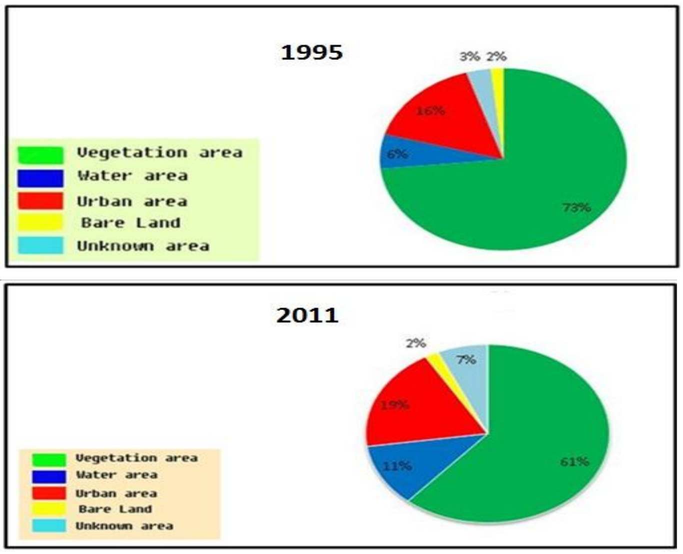

Fig. 6. Pie charts of land use/land cover for 1995 and 2011

The urban area as well as vegetation area has been changed from 1995 to 2011. Urban area has been increased by 3% (from 16% to 19%), however, the vegetation area has been witnessed decreasing by 12% (from 73% to 61%) and that reflect that the population of people increased in study area. The increase in urban area has many reasons. Johor has large borders with Singapore republic and that help to increase the commercial relationship and increase the population of people means new building and housing area, commercial area should be built to the new people. For barren area still remains 2%. The results of monitoring change detection analysis are presented in the Table1, and from figure 7 we can see the thematic maps for each year for land use/land cover and the pie charts that reflect the difference in covered area.

Table-1 the area of study area for period (1995-2011)

1995		**2011**	
Area	%	Area	%
Vegetation area	61.34	Vegetation area	73.34
Water bodies	11.37	Water bodies	6.13
Urban area	18.78	Urban area	15.67
Bare land	1.82	Bare land	1.67
Unknown area	6.69	Unknown area	3.24

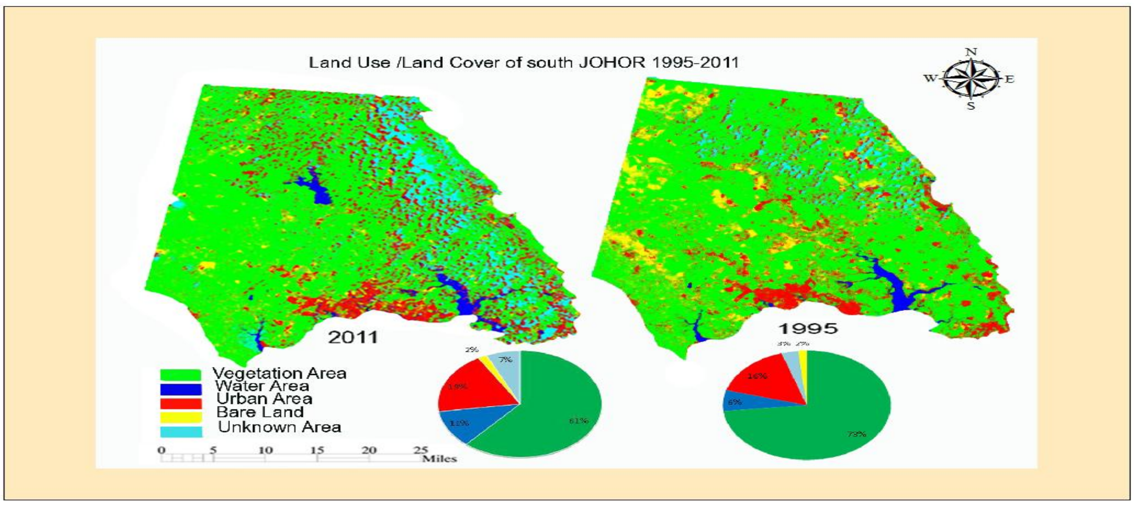

Fig. 7. Land cover/land use for south Johor in between (1995-2011)

V. PREDECTION FOR FUTURE

1. Urban area increased because increase in the population of people that lead to infer that the quality of standards of life in Johor will be improved and our prediction, that the increase of urban area will continue for the coming couple of decades in the south of Johor.
2. Bare area: will decrease to the same reasons above.

VI. CONCLUSION

Johor Bahru is the fifth largest city in Malaysia and commercial capital for the state. This study attempted to identify such urban changes for 1995 to 2011. Remote sensing has the capability of monitoring such changes, extracting the changes information from satellite data. For this research, we have taken Landsat images of southern part of Johor collected from USGS earth explorer website. The images were related to 1995 TM, and 2011 ETM+ respectively. The land use/land cover maps of the study area are developed by supervised classification of the images. Five classes have been identified as urban, water body, vegetation land, barren land and unknown (clouds). Over all classification accuracy for 1995 and 2011 are 84.14% and 89.11% respectively. Monitoring Change detection analysis shows that urban area has been increased by 3%, vegetative area has been decreased by 12% and barren area remained constant. Information on land use/land cover and possibilities for their optimal use essential for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs and welfare.

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