

URBAN SPRAWL AND LANDUSE CHANGE IN SUVARNABHUMI AIRPORT (NEW BANGKOK INTERNATIONAL AIRPORT) AREA, BANGKOK, THAILAND

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ABSTRACT: The Suvarnabhumi Airport or New Bangkok International Airport (NBIA), the vision of the Government of Thailand was conceived during the 1960's. The total floor area is expected to be 500,000 square meters (world's largest for a single terminal complex) with the capacity of 45-50 million passengers per annum and handling 112 flights per hour upon completion. The foundation stone was laid by His Majesty, the King on January 19, 2002 and the construction works followed soon after. Commencement of the construction works has resulted in a significant change in the landuse pattern of the surrounding areas of NBIA. This study attempts to analyse the pattern of intermittent change in landuse and also highlights development and layout of roads in the subject area. Landsat Thematic Mapper (TM) data from various years (1988, 2004 and 2006) was used for the analysis with GIS. Data from the recently launched satellite - Advanced Land Observing Satellite (ALOS) data of 2006 was also used for comparison with the Landsat data to depict the level of details between the two sensors. This study also incorporates the changes in the landuse pattern in terms of human settlements, agriculture, aquaculture and other activities. A comparative analysis of the Landsat TM and ALOS depicts that the latter can extract more details than the former. This Paper is under the Pilot Project for ALOS Data Utilization in Thailand between Japanese Aerospace Exploration Agency (JAXA) and Geo-Informatics and Space Technology Development Agency (GISTDA).

1. INTRODUCTION

Urban growth can take place either in radial direction around a city or linearly along the highways. This dispersed development along highways, or surrounding the city and in rural countryside is often referred as sprawl (Theobald, 2001). In simpler words, as population increases in an area or a city, the boundary of the city expands to accommodate the growth; this expansion is considered as sprawl. Usually sprawls take place on the urban fringe, at the edge of an urban area or along the highways. Some of the causes of the sprawl include – population growth, economy, patterns of infrastructure initiatives like the construction of roads and the

provision of infrastructure using public money encouraging development. The direct implication of such urban sprawl is the change in land use and land cover of the region.

The spatial patterns of urban sprawl over different time periods, can be systematically mapped, monitored and accurately assessed from satellite data (remotely sensed data) along with conventional ground data (Lata et al., 2001). Mapping urban sprawl provides a “picture” of where this type of growth is occurring, helps to identify the environmental and natural resources threatened by such sprawls, and to suggest the likely future directions and patterns of sprawling growth (Sudhira et al., 2003).

The Government of Thailand first conceived the Suvarnabhumi Airport or New Bangkok International Airport (NBIA) during 1960's. The total floor area is expected to be 500,000 square meters (world's largest for a single terminal complex) with the capacity of 45-50 million passengers per annum and handling 112 flights per hour upon completion. However, it took nearly 40 years for the government to actually go ahead with the project. The foundation stone was laid by His Majesty, the King Bhumiphol Adulyadej on January 19, 2002 and construction for the same followed soon after. The Government of Thailand's decision to create new infrastructure by way of building a new international airport and subsequent commencement of construction work for the same has resulted had significant impact in the surrounding region of NBIA. The present study therefore, attempts to analyse the pattern of intermittent change in landuse, urban sprawl and resultant development and layout of roads in this region. Understanding the extent of sprawl would help planners and administrators to better plan and facilitate various services that would affect in these regions like, water supply, sanitation and change in land use from agriculture to urban.

The satellite remote sensing data are known to be very effective for temporally monitoring the land use change. Among the popular programs for acquiring satellite remote sensing data is Landsat program. The Landsat program is a series of Earth-observing satellite missions jointly managed by NASA and the U.S. Geological Survey. Since 1972, Landsat satellites have collected information about Earth from space. Landsat satellites have taken specialized digital photographs of Earth's continents and surrounding coastal regions for over three decades, enabling people to study many aspects of our planet and to evaluate the dynamic changes caused by both natural processes and human practices (NASA, 2006). In spite of several advantages of Landsat products, the spatial resolution of 30m for multispectral bands, restrain them from being used for cadastral and micro-level planning and analysis. In the context of assessing the change in land use and urban sprawl around the NBIA, it would be appropriate to make use of higher spatial resolution remote sensing data. Currently there are quite a few data products available offering higher spatial resolution like IKONOS (1m PAN), Quickbird (61cm PAN), IRS-Cartosat (2.5m PAN) and the recent ALOS - PRISM (2.5m PAN). Thus, to ascertain the advantages of mapping urban sprawl using higher resolution data over the prevalent Landsat 5 TM data, the ALOS -PRISM data was used. The data product Advanced Land Observation Satellite (ALOS), also called Daichi is a 4-ton Japanese satellite. It was launched from Tanegashima Island, Japan on January 24, 2006 by H-IIA rocket. The ALOS can be used for cartography, regional observation, disaster monitoring, and resource surveying. The ALOS has three remote-sensing instruments: the Panchromatic Remote-sensing Instrument for Stereo Mapping (PRISM) for digital elevation mapping, the Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2) for precise land coverage observation, and the Phased Array type L-band Synthetic Aperture Radar (PALSAR) for day-and-night and all-weather land observation. The spatial resolution for different sensors ranges from 2.5m to 20m (JAXA, 2006).

In order to ascertain the urban sprawl arising out of the NBIA, data for different time period was analyzed. The Landsat TM data for different years was used for current analysis over a geographic information system (GIS). Data from the recently launched satellite - ALOS data was also used for comparison with the Landsat data to depict the level of details between the two sensors. This study also attempts to study the changes in land use pattern in terms of human settlements, agriculture, aquaculture and other activities. A comparative analysis of Landsat TM and ALOS is attempted to ascertain that whether the latter can extract more details than the former. Hence, conspicuous feature like roads were extracted and compared.

2. METHODOLOGY

Three scenes of Landsat 5 TM image namely 1988, 2004 and 2006, and ALOS –PRISM 2006. The land use map for the respective years was prepared from the classifying the images through visual interpretation and on-screen digitizing. A change detection analysis of the three Landsat scenes was performed in GIS environment. The pattern of change and direction of change were analysed, and the rate of change of each land use was calculated. Changes from one landuse to another landuse in different time period ie, 1988-2004, 2004-2006, and 1988-2006 were analyzed. The land use of the three different years (1988, 2004 and 2006) were combined using raster calculation to see the status different parts of the area, which has undergone changes in land use. To see the extent of urban sprawl and the direction of urban growth, settlement of different years, layer overlapping method was used. Roads were extracted from the three images. The length of roads in different years was calculated to see the development of roads in the study area over the years. ALOS image of 2006 was georeferenced to those of the Landsat images. The ALOS image around the airport area was clipped and road features were extracted to compare the level of detail with the Landsat images.

3. RESULTS AND DISCUSSION

3.1 Land use in different years

The map depicting land use in different years around the NBIA was obtained after classification (Figures 1, 2 and 3). The extent and change in extent of different land use and their proportional annual growth is tabulated (Table 1).It is found that agriculture, aquaculture and water body has declined, while the land use like, airport, golf course and settlements have increased.

From the land use maps for 1988, 2004 and 2006, it is evident the rate of change in land use has been driven significantly with human activities, say like the emergence of golf course and significant increase in built-up areas. Accordingly a land use change map was prepared by overlaying two different time lines, 1988 and 2006.

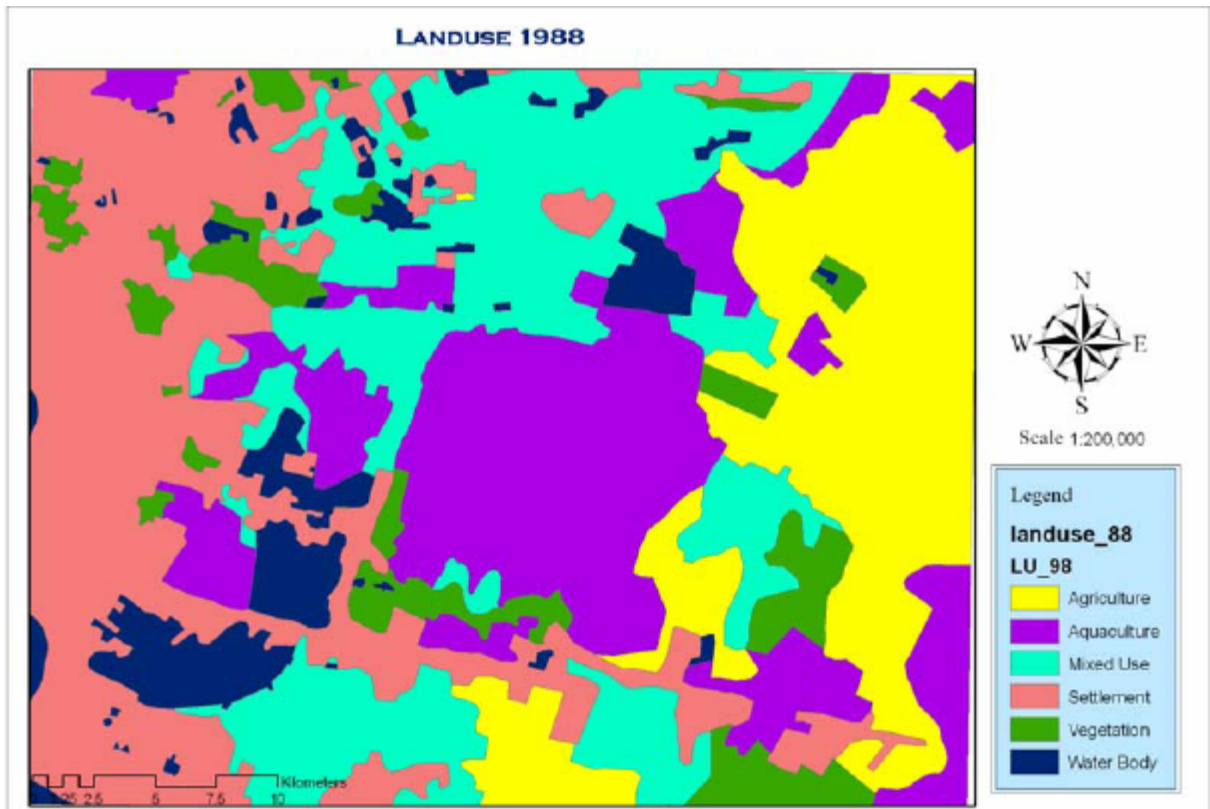


Figure 1: Land use in 1988- Landsat TM

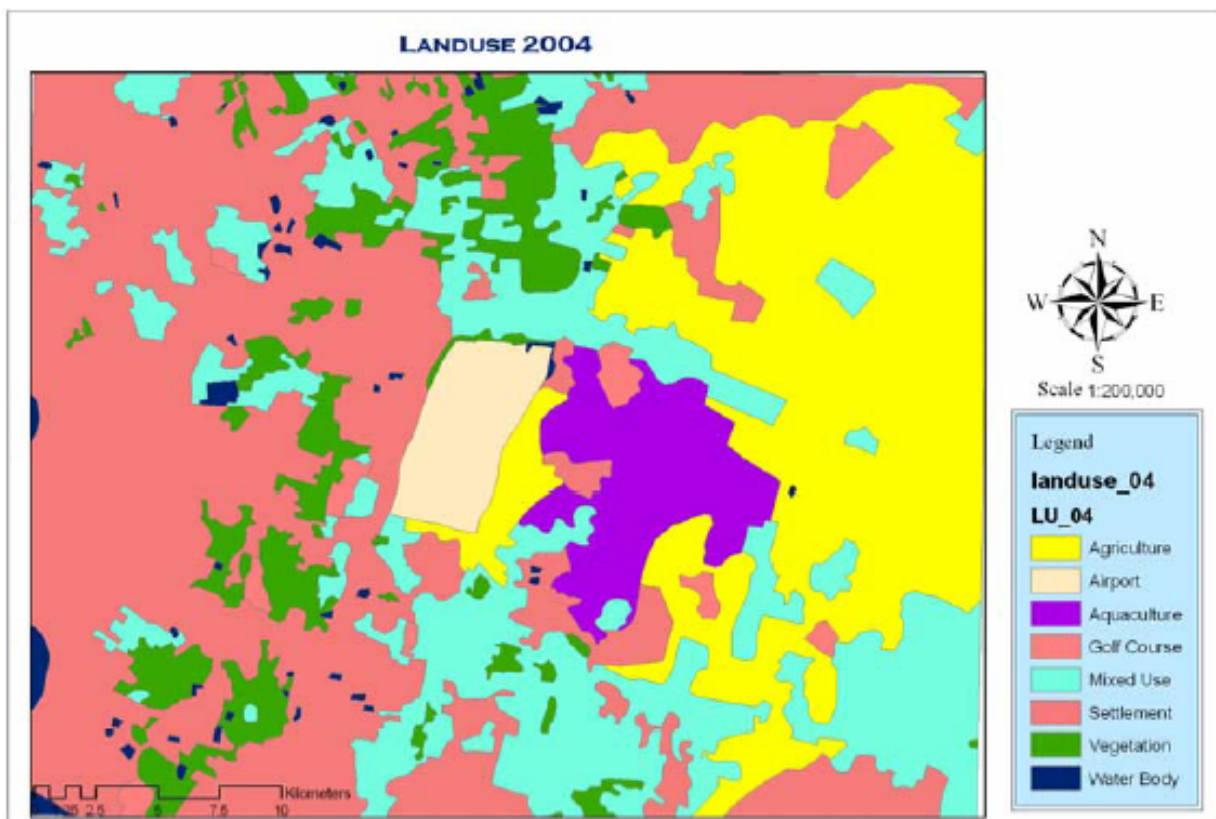


Figure 2: Land use in 2004 - Landsat TM

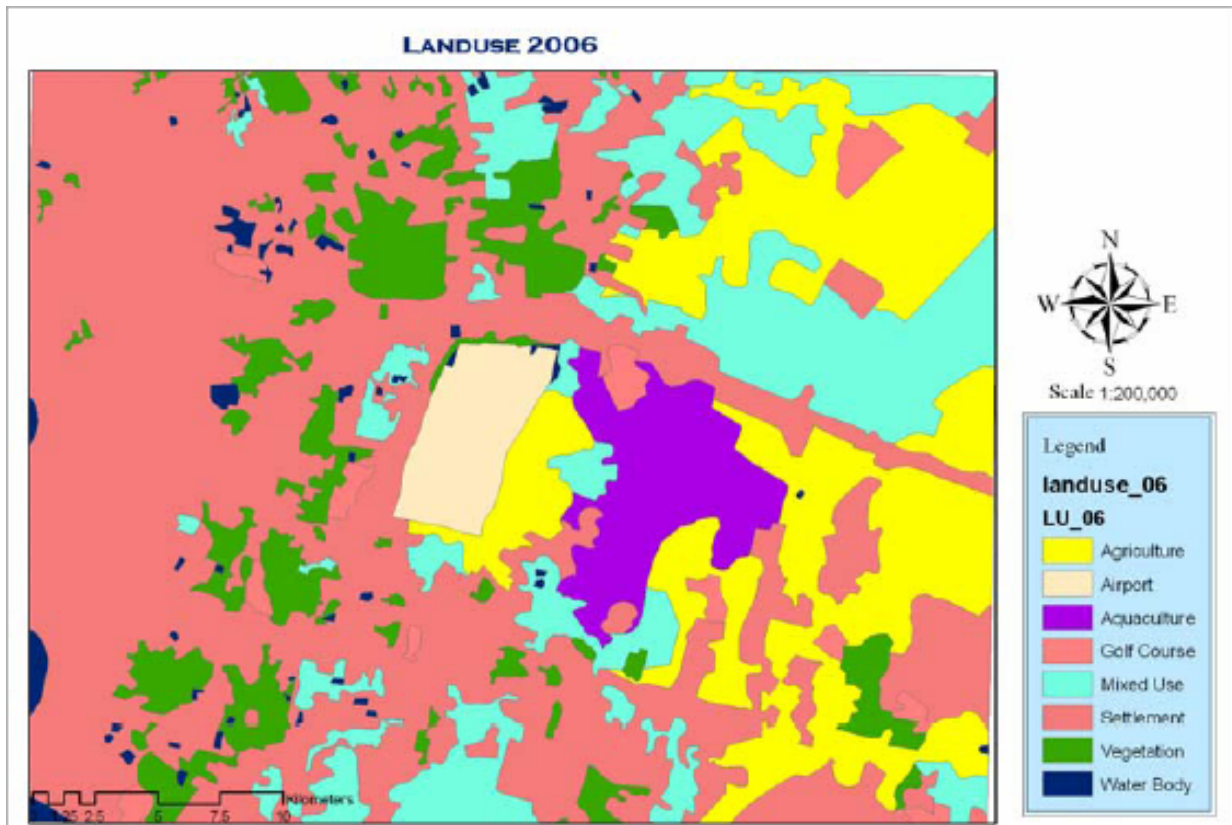


Figure 3: Land use in 2006 – Landsat TM

Table 1: Extent and Change in Extent of different Land use and their proportional annual growth Land use Change

Sl No	Land use	Year - (Area (Ha))			Percentage Share		
		1988	2004	2006	1988	2004	2006
1	Agriculture	21992.09	26354.92	20142.79	18.61	22.30	17.05
2	Airport		2958.00	2942.13		2.50	2.49
3	Aquaculture	24654.76	5663.46	5065.16	20.86	4.79	4.29
4	Golf Course		1757.35	2096.27		1.49	1.77
5	Mixed Use	25404.13	24286.24	17370.96	21.50	20.55	14.70
6	Settlement	30785.70	46312.39	58303.58	26.05	39.19	49.34
7	Vegetation	7940.22	9524.62	10729.24	6.72	8.06	9.08
8	Water Body	7397.88	1301.98	1507.97	6.26	1.10	1.28
	Total	118174.79	118158.96	118158.09	100.00	100.00	100.00

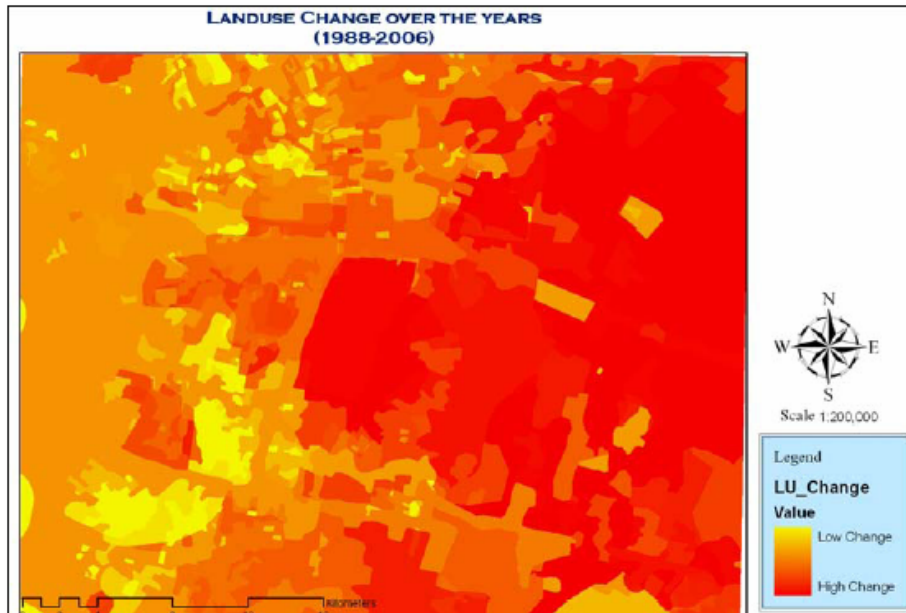


Figure 4: Land use Change during 1988 and 2006

The above figure shows the change in landuse from 1988 to 2006. The dark red colour indicates higher changes and the bright yellow shows no change or low change in the landuse. The map (Figure 4) indicates more change in landuse in the eastern part of the study area. Conversely, the western part, which is predominantly settlement, shows no changes.

Table 2: Land use change from 1988-2004 - (Area (Ha))

		2004									
		Agri	Airport	Aqua	Golf Course	Mixed Use	Settlm	Veg	Water Body	Total	
1988	1	Agriculture	16511.73	0.00	199.17	585.69	3333.80	1050.88	310.21	0.16	21991.63
	2	Airport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3	Aquaculture	4131.34	2865.76	4699.99	595.90	5460.55	5120.95	1575.57	204.57	24654.64
	4	Golf Course	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5	Mixed Use	3136.42	0.00	764.31	0.43	7365.96	10319.03	3655.49	162.35	25403.98
	6	Settlement	98.12	0.00	0.00	9.68	84.43	30481.22	105.82	6.81	30786.08
	7	Vegetation	1301.33	92.24	0.00	191.98	3007.97	2770.30	518.55	57.79	7940.17
	8	Water Body	1045.43	0.00	0.00	153.64	1138.05	1922.12	2418.20	720.44	7397.88
										118174.38	

Table 3: Land use change from 2004-2006 - (Area (Ha))

		2006									
		Agri	Airport	Aqua	Golf Course	Mixed Use	Settlm	Veg	Water Body	Total	
2004	1	Agriculture	17405.47	0.00	0.00	0.00	7303.04	1620.58	25.27	0.00	26354.37
	2	Airport	0.00	2942.12	0.00	0.00	0.00	0.00	0.00	15.88	2958.00
	3	Aquaculture	471.25	0.00	5065.16	0.00	108.08	18.97	0.00	0.00	5663.46
	4	Golf Course	12.67	0.00	0.00	1719.09	0.00	25.57	0.00	0.00	1757.33
	5	Mixed Use	1134.90	0.00	0.00	218.55	461.48	20990.10	1334.01	151.72	24290.76
	6	Settlement	18.47	0.00	0.00	8.61	91.75	46105.83	43.13	43.71	46311.50
	7	Vegetation	0.00	0.00	0.00	0.00	906.25	446.52	8113.23	70.84	9536.83
	8	Water Body	0.00	0.00	0.00	0.00	0.00	50.35	25.82	1225.96	1302.12
										118174.38	

Table 4: Land use change from 1988-2006 - (Area (Ha))
2006

	Agri	Airport	Aqua	Golf Course	Mixed Use	Settlm	Veg	Water Body	Total	
1988										
1	Agriculture	11137.93	0.00	199.17	705.24	5375.21	3673.30	900.62	0.16	21991.63
2	Airport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Aquaculture	4579.82	2849.88	4101.68	736.85	3818.53	6233.09	2093.38	241.39	24654.64
4	Golf Course	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	Mixed Use	1349.73	0.00	764.31	0.43	6636.68	12847.18	3617.11	188.55	25403.98
6	Settlement	89.00	0.00	0.00	29.00	10.00	30606.08	31.00	21.00	30786.08
7	Vegetation	1329.75	92.24	0.00	270.40	345.04	5043.43	711.08	148.24	7940.17
8	Water Body	806.27	0.00	0.00	153.64	485.06	2916.57	2288.22	748.12	7397.88
										118174.38

Further to ascertain the nature of growth during the period, 1988 – 2006, the land use change matrix is prepared. It is found that during 1988-2004, settlement in general has increased while taking away some areas from aquaculture, vegetation and water bodies. Similarly during 2004-2006, the land use type corresponding to mixed use was subjected to change to built-up. Furthermore, analyzing the changes during 1988 – 2006 (Table 4), it is found that airport has come up mostly in the area which was earlier predominated by aquaculture.

3.2 Urban Sprawl

The urban sprawl is taking place in the east direction towards the new airport. A map prepared (Figure 5) depicts the urban sprawl in the region during the three different time period. The red color indicates the urbanization in 1988 and blue and green indicates urban sprawl in 2004 and 2006 respectively.

Urban growth in the study is sprawling in eastern direction at an increasing rate. During the period 1988-2004, the rate of urban growth was 3.15% per annum, which was followed by 12.95% in 2004-06. The annual average rate of growth (1988-2006) was at a rate of 4.97%.

Table 5: Extent of urban sprawl in the study area

Year	Area (Ha)
1988	30785.70
2004	46312.39
2006	58303.58

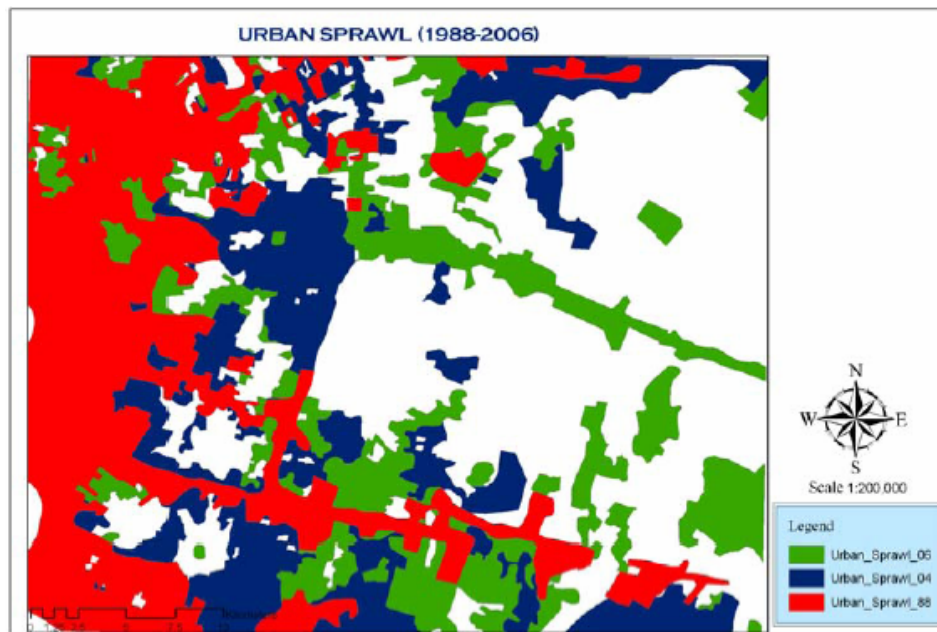


Figure 5: Urban Sprawl during 1988 - 2006

Table 6: Rate of Urban Sprawl (annual)

Rate of Urban Sprawl (annual)			
Year	1988-2004	2004-2006	1988-2006
Growth Rate (%)	3.15	12.95	4.97

3.3 Road Network

The road network was extracted from the Landsat TM and ALOS imageries to ascertain the utilities of the respective remote sensing data. The extracted road network is shown in Figures 6 and 7. It is observed that since ALOS has a higher resolution, it is better suited for undertaking mapping at cadastral levels that can be suitable in town planning.

4. CONCLUSIONS

The current study attempted to ascertain the extent of urban sprawl during 1988 – 2006 using Landsat TM and ALOS data products. A significant aspect that has emerged from mapping urban sprawl is the loss of land use in aquaculture to airport in eastern areas. As well, as an important aspect of the study, this attempted at extracting the road features from two different data products to determine the suitability of high resolution ALOS data for mapping urban sprawl and extracting road features better than the middle-level resolution Landsat TM data.

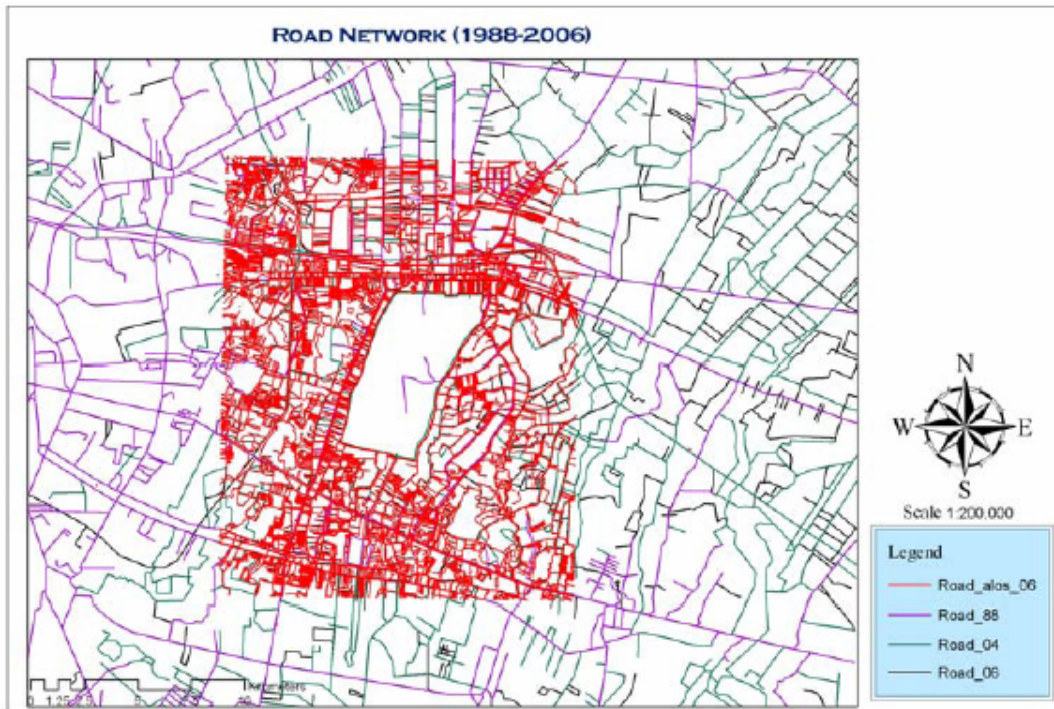


Figure 6: Road Features extracted from Landsat TM



Figure 7: Road Features extracted from ALOS

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