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## Detection of Usefulness of Integrating Remotely Sensed Data (Landsat TM) with GIS

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**Abstract:** A study integrating remote sensing and Geographical Information System (GIS) was carried out in the Kuala Terengganu district, Terengganu, Malaysia to map and determine the land use change as a result of development pressure in the area. Two sets of Landsat Thematic Mapper (TM) dated 31 July 1988 and 14 July 2002, at scale 1: 150 000 were acquired. Land use classes were interpreted from these images and the resultant maps were checked in the field to determine ground truth and mapping accuracy. The land use map data were transferred directly into the computer via ILWIS (Integrated Land Water and Water Information System) version 3.1 software. It shown that in this study seven categories of land use changes were detected namely forest (-9.93%), agricultural (-1.46%), swamp (-36.92%), urban (190.29%), cleared land (-21.43%), water bodies (-7.48%) and bush/shrub (6.34%). The accuracy assessment undertaken showed that the total accuracy for produced the map is 77.89%. This study showed that Landsat TM is a useful data for study in land use change.

**Key words:** Land use dynamic, landsat TM, GIS

### INTRODUCTION

Remotely sensed data and geoinformatics give a revolution in research of agriculture, land, water and marine resources and geomorphology. Remotely sensed data offers the researcher to facilitate the investigations, assessments and they may lead to a more understanding of sustainable development.

The remote sensing techniques have proven useful for gathering information about the natural resources on a large-scale basis, such as for a whole country. The Malaysian Ministry of Agriculture has been using aerial photo interpretation for land use mapping for Peninsular Malaysia. With its aggressive land development policy, there is great need for timely information on the agricultural and forestry resources of the country (Mout *et al.*, 1993). Land use concerns the function or purpose for which the land is used by the local human population and can be defined as the human activities which are directly related to land, making use of its resources or having an impact on them (FAO/IIASA, 1993). The terms land use and land cover is not synonymous. Land cover is the biophysical state of the earth's surface and immediate subsurface" (Turner *et al.*, 1995).

Land use mapping in an area can be done using Landsat Thematic Mapper (TM). Landsat TM has an ability to make an assessment for vary land use classes and land covers such as water body, forest, agricultural area, main road and urban area. According to Scepán *et al.* (1999) the most useful band combination in Landsat TM for discriminating the land cover categories were 4-5-3, 4-3-2 and 3-2-1 in red, green and blue (R-G-B) respectively. Mapping the land use change is using post-classification comparison, aiming to find out the difference between the classified images of two different dates (Lillesand and Kiefer, 1994).

The objective of this study was to assess the usefulness of integrating remotely sensed data (Landsat TM) with GIS for detection of land use change. The specific objectives were to quantify and map the land use change in the Kuala Terengganu district, Terengganu, Peninsular Malaysia between 1988 and 2002.

### MATERIALS AND METHODS

**Study sites:** The study area located at Kuala Terengganu (within latitudes 5° 10' U to 5° 31' U and longitudes 102° 52' E to 103° 12' E, Malaysia, Terengganu,

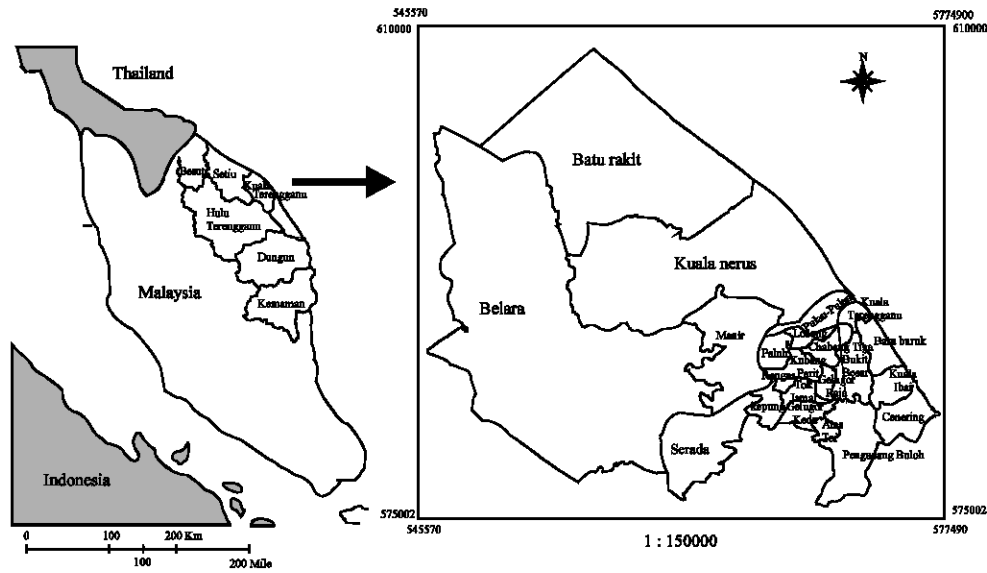


Fig. 1: A map showing the state of Terengganu and study area in Kuala Terengganu district

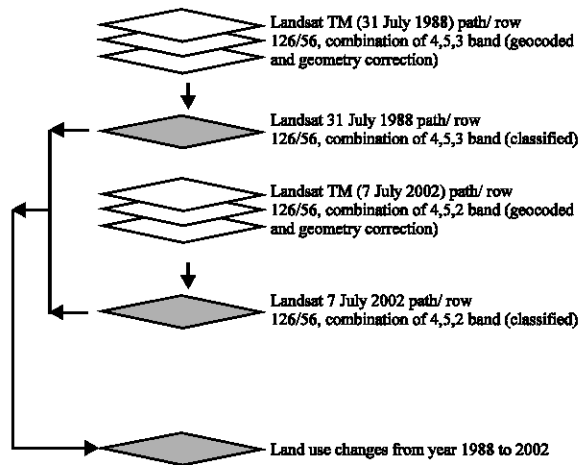


Fig. 2: Methodology flowchart of the study

east peninsular Malaysia (Fig. 1). Kuala Terengganu consists of 22 mukim including Mukim Batu Rakit, Belara, Kuala Nerus, Manir, Serada, Kepung, Renas, Kubang Parit, Chabang Tiga, Losong, Pulau-pulau, Kuala Terengganu (bandar), Batu Buruk, Kuala Ibai, Chenering, Pengadang Buloh, Gelugor Kedai, Gelugor Raja, Atas Tol, Atas Tol, Bukit Besar and Tok Jamal. The total area is 67629 ha. Initially, it was decided that the study area cover the whole Kuala Terengganu. Instead a part of Belara and Batu Rakit was unavailable at time of the study and only 60547 ha were covered for the study site. The land use mainly composed of forest, oil palm, rubber, cleared land, mixed horticulture, homestead

garden and villages. Kuala Terengganu was chosen as study area due to rapid conversion of agricultural land occurring in the region.

**Climate:** Kuala Terengganu has a hot, humid tropical climate. Temperature and rain fall are generally high throughout the year. The mean annual temperatures vary from 25 to 28° and mean rainfall exceeds 2000 mm (MMS, 2000).

**Imagery:** The primary data used in this study were Landsat TM dated 31 July 1988 and 14 July 2002 (path/row: 126/56) acquired in CD-ROM format from the

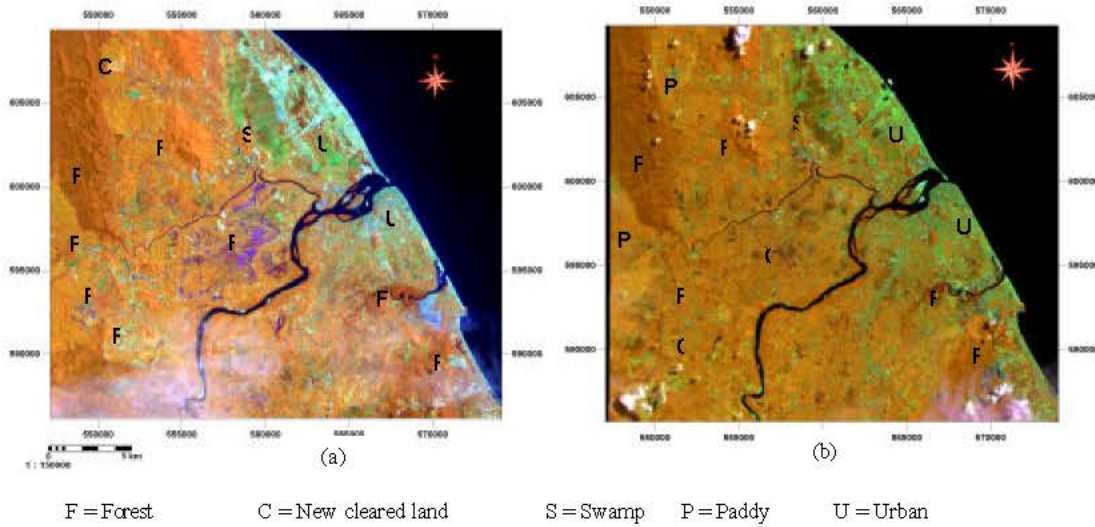


Fig. 3: Subset of study area showing band combination of Landsat TM of (a) 1988 and (b) 2002 using bands 4, 5, 3 in R-G-B respectively and training area

Malaysian Center for Remote Sensing (MACRES), Kuala Lumpur. The images were geometrically and radiometrically corrected by MACRES (2002).

**Ancillary data:** Additional data were obtained from Department of Agriculture and Department of Forestry, Terengganu. The ancillary data used were:

- Topographic map (Series L7030, Ed. 2-PPNM) Sheet 4266, 4265 and 4365 scale 1: 50 000.
- Development map of Kuala Terengganu District.

**Hardware and software:** The hardware used for this study was digitizer, a computer and a printer. The GIS software used was Arc-View version 3.1. For the image processing, ILWIS (Integrated Land Water and Water Information System) version 3.1 was used. A hand held global positioning system GPS was used for the positioning of ground truth.

**Methodology:** The technique used in this study included image enhancement such as contrast enhancement and band combination. Visual interpretation was applied to categorized the different land use classes on the images. The ILWIS version 3.1 was used to analyze using supervised classification (maximum like hood). Figure 2 shows the methodology flow chart of the study. A band combination of 4, 5, 3 (Fig. 3) was selected and printed for the hard copy scale 1:150 000.

## RESULTS AND DISCUSSION

Visual interpretation technique, enable us to classify the land use classes in the study (Fig. 4). The land use change, from their total area and magnitudes of change in 1988 and 2002, are shown in Table 1. It shown that in this study seven categories of land use changes were detected namely forest (-9.93%), agricultural (-1.46%), swamp (-36.92%), urban (190.29%), cleared land (-21.43%), water bodies (-7.48%) and bush/shrub (6.34%).

It is evident that the agricultural area and forest were the most dominant land use types. Their total areas were 48.01 and 17.37% in 1988. Swamp area, cleared land, water bodies occupied 7907, 1,259 and 1,591 ha, respectively in 1988. In 2002, the agricultural and forest area are 47.66 and 15.65%. Swamp area, cleared land and water bodies occupied 4987.52, 989.24 and 1472.00 ha in 2002.

The land use that has highest magnitude of change from 1988 to 2002 is urban area, increasing 190.29%. That can be concluded this area is changing over time to urban area. Some plantation area has been changed such as rubber to palm oil estate within 14 years.

Accuracy assessment is general term for comparing the known reference data from ground truth and the corresponding result of classification accuracy. The identification accuracy check by sample point summarized in Table 2.

Table 1: Land use classes and magnitude of change in Kuala Terengganu district in 1988 and 2002

	Landsat TM 1988		Landsat TM 2002		Change (1988 to 2002)	
	Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)
Forest	10582.00	17.37	9531.00	15.65	-1051.00	-9.93
Agricultural	29239.54	48.01	28813.90	47.66	-425.64	-1.46
Swamp	7907.00	12.98	4987.52	8.19	-2919.48	-36.92
Urban	1960.00	3.22	5689.78	9.34	3729.78	190.29
Cleared land	1259.00	2.07	989.24	1.62	-269.76	-21.43
Water bodies	1591.00	2.61	1472.00	2.42	-119.00	-7.48
Bush, shrub	7764.00	12.75	8256.00	13.56	492.00	6.34
Unclassified	603.84	0.99	717.54	1.18		
Total	60906.38	100.00	60456.98	100.00		

Table 2: Accuracy check by sample points of visually interpreted 1988 and 2002 satellite images

Land use class	Total number of sample points		Total number of sample points correct		Total number of sample points wrong		Overall total points correct	Overall total points wrong
	2002	1988	2002	1988	2002	1988		
Forest	5	4	3	3	2	1	6	3
Agricultural	17	15	9	11	8	4	21	12
Swamp	4	5	3	3	1	2	6	3
Urban	16	18	14	17	2	1	31	3
Cleared land	3	3	3	2	0	1	5	1
Water bodies	3	2	3	2	0	0	4	0
Bush, shrub	4	5	3	5	1	0	8	1
Total	52	52	38	43	14	9	81	23
Percentage			(73.08%)	(82.69%)	(26.92%)	(17.31%)	(77.89%)	(22.11%)

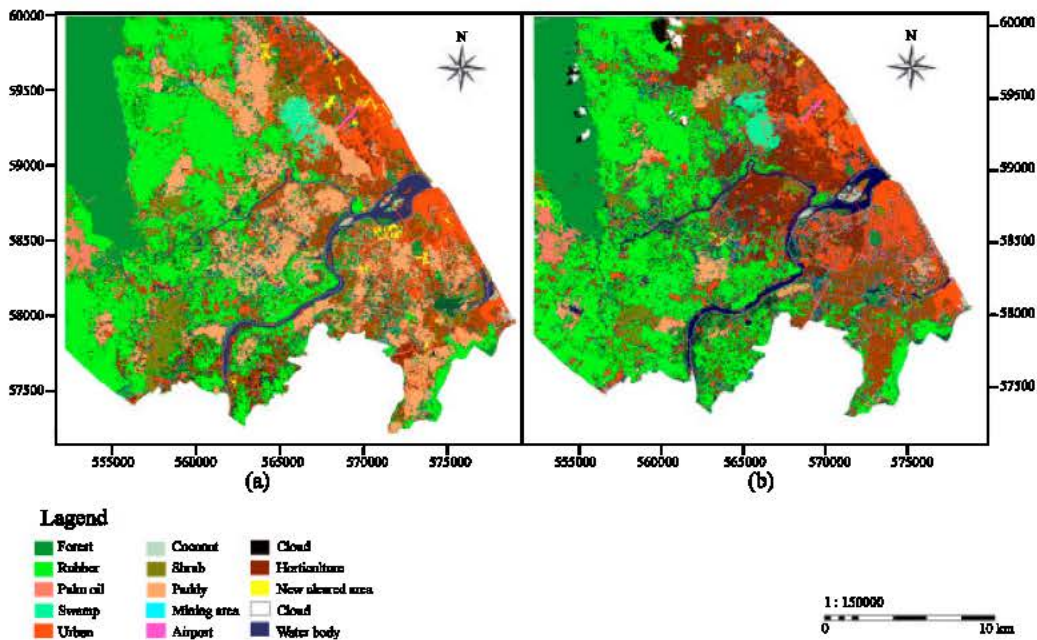


Fig. 4: Land use maps of the Kuala Terengganu district: (a) 1988 dan (b) 2002

This assessment has to make because some of the images are covered by cloud and could not be processed. So some point should be checked for the accuracy.

Ground verification showed that the total overall map accuracy was 77.89%. This percentage gained by dividing

total overall point correct and total point observes. However there were sample points that were misclassified. The misclassified was probably because of the prominent cloud cover and similar reflectance of some land uses on the image.

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