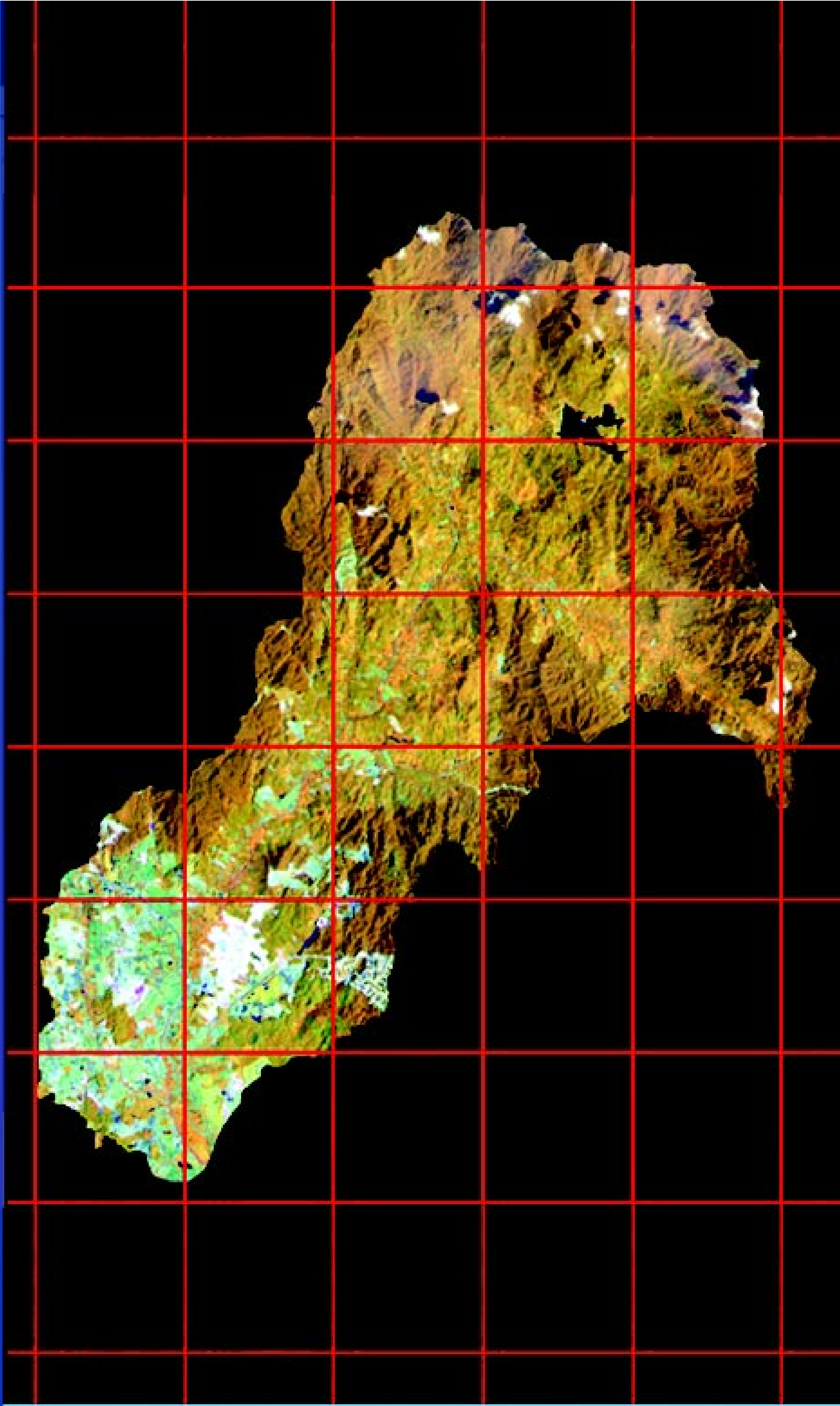
BULETIN GIS



JAWATANKUASA PEMETAAN DAN DATA SPATIAL NEGARA

BIL. 2 2005 ISSN1394 - 5505

PENDAHULUAN

Jemaah Menteri berasaskan Kertas Kabinet No.243/385/65 bertajuk *National Mapping Malaysia* telah meluluskan jawatan dan terma-terma rujukan *"Surveyor-General Malaya and Singapore"* sebagai Pengarah Pemetaan Negara Malaysia dan mengesahkan keanggotaan serta terma-terma rujukan Jawatankuasa Pemetaan Negara pada 31 Mac 1965.

Cabutan para-para 2(b), 2(c) dan 2(d) daripada kertas kabinet tersebut mengenai keanggotaan dan terma-terma rujukannya adalah seperti berikut:

"2(b) National Mapping Committee

That a National Mapping Committee be appointed to comprise the following:

- *i. Director of National Mapping*
- *ii. Director of Lands & Surveys, Sabah;*
- *iii. Director of Lands & Surveys Sarawak;*
- *iv. Representative of the Ministry of Defence;*
- *v. Representative of the Ministry of Rural Development (now substituted by the Ministry of Natural Resources and Environment);*
- *vi. Assistant Director of Survey, FARELF*

2(c) The terms of reference of the National Mapping Committee to be as follows:

- *i. to advise the Director of National Mapping on matters relating to mapping policy;*
- *ii. to advise the Director of National Mapping on mapping priorities.*

2(d) That the Committee be empowered to appoint a Secretary and to co-opt persons who would be required to assist the Committee,"

Seterusnya pada 22 Januari 1997, Jemaah Menteri telah meluluskan pindaan terhadap nama, keanggotaan dan bidang-bidang rujukan Jawatankuasa Pemetaan Negara kepada Jawatankuasa Pemetaan dan Data Spatial Negara (JPDSN), bagi mencerminkan peranannya yang diperluaskan ke bidang data pemetaan berdigit. Keanggotaan JPDSN pada masa kini adalah terdiri daripada agensi-agensi seperti berikut:

1. Jabatan Ukur dan Pemetaan Malaysia
2. Jabatan Tanah dan Ukur Sabah
3. Jabatan Tanah dan Survei Sarawak
4. Wakil Kementerian Pertahanan
5. Jabatan Mineral dan Geosains Malaysia
6. Jabatan Perhutanan Semenanjung Malaysia
7. Jabatan Pertanian Semenanjung Malaysia
8. Jabatan Perhutanan Sabah
9. Pusat Infrastruktur Data Geospatial Negara (MaCGDI) *(co-opted)*
10. Jabatan Pertanian Sabah
11. Jabatan Pertanian Sarawak
12. Pusat Remote Sensing Negara (MACRES)
13. Universiti Teknologi Malaysia
14. Universiti Teknologi MARA *(co-opted)*
15. Universiti Sains Malaysia *(co-opted)*
16. Jabatan Laut Sarawak *(co-opted)*
17. Jabatan Perhutanan Sarawak
18. Jabatan Perancangan Bandar dan Desa

Buletin GIS ini yang diterbitkan dua kali setahun adalah merupakan salah satu aktiviti oleh Jawatankuasa Pemetaan dan Data Spatial Negara, sebagai salah satu media pendidikan dan penyebaran maklumat dalam mendidik masyarakat memanfaatkan maklumat spatial dalam pembangunan negara. Walau bagaimanapun, sebarang kandungan artikel-artikel adalah tanggungjawab penulis sepenuhnya dan bukan melambangkan pandangan penerbit.

Kandungan

MESSAGE FROM THE CHIEF EDITOR

It is with great pleasure that I would like to draw your attention to the fact that this Bulletin is now a decennary. The first GIS Bulletin was published in 1996.

Recently, MaCGDI who is also a member of JPDSN has proposed to publish a Public Sector Geospatial Bulletin, which would probably mop up the limited resources available to this bulletin. Both bulletins would probably comprise of similar articles and targeting the same reader groups. This duplication could lead to wastage of resources and give rise to confusion amongst readers. I hope the Committee could provide some indications as to the future of these two bulletins.

Since the conception of GIS, there is perhaps nothing more significant and challenging than the innovation of web-based satellite imagery mapping products such as the Google Maps, Google Earth, MSN Virtual Earth and Amazon's A9. Their impact is beyond imagination and their threat to national security is increasingly real.

In the wake of the infamous 911 incident, many governments have imposed various safety measures to prevent vital geospatial information from getting into the wrong hands. Some of the measures include subtle omission, deletion and displacement of sensitive information on maps, and subjecting users and purchasers of geospatial information to stringent security vetting. Actions which have in effect pushed the GIS industry a step backward.

With the availability of web-based satellite imagery mapping products users can now freely access satellite image maps moving from space to street level views by just a mere click of the mouse. In certain areas the resolution can be up to metre or even sub-metre level. Although the accuracy of these products may not be as good as a map, but it would not be too difficult for anyone with a hand-held GPS to geo-reference them. Moreover, precise and accurate coordinates are usually not necessary in most subversion. It is on this ground that some countries have formally protested to the producers. Malaysia might follow suit soon.

These products are even available to Java-enabled mobile phones or similar devices. In the pipe-line is plan to show live satellite images instead of the current static ones, which are often months old.

Although the dissemination of restricted geospatial data is regulated by the Official Secret Act 1972 and the Security Directives (Arahan Keselamatan), there is no legislation per se to control mapping activities within the country. Needless to say, satellite image mapping is also an uncontrolled arena where the public could purchase such product directly from agents outside the country. In view of the development of web-based satellite imagery, perhaps we should seriously consider easing the stringent control of geospatial data, which will in turn promote the growth of GIS industry in Malaysia. However, this should be done by keeping in mind the security issue mentioned earlier. There is a need to strike a balance between promoting GIS and security of the nation.

On another note, JUPEM has finally obtained approval for the setting up of a Utility Mapping Section. With the appointment of its first director and the procurement of some essential equipment, this section is now formally established. As an initial task, the initial Guidelines on Utility Mapping has been finalised as well a Utility Map Specification has also been developed. It is hoped that this section will play an essential role in arresting the problem of haphazard digging by utility companies, which often results in great inconveniences and huge losses to the public.

Lastly, on behalf of the Editorial Board, I would like to appeal to members of JPDSN to contribute their articles to this bulletin. This bulletin exists solely to serve the needs of JPDSN members and it provides members with a free platform to publish their works. All contributions will be greatly appreciated.

Thank you.

URBAN DEVELOPMENT DETECTION BASED ON OBJECT ORIENTED CLASSIFICATION IN UPPER LANGAT WATERSHED

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Abstract

Remotely sensed imagery has been used to perform change detection and time-series analysis of land cover features in regions experiencing rapid growth. In this study, four sets of Landsat TM images were analyzed for the urban development detection in Upper Langat Watershed. The object oriented classification has proved to be more reliable method to classify the remote sensed images compared to pixel-based classification. Therefore, eCognition is recommended to perform the object oriented classification. It is based on fuzzy logic, allows the integration of a broad spectrum of different object features, such as spectral values, shape and texture. Sophisticated classification, incorporating contextual and semantic information, can be performed by ultilizing not only image objects attributes but also the relationship between networked image objects. Before these images being classified, they were geometric corrected, atmospheric corrected and normalized for direct comparison and analysis. The automation of workflow that can be recorded in eCognition allows the corrected time-series data to the desire classified output by pressing a single button only. The classification result can also be exported to vector format as well as the spatial information for further analysis.

1.0 INTRODUCTION

Remotely sensed data have been increasingly used for analyzing urban land use and land cover status and their dynamic change over time. In this study, four sets of Landsat TM images were analyzed for the urban development detection in Upper Langat Watershed. On site data acquisition for watershed and land use studies is labour intensive, time consuming and expensive especially when the watershed is large and located in an inaccessible area. Remote sensing may be the only way to obtain input data for remote and inaccessible areas, and a large number of basins in a particular region. In addition also, remote sensing provides fast, up to date, high accuracy and even cost effective data for urban development detection.

Obviously, cloud cover restricts the use of optical remotely sensed data in low-latitude regions such as Malaysia. The atmosphere modifies the radiance reflected at the ground and contributes an additive path radiance term, so it is necessary to correct the atmospheric effect to retrieve the surface reflectance (Mispan, 1997). Atmospherically corrected surface reflectance images improve the accuracy of surface type classification (Kaufman, 1985). More useful information generally can be derived by using physical units because the data obtained from different sensors, scenes or times can be analyzed using the same unit of measurement and can thus be directly compared (Price, 1987). So, to relate the remote sensing data and ground surface characteristics, which are based on the characterisation of spectral response, the digital numbers making up the image must be converted to physical values. When multi-temporal and multi-sensor data sets are used, it is also essential that the measured radiance should be calibrated and convened to radiance values or at least to a common datum before any further analysis is performed (Robinove, 1982; Duggin and Robinove, 1990; Mather, 1992).

Pseudoinvariant ground targets, which are the ground objects that do not change spectrally from image to image are needed to normalize multitemporal datasets to a single reference scene. A problem associated with using temporal remotely sensed data for change detection is that the data are usually nonaniversary dates with varying sun angle, atmospheric, and soil moisture conditions. Ideally, the multiple dates of remotely sensed data should be normalized so that these effects can be minimized or eliminated (Eckhardt et al., 1990; Hall et al., 1991).

In previous research, the standard per pixel classification method was frequently applied to multi-spectral or band ratio index images for the purpose of differentiating urban land use and land cover types. The conventional pixel-based approach primarily relies on the tone, color, or spectral information of individual pixels, but the size, shape, texture, contextual, and other type of information inherent in the image scene were ignored or not fully utilized. Therefore, the classification accuracy and reliability are often limited (Liu, 2002).

This conventional classification approaches to image analysis produces a characteristic, inconsistent salt-and-pepper classification, this method is however far from being capable of extracting objects of interest. It is able to carry out the classification parameter based on the spectral properties of each band that is available in the image only. Difficulties increased when dealing with temporal data where the spectral information represent the cloud cover and shadow occurred in optical remote sensing data always mix up with urbanization area, water body and vegetation classes. The object-oriented approach brings the supervised classification process into polygon base. It makes the remote sensing data contents manageable by performing the segmentation process. Beyond that, additional information such as criteria, textual or contextual information of the segments can be described in an appropriate way to derive improved classification results. Object oriented classification output has proved to be more reliable than pixel based classification (Mansor et. al., 2002, Wong et. al., 2003).

2.0 MULTIRESOLUTION SEGMENTATION

The multiresolution Segmentation process in eCognition software performs a first automatical processing in the imagery. This results to a condensing of information and a knowledge-free extraction of image objects. The formation of the objects is carried out in a way that an overall homogeneous resolution is kept. The segmentation algorithm does not only rely on the single pixel value, but also on pixel spatial continuity (texture, topology). The organized images objects carry not only the value and statistical information of the pixels of which they consists, but also information on texture and shape as well as their position within the hierarchical network (Humano, 2000; Manakos, 2001).

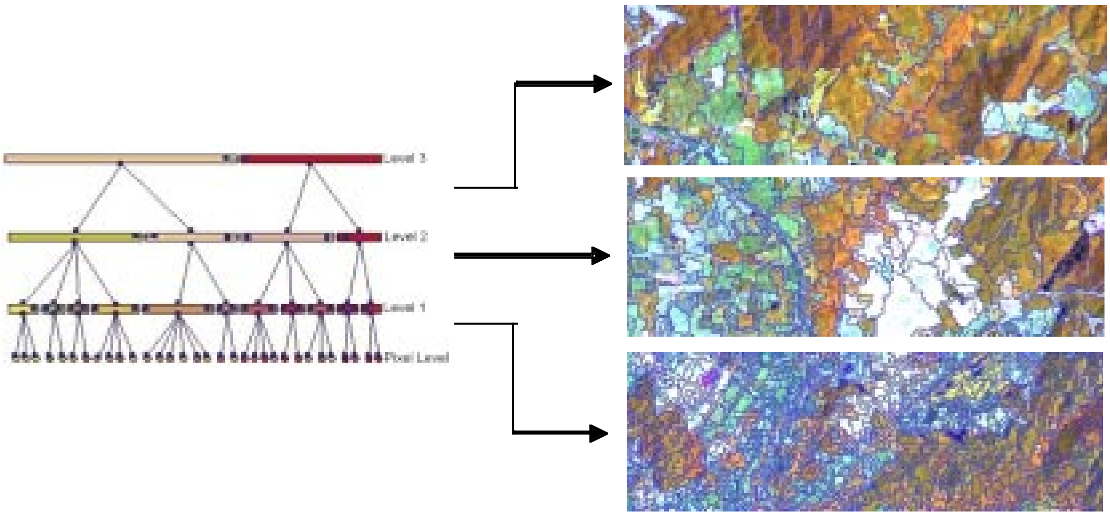

Figure 1: Hierarchical net of image objects derived from image segmentation level 1 (5 pixels scale parameter), level 2 (15pixels scale parameter) and level 3 (30 pixels scale parameter)

Figure 1 shows the concept of segmentation, in which where mainly three different levels of image objects have been created representing different scales. All of the image objects were automatically linked to a network after the segmentation process. Each image object knows its neighbors, thus affording important context information for later analysis. Subsequently, repetition of segmentation with different scale parameter creates a hierarchical network of image objects. Each image object knows its super-object and its sub-objects. The basic difference, especially when compared to pixel-based procedures, is that object oriented analysis does not classify single pixels, but rather image objects which are extracted in a previous image segmentation step.

When dealing with certain features extraction, the researchers must have well known about the sensitivity of the bands to be set as priority input for segmentation. Wrong bands or unnecessary bands input will result deficient image objects output. Bear in mind that the classification will be based on the segmented image objects, if the interested features are not in the proper segmented objects, it won't be able to give satisfying result finally. (Wong, et. al., 2003)

2.1 Object Oriented Classification

eCognition supports different supervised classification techniques and different methods to train and build up a knowledge base for the classification of image objects. The frame of knowledge base for the analysis and classification of image objects is the so-called class hierarchy. It contains all classes of a classification scheme. The classes can be grouped in a hierarchical manner allowing the passing down of class descriptions to child classes on the one hand, and meaningful semantic grouping of classes on the other. This simple hierarchical grouping offers an astonishing range for the formulation of image semantics and for different analysis strategies. The user interacts with the procedure and based on statistics, texture, form and mutual relations among objects defines training areas. The classification of an object can then follow the "hard" nearest neighbourhood method or the "soft" method using fuzzy membership functions (Manakos, 2001).

Under the soft method, each class of a classification scheme contains a class description. Each class description consists of a set of fuzzy expressions allowing the evaluation of specific features and their logical operation. A fuzzy rule can have one single condition or can consist of a combination of several conditions that have to be fulfilled for an object to be assigned to a class. The fuzzy sets were defined by membership functions that identify those values of a feature that are regarded as typical, less typical, or not typical of a class, i.e., they have a high, low, or zero membership respectively, of the fuzzy set (Mitri, et. al., 2002).

2.2 Urban Development Detection

Change detection is a topic of great importance for modern geospatial information systems. Rapidly evolving environment, and the availability of increasing amounts of diverse, multiresolutional datasets bring forward the need for frequent updates in modern GIS (Agouris, et. al., 2000). Remotely sensed imagery has been used to perform change detection and time-series analysis of land cover features in regions experiencing rapid growth. It is a central task for all kinds of monitoring purposes. It uses multitemporal image data sets in order to detect land cover changes caused by short-term phenomena such as flooding and seasonal vegetation change, or long-term phenomena such as urban development and deforestation. In particular, change detection based on remotely sensed multispectral images has developed into an important technique for a multitude of fields (Singh, 1989).

eCognition software provides a method for change detection that is able to quickly and directly produce accurate information for nearly any spot on the image, while simultaneously delivering comparable results independent of human influence. The automation of workflow that can be recorded, executed and edited protocols in eCognition allows the corrected time-series data to the desire classified output by pressing a single button only. Once the stable sequence for handling the first image, it can be transferred to other images. The created protocol consists of one or more operations which can be executed all at once or step by step (Baatz, 2004).

3.0 DATA ACQUISITION

The Upper Langat area is selected for this study. It is located at the South - East of Selangor Darul Ehsan state and approximately 27 km to the south east of Kuala Lumpur city. The area is situated within latitudes 101ϒ 43'E to 101ϒ 58'E and longitudes 02ϒ 59'N to 03ϒ 17'N. Data required for this study were topographic maps, land use maps and satellite imagery. In general, the required data and their relational sources are as listed in Table 1 below:

Table 1: Sources of Data Collected

Sources	Types of data
Malaysian Centre of Remote Sensing (MACRES)	Satellite image - Landsat TM 5 (Path 127, Row 58), 1994, 1996, 1998, 1999
Survey and Mapping Department of Malaysia (JUPEM)	Topographic maps (scale 1: 50,000) - Rectified Skew Orthomorphic (RSO) Projection - Scene index number 3757, 3857, 3858
Department of Agriculture, Malaysia (DOA	Landuse map 1995, 1997
Ground Truthing	March, 2001

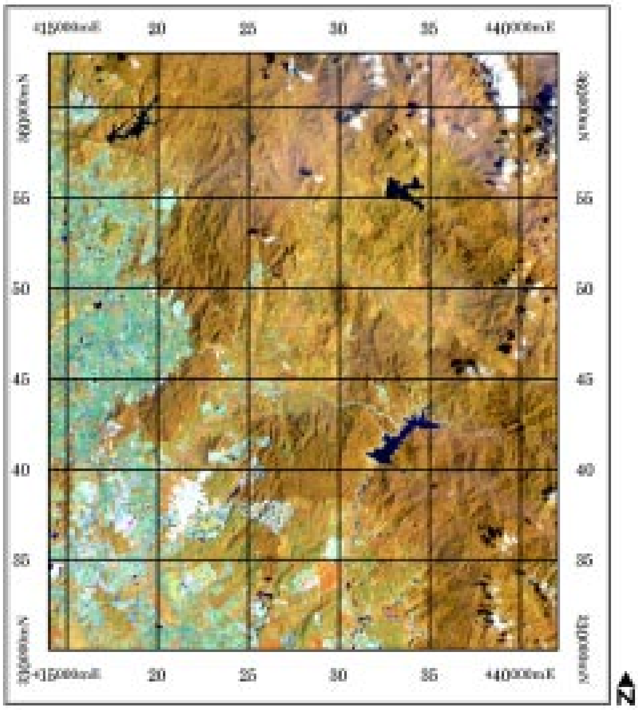

Figure 2: Subset Landsat TM image 1999 with composite color (Band TM 4, TM 5, TM 3)

The topographic maps are required to register the satellite image. The satellite image has been performed geometric correction and registered to RSO projection before carried out the classification. Land use map is required to identify the features in the image as well as accuracy assessment. The registered subset image is shown in Figure 2.

4.0 METHODOLOGY

Figure 3 is the schematic diagram showing the steps involve in urban development detection.

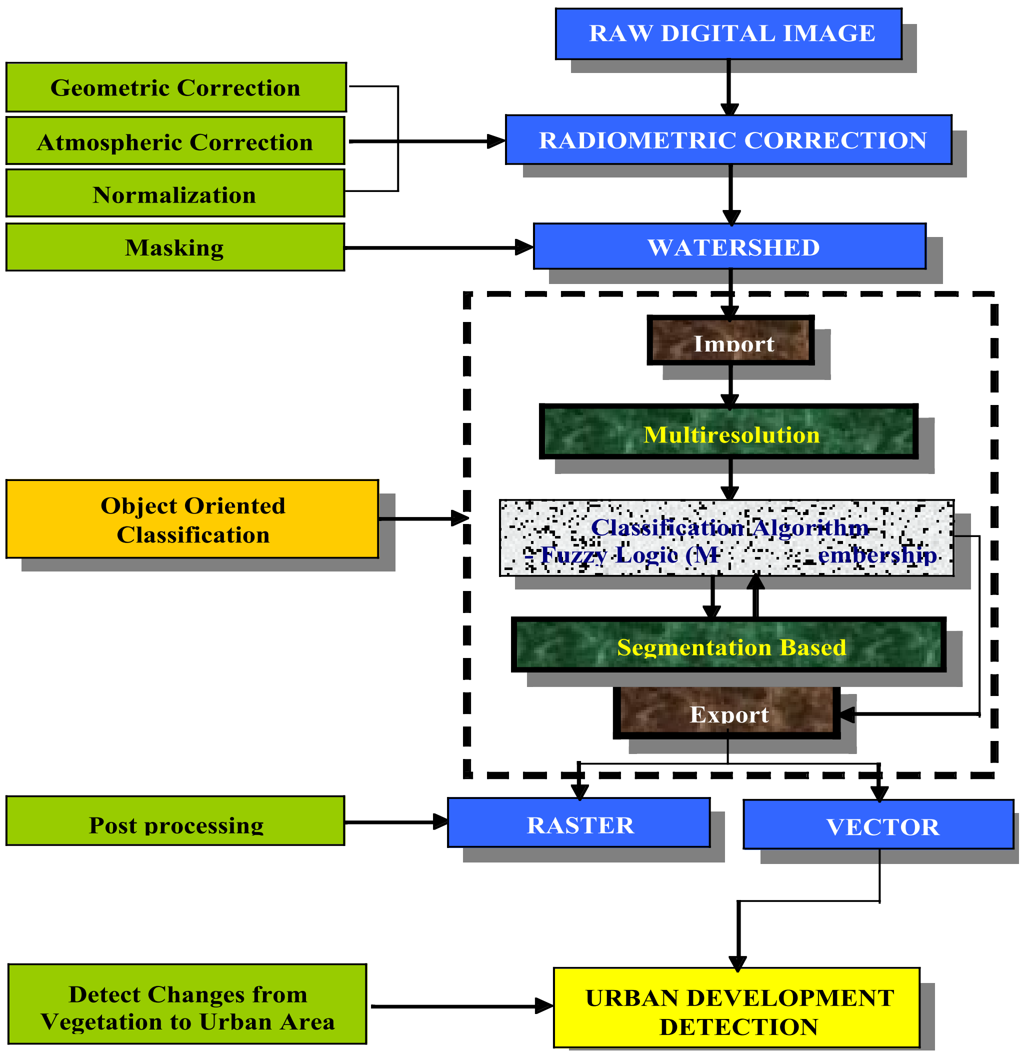

Figure 3: Schematic diagram showing overall procedure of the study

4.1 Pre-processing

The atmospheric correction process is carried out for the Landsat TM image 1994 only. The offset coefficient in minimum spectral radiance (L_{min}) and maximum spectral radiance (L_{max}) is increasing proportionally from year to year (Olsson, 1995). Since Landsat TM 1994 is the earliest image captured among 4 images, so the sensors errors occurred the least. Besides, not all the Landsat TM data are originally raw data. It is necessary to carry out the normalization for the Landsat TM 1996, 1998 and 1999 by referring to Landsat TM 1994 (Raw and atmospheric corrected data). Few criteria as described by Eckhardt et al., (1990), had been taken into account to perform this process.

1. Targets below 1000 m from the sea level.
2. Vegetation targets will not be considered at all.
3. Target must be in relatively flat area.
4. Targets that will not change over time.

A 16 bits digital elevation models (DEM) band is created by digitizing the contour lines with 20 m interval based on the topography map obtained from JUPEM. It is used to delineate the watershed (Jenson et. al., 1988).

4.2 Classification Process

The objected oriented classification process can be divided into few simple steps. After bringing the image into eCognition, the image will be applied the multiresolution segmentation. The consideration of the bands should be based on the types of features that are going to extract. After satisfied with the segmentation result, NDVI was introduced to call out the vegetation area. The NDVI for Landsat TM multispectral data is generated as follows (Marsh et al., 1992; Larsson, 1993):

$$NDVI_{TM} = \frac{TM4 - TM3}{TM4 + TM3} \qquad (1)$$

Generally, NDVI shows the results where the brighter the pixel is, the greater the amount of photosynthesizing vegetation present. Khali et al. (2002), mentioned in the paper presented at the Seminar of TiungSAT-1 first user group, that NDVI provides a measure of the amount and vigour of vegetation at the land surface. It is a non-linear function that varies between –1 to +1 (undefined when VIR and VIS are zero). The magnitude of NDVI is related to the level of photosynthetic activity in the observed vegetation. Values of NDVI for vegetated land generally range from about 0.1 to 0.7 with values greater than 0.5 indicating dense vegetation. In general higher values of NDVI indicate greater vigour and amounts of vegetation. The reason NDVI is related to vegetation is that healthy vegetation reflects very well in the near infrared part of the spectrum.

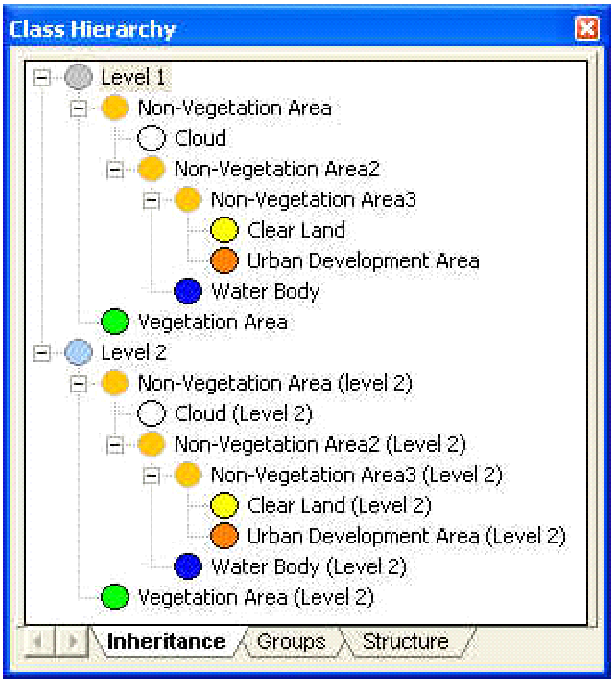

Figure 4: Class Hierarchy Dialog

Further classification process can be carried out to generate the desire classes, for example, urban area, clear land, water body and cloud cover from non-vegetation area main class. Take note that shadow is not a dominant class in this case and it falls over the vegetation area, so it is considered as vegetation area as well where the nature of shadow spectral similar to vegetation area. These child classes can be generated by its' full range of fuzzy logic functions availability. The complete class hierarchy is shown in Figure 4. The segmentation based classification is then applied to the image to call out the desire classes to merge together to new level. The classification can be carried out again to assign those desire classes for exporting. All the steps were recorded in protocol and applied to the rest of images (Figure 5). The final step is exporting the classification results as well as its' attributes table to raster or vector format for further analysis. The accuracy assessment was carried in raster format vice versa exporting the vector format can shows the trend of the urban development changes.

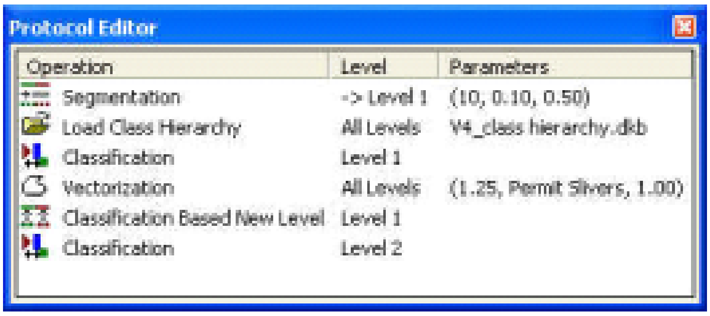

Figure 5: Protocol Editor

5.0 RESULTS AND DISCUSSIONS

The Landsat TM image 1994 has been carried out for atmospheric correction. Table 2 shows the average raw digital numbers and atmospheric corrected reflectance values. Figure 6 shows the graph derived from the Table 2. The Digital Numbers in the image are representing the radiance as well as reflectance from the actual objects on the ground. From the derived graph as shown in Figure 7, generally band 1, band 2 and band 3 can be used to differentiate the urbanization objects and band 4, band 5 and sometime band 7 can be used to differentiate the vegetation area and water body.

Table 2: Average raw digital numbers (R) and reflectance in percent (C) for different classes

Class	Band 1 (R)	Band 1 (C)	Band 2 (R)	Band 2 (C)	Band 3 (R)	Band 3 (C)	Band 4 (R)	Band 4 (C)	Band 5 (R)	Band 5 (C)	Band 7 (R)	Band 7 (C)
Urban	98.00	11.31	43.11	14.59	67.56	17.76	58.33	20.10	100.11	24.38	47.33	25.13
Clear Land	131.67	19.36	79.33	27.84	147.50	43.60	109.00	49.88	144.67	40.84	45.83	24.20
Water	66.67	4.45	24.00	5.35	21.67	3.21	12.83	1.54	12.83	1.29	4.33	1.84
Vegetation Area	69.83	4.91	28.67	7.54	27.28	4.83	82.78	37.07	66.28	12.07	17.06	7.32

〈 (R) = Raw Digital Numbers (DN)
〈 (C) = Corrected Digital Number (DN)

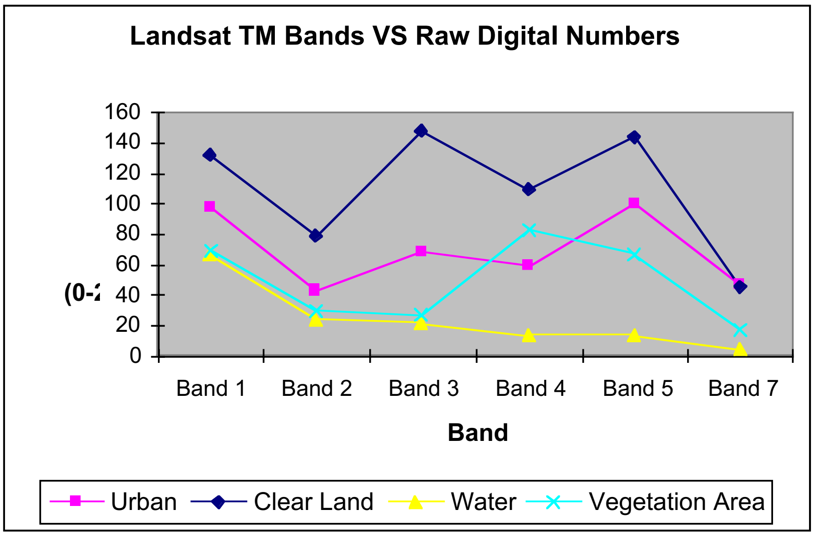

Figure 6: Classes signature based on raw digital numbers

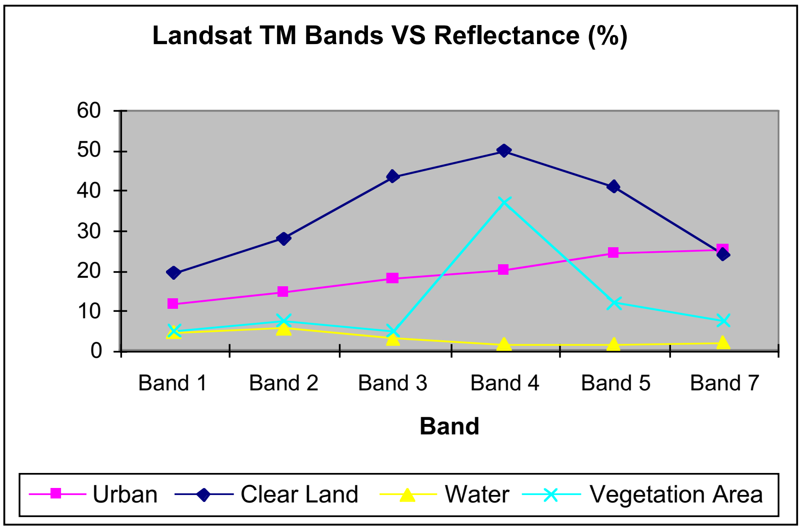

Figure 7: Classes signature based on reflectance

As mentioned earlier in this paper, all the targets were carefully selected based on the criteria that below 1000m, no vegetation, flat area and consistent targets. There are 20 targets being selected for normalization process. They are generally from urban area, bare soil and water body. The 1996, 1998 and 1999 were normalized to image 1994 based on the equation generated. Table 3 below shows the equation generated for all the three years.

Table 3: Equation generated for normalization

Band	Landsat TM 1996		Landsat TM 1998		Landsat TM 1999	
	Equation	R^2	Equation	R^2	Equation	R^2
1	$y = 1.0887x - 71.558$	0.9102	$y = 0.8409x - 52.140$	0.9209	$y = 0.7810x - 49.764$	0.8981
2	$y = 2.2655x - 49.424$	0.9001	$y = 1.7056x - 35.512$	0.9538	$y = 1.7714x - 35.774$	0.8610
3	$y = 1.7150x - 25.413$	0.8771	$y = 1.6873x - 15.879$	0.9715	$y = 1.6640x - 23.922$	0.9507
4	$y = 2.6353x - 13.807$	0.8901	$y = 2.1788x + 3.7771$	0.9642	$y = 2.2071x - 9.4577$	0.9643
5	$y = 1.1950x + 17.554$	0.9329	$y = 1.1676x + 14.852$	0.9637	$y = 1.3932x + 1.6619$	0.9552
7	$y = 1.7027x + 2.6254$	0.9150	$y = 1.4733x - 0.5954$	0.9316	$y = 1.6053x - 2.3127$	0.9362

The watershed has been generated accordingly to the topology condition in the DEM band. After applying the masking method on to the image, the watershed is appeared as Figure 8. Besides generating watershed, the DEM band is brought to further analysis in classification purposes.

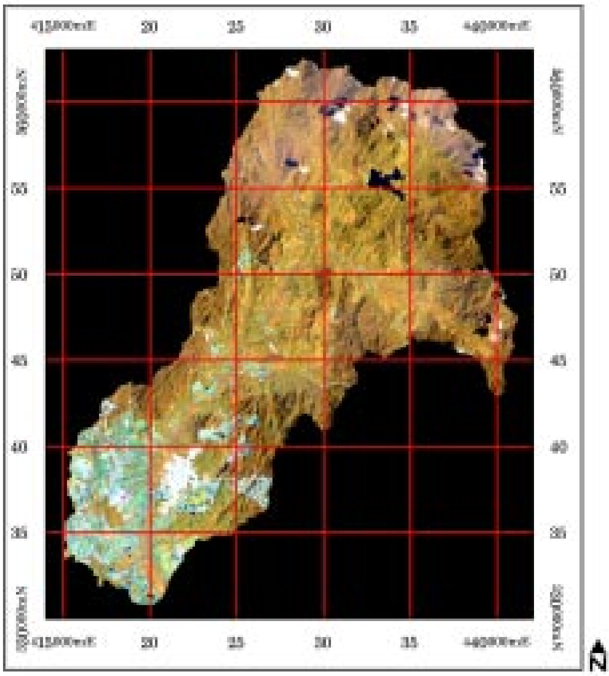

Figure 8: Upper Langat watershed shown on Landsat TM 1999.

Based on the class signature in Figure 8, band 2, band 3, band 4, and band 5 are chosen for multiresolution segmentation process. At the earliest stage of classification, NDVI layer was created for vegetation extraction by assigning the membership function above 0.1 for vegetation area, and otherwise for non-vegetation area. Secondly, the critical cloud cover class that always mix the spectral information with urban and clear land classes was separated by using the DEM layer since most of the cloud occurred at hilly area in all 4 years. Near Infra Red band reflects the least to the sensor on water body, so it was used to extract the water body. Finally, green band was used to separate the clear land and urban area. Figure 9 shows the classified results for all four years.

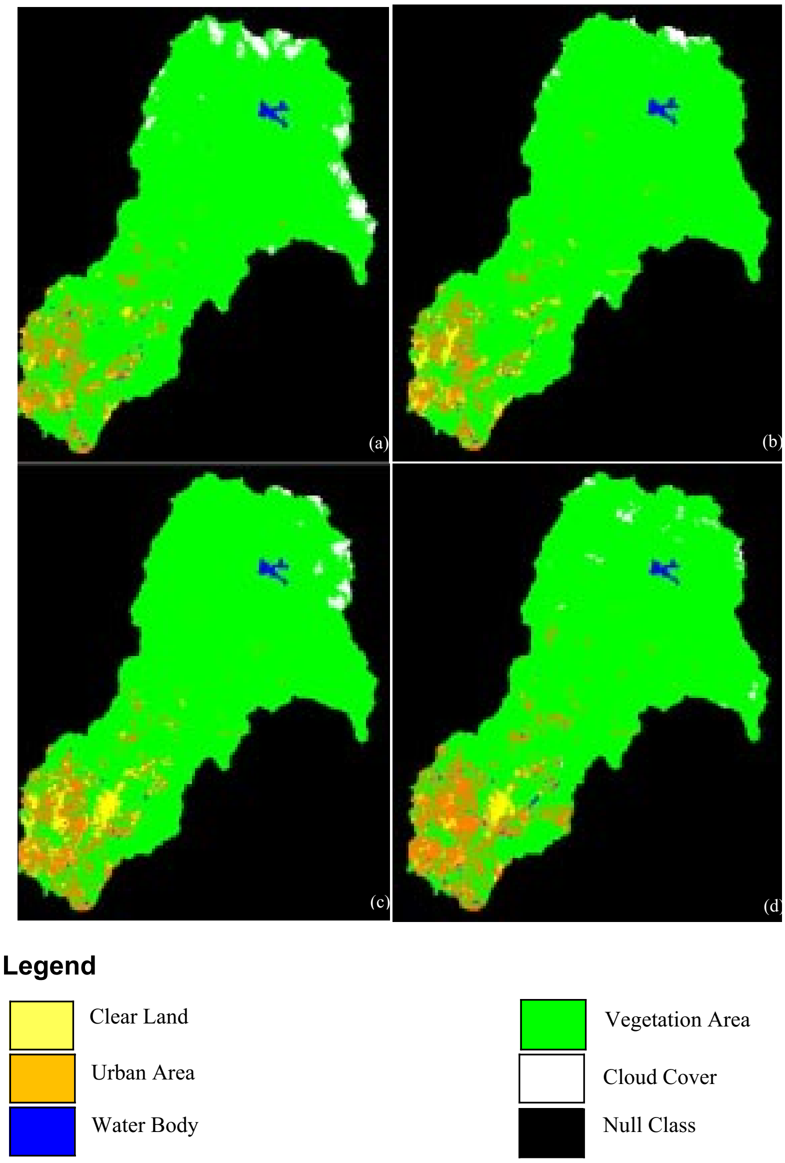

Figure 9: Object Oriented Classification Results for Landsat TM images (a) Date captured: 28 Nov 1994; (b) Date captured: 25 May 1996; (c) Date captured: 8 Feb 1998; (d) Date captured: 11 Feb 1999

5.1 Post Classification Analysis

In order to ensure the accuracy of classified images, the accuracy assessment has been carried out by exporting the classified result in raster format. The program automatically picks out 300 random sample points for Landsat TM 1994, 1996, 1998 where Landsat TM 1999 plus 15 ground truth points for accuracy assessment. Landuse map 1995 and 1997 which obtained DOA were used to identified the samples points. More of the ground truthing points were carried out at downstream area because the hand-held Global Positioning System (GPS) cannot receive the signal under the dense vegetation canopy. Since these fieldworks were carried out in the beginning year of 2001 (19th and 24th Mac, 2001), few ground truth points that were identified as clear land may falls under the vegetation area and the build up area may falls under clear land for Landsat TM 1999 image.

Figure 10 shows all the sample points that generated from program itself (dark blue) plus 15 ground truth points (red). Generally, most the classes achieve more than 90% accuracy.

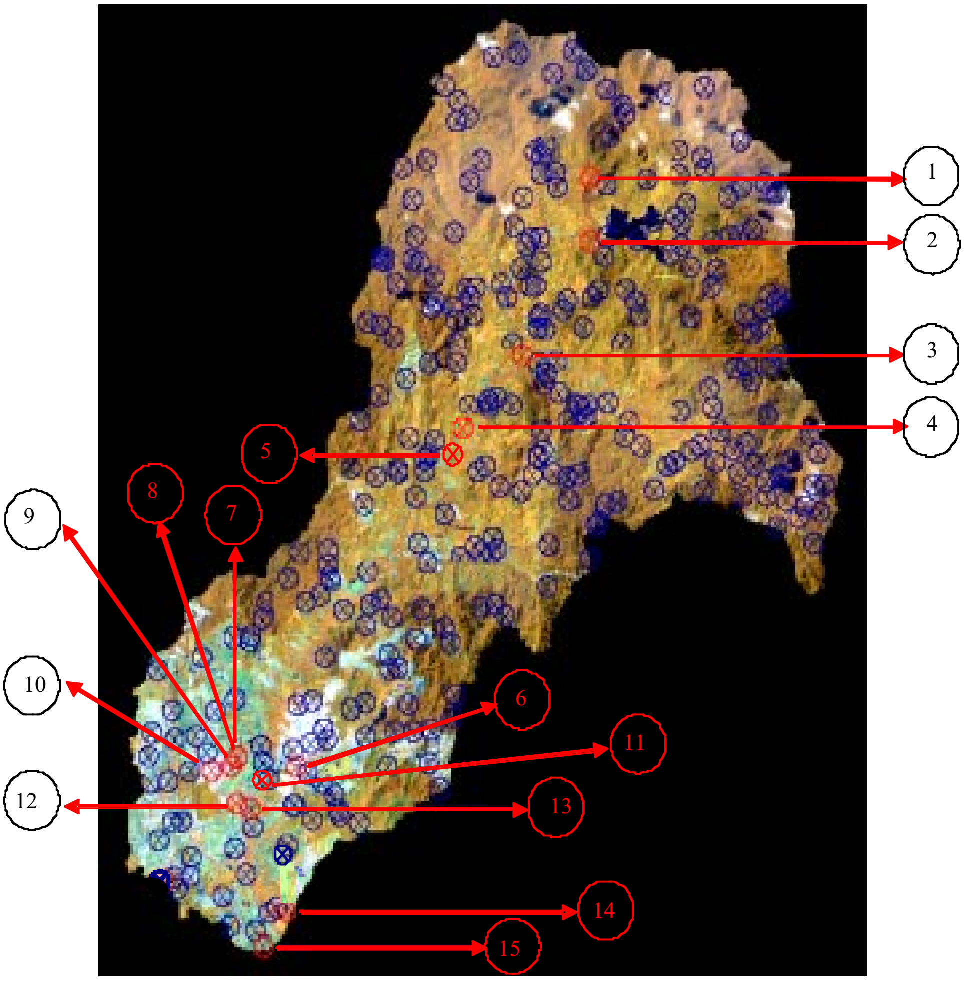

Figure 10: Random Sample Points (Dark Blue) and 15 Ground Truth Points (Red) for Accuracy Assessment (Source: Landsat TM 1999).

5.2 GIS Environment

The Classified outputs were exported to vector format for urban development detection. The statistical analysis as shown in Table 4 shows the trend that the area of vegetation area is keep on decreasing and the developed area is keep on extending.

Table 4: Land use and area information obtained from Landsat TM 5 satellite images

Land Use types	1994 (km^2)	1996 (km^2)	1998 (km^2)	1999 (km^2)
Vegetation Area	347.01	337.89	327.49	316.62
Urban Area	24.39	37.66	40.39	50.07
Clear Land	10.82	10.21	16.37	16.09
Water Body	3.49	3.54	2.38	2.55

Notes:

Vegetation Area includes: Cloud and Shadow are considered as vegetation area because they are mostly located at hilly area, when look at various sources (Topography map, Land Use map, other years of images), it can be identified that vegetation class is under the cloud and shadow (Shadow has been pre-identified as vegetation area in earlier stage of classification).

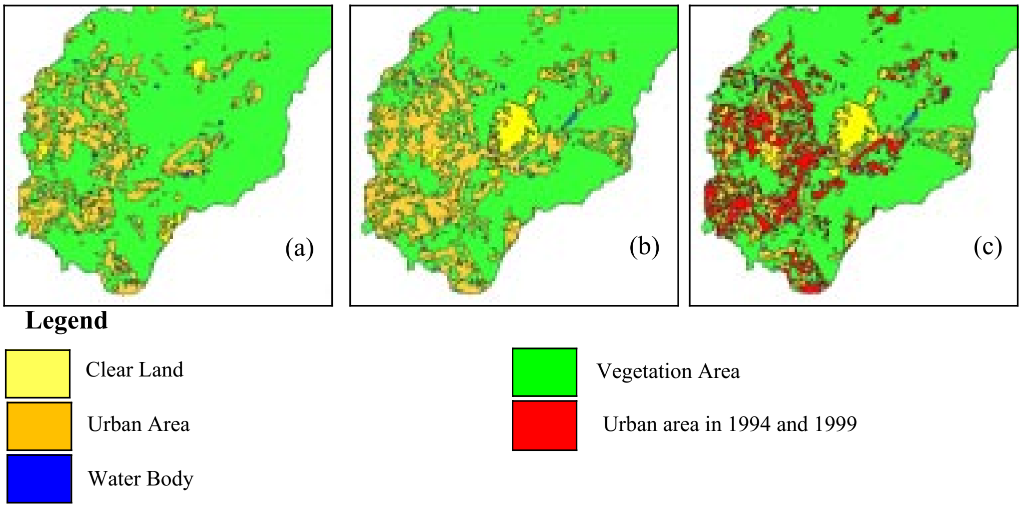

Figure 11: Urban development area detected from overlaying analysis (a) Land use 1994; (b) Land use 1999; (c) Overlaying analysis

The overlaying analysis was carried out to detect the development area from 1994 to 1999. It can be easily identified the location of rapid development in Figure 11 (c). From the Table 5 also, the attribute table shows the land use cover changes from 1994 to 1999.

Table 5: Attribute table of overlay layer

Attribute Manager: overlay_new.pix - 2 [VEC] Vector:Overlay

ShapeID	BestClass_1	BestClass_2	Area (sq km)	Perimeter (km)
1048	Vegetation Area [Level 2]	Vegetation Area [Level 2]	0.031494896	2.7
1326	Vegetation Area [Level 2]	Vegetation Area [Level 2]	0.043528563	3.78
1344	Vegetation Area [Level 2]	Vegetation Area [Level 2]	333.04315	421.70077
1345	Vegetation Area [Level 2]	Urban Development Area [Level 2]	0.0014113522	0.21623171
1348	Clear Land [Level 2]	Urban Development Area [Level 2]	0.0097143746	0.50884242
1350	Clear Land [Level 2]	Urban Development Area [Level 2]	6.9708252e-007	0.0048824502
1351	Clear Land [Level 2]	Clear Land [Level 2]	0.0062066997	0.4694552
1352	Clear Land [Level 2]	Urban Development Area [Level 2]	0.038015022	1.5508889
1353	Urban Development Area [Level 2]	Urban Development Area [Level 2]	0.000428724	0.12136338
1355	Vegetation Area [Level 2]	Vegetation Area [Level 2]	0.10636476	2.5522869
1356	Vegetation Area [Level 2]	Urban Development Area [Level 2]	0.28682885	5.5352282
1358	Urban Development Area [Level 2]	Urban Development Area [Level 2]	0.0037624409	0.25818769

Record 14 : Field 1 | 0 of 2000 Records | 0 of 5 Fields

Notes:
BestClass_1: Classes in 1994
BestClass_2: Classes in 1999

6.0 CONCLUSION

In this paper, the rule-based technique has been used for classification and all steps involved in the image analysis also being recorded as a complete procedure to apply onto time series data for urban development detection. It gives promising results for land use recognition and land use change detection. In addition also, the results that exported to GIS environment allow further analysis being carried out. It constitutes an important step towards the integration of remote sensing and GIS. As a conclusion, it is a cost effective, time saving, highly accuracy classification technique. This technique is recommended to test on VHR data such as Ikonos or Quickbird data especially in town area where more details classes can be generated.

ACKNOWLEDGEMENT

With a deep sense of gratitude the author would like to acknowledge MACRES for providing the satellite images. Appreciation is extended to DOA and JUPEM for providing the land use maps and topographic maps. Sincere thanks also extended to Engineering Faculty, UPM for the Hand Held GPS and transportation for Ground Truthing.

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WEB 3D GIS FOR URBAN ENVIRONMENTS

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Abstract

Urban environments like city centers are recognized as one of the most complex systems for modeling. Because of their high density of big buildings as well as their complicated processes, there is the strong need for planning and managing properly. Here, the heavy trend towards web-enabled systems can help to improve communication, organization and decision-making in favor. In the field of urban environments, 2D Geographic Information Systems (GIS) have proven to be a very useful tool. However, since real objects are in 3D, GIS should offer sufficient functionality for dealing with the third dimension as well. Therefore, the intention of our research is to integrate 3D GIS in web-orientated environments in order to provide appropriate applications to urban planners.

The aim of this paper is to introduce the current status of Web 3D GIS and most recent trends and developments. First, we will present technologies linked to web-enabled systems. Here, the field of distributed computing in relation to tasks in the field of Geo-Information is most interesting. Therefore, corresponding standards recommended by e.g. the Open GIS Consortium (OGC) will be discussed, too. After that, the paper focuses on 3D data management and corresponding functionality. The third aspect is 3D visualization for web-environments. Different techniques like VRML as well as the problematic task of a Graphical User Interface (GUI) to access and query data will be clarified. Finally, the paper discusses bottlenecks of Web 3D GIS and proposes new aspects to solve them.

1. INTRODUCTION

Recent developments in GIS are showing a general movement towards web-enabled GIS. The gap between Desktop-GIS and Web-GIS is closing. Applications based on network environments have already shown great potential in relation to geo-information. Examples can be online city maps and finding places (respectively routing) between points (MAP24, 2004). The developments in web-enabled GIS are driven by user requirements and technology developments. But is the third dimension sufficiently exploited by Web-applications?

In general, the need of 3D geo-data is rising more and more. Especially people involved in urban and landscape planning, cadastre, real estate, utility management, geology, tourism, army, etc. are keen on taking advantages of the third dimension. Since real objects are in 3D it is obvious to extend GIS to the third dimension as well. However, the acceptance of 3D applications depends heavily on the profits of these. Therefore, one can say the number of users is increasing by introducing new and additional 3D functionality.

The steadily growth of urban environments worldwide is challenging our society. In order to avoid chaos and confusion, urban scenarios like cities and their complex streams have to be planned well. Therefore, geo-information and corresponding spatial data are able to support planners and their decision makers heavily (Laurini, 2001). Possible fields of application are comprised in Table 1.

Table 1: Possible Fields of Application within Urban Environments for web-based 3D GIS (based on Altmaier and Kolbe, 2003)

Sector	Description	Example
Event management	Simulation of the event to attract people	Offering the possible 3D view of a certain seat in a stadium
Facility management	Management of big building complexes	Organizing the room availability of a hospital
Navigation support	Car and pedestrian navigation systems	Location-based displaying the recent position and its environment
Environment	Environmental Topics in Cities: noise characteristics, air flows, emission dispersions, etc.	Visualizing the emission dissemination
Disaster/emergency	Organizing the workflows if there is an emergency	Directing rescue teams through complicated environments with support of real-time data
Supply engineering	Management of supply related tasks	Organizing the power network

Table 1 shows many useful scenarios for 3D applications in urban environments. Whereas some of them – e.g. even management – mainly deals with visualization only, there are applications involving spatial analysis. Particularly the topic around disaster and emergency management enjoys great popularity recently.

On the technological side, state-of-the-art computer hardware is already offering a reasonable means to deal with the third dimension such as improved 3D visualization techniques. Among others, there is photo-realistic texturing, advanced lightning or real-time navigation. These in return attract more users and applications. We firmly believe, the Web offers the possibility to make the third dimension widely accessible.

The aim of this paper is to provide an overview about web-oriented 3D GIS. Since we consider system architecture, data management, 3D GIS functionality and visualization (respectively user interaction) critical for Web 3D GIS, we address them in detail. The paper explains needed system components and their importance with respect to the requested Web 3D GIS functionality. System architectures and possible approaches for implementing a web-enabled 3D GIS are reviewed and profoundly explained. Finally directions for further research are outlined.

2. WEB 3D GIS

Traditionally, any Geographic Information System is based on the principles of data input, management, analysis and representation. Within a web-enabled environment, these principles are represented by or implemented within the components as shown in Table 2.

Table 2: GIS Principles and their Corresponding Web Component

GIS Principle	Web Component
Data Input	Client
Data Management	DBMS possibly extended by a spatial component
Data Analysis	GIS Library on Server
Data Representation	Client/ Server

In order to achieve communication between the different components in a web environment, a web server is common. Since the geo-data is a very specific type of data, different standards, e.g. the OpenGIS Consortium (OGC) specifications are already developed and their utilisation has to be considered (see below). A system composed of these components is called here Web-GIS. It should cover a complete GIS workflow within a Web environment. Fig. 1 shows the general system architecture which is mostly “Client-Server”.

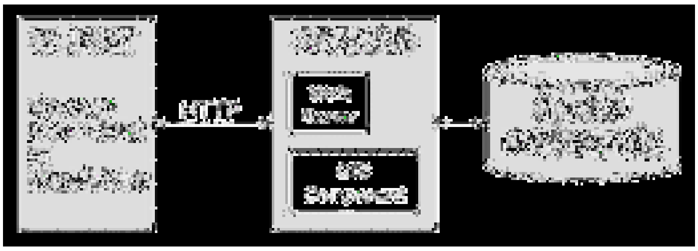

Fig. 1: Typical Web-GIS Architecture

Fig. 1 shows the minimum system architecture of Web-GIS. The Client is an application, which can communicate with the Server through a standard web protocol, for example HTTP. This application can either be in form of a web browser or standalone utility. In order to view and interact with GIS data, the browser needs to be extended by using an adequate Plug-In, Java Applet or both. Instead a standalone application can be used. This can be for example any GIS, which is supporting the appropriate protocol to access other computers in computer networks.

The web server is responsible for processing the request from the client and delivering the corresponding response. In Web-GIS architecture, the web server is also communicating with the server-side GIS component. This is adding spatial analysis functionality to the system. Moreover, server-side components are responsible for the connection to the spatial database, such as translating queries into SQL and creating appropriate representations to be forwarded to the server. In reality, GIS components are software libraries, which are offering classes to do spatial analysis on data. Besides the components, a very critical aspect is the functionality offered by the client- or server-side within Web-GIS. Fig. 2 shows possible distributions of functionality for a client-server system based on the concept of the visualization pipeline (OGC, 2003b).

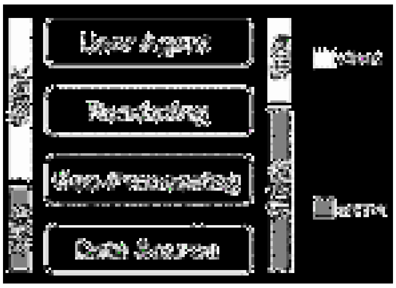

Fig. 2: Thin vs. Thick within Client Server Systems

Fig. 2 shows that a client is considered “thick” or “fat”, if the main GIS functionality and the data rendering are client-side hosted. Consequently the server in this specific system would be called “thin”. The server is called “thick” if GIS functionality and pre-rendering is hosted server-side. Within this system, the client would be called “thin”. Altmaier and Kolbe (2003) exclude rendering for interactive 3D worlds on the server since real-time navigation in static images would not be possible anymore.

However, it is still an interesting question how to find the balance between server and client. Because of the system complexity, required functionality, type of application, data sets, even available funds for implementing one or another solution and user experience, no ordinary rules can be specified. The question has to be answered for each system individually. Regarding the general system architecture, 2D/3D Web-GIS don’t have many differences. The setup shown in Fig. 1 can be used for both.

2.1 Differences between 2D and 3D

Traditionally, most GIS spatial operations are very expensive and more complex compared to for example administration numerical and textural type of data. This is especially the case if systems are dealing with the third dimension. Since calculations on 3D geo-information are by far more expensive than those in 2D, developers have to choose very carefully which system component is hosting certain GIS functionality. As stated before there is no general rule. Section 5 is discussing concrete implementations and gives answers for individual approaches.

On the operational/functional side, the differences between 2D and 3D calculations are most critical. Typical common operations for 2D- and 3D GIS are accessing attributes or further information on objects, calculating distances and areas, buffering, routing and nearest neighbour analysis. Whereas operations like volume calculations are 3D only. Because 3D information is much more complex and has a higher quantity, the processing is much more complex and therefore is taking by far more time and resources. 3D buffering for example needs much more efforts than the corresponding operation in the second dimension. These operations are done by the GIS component; either server- or client-side. In this respect third party tools or an individual developed component can be used. However, there are very few available third-party tools which are supporting 3D functionality. Therefore the available systems have to be customized. Individual implementations can be realized in any programming language, the server environment is supporting. Here, Java in conjunction with Servlets Technology is one approach (Vries and Stoter, 2003).

2.2 Important Aspects of Web 3D GIS

At the moment, regarding fundamental spatial analysis, database management systems are offering spatial extensions, too. There are spatial extensions for databases like Oracle, PostgreSQL, Informix, DB2, Ingres and most recently MySQL available. Unfortunately these do not support 3D sufficiently (Vries and Stoter, 2003).

In order to provide the development of analysis functionality at a database level, many DBMS are supporting procedural languages as well. Oracle's DBMS for instance offers two possibilities to create individual operations at the database level. First there is PL/SQL a procedural language. Second it has integrated its own Java Virtual Machine in order to process Java classes at the database level. The advantage compared to external spatial analysis will mainly be in terms of a better querying performance. In addition, operators on database levels can be used by anyone who has access to the database. Therefore, basic spatial analysis operations can be reused within other applications (Jansen, 2003). Systems implementing a spatial extension are called integrated systems (Oosterom *et al*, 2002). Overall, the trend towards GIS in Web environments is still ongoing. Recently, the term of Distributed GIS has been introduced. Here, a GIS will be completely distributed in a computer network. The corresponding functionality, data and certain clients are operating like nodes in an object-oriented application (Peng and Tsou, 2003). However, there are not Distributed GIS for the third dimension available so far.

Furthermore, since geo-data is a very specific type of data, standards have to be considered. Therefore the OGC has developed a wide range of specifications/documents which should be considered for utilization. The base for OGC conform GIS are defined spatial data types and their relationships (Simple- and Abstract Feature Specification). In addition, "implementation specifications" are describing interfaces and rules of exchanging/transferring data between components. In context of web mapping, the Web Map Service Implementation Specification (OGC, 2001) has to be considered. It is defining an interface for requesting maps. The corresponding Web Map Service (WMS) is creating maps of geo-information. It has to support the operations of "GetCapabilities" and "GetMap". The operation "GetFeatureInfo" is optional but necessary for retrieving further information about objects through user interaction. Whereas "GetCapabilities" is returning information about the Web Map Service itself, "GetMap" is returning the map/figure. Since editing/manipulating of data is one GIS principle, the Web Feature Service Implementation Specification (OGC, 2002) is a must as well. Operations of a Web Feature Service (WFS) are insert, update, delete, query and discover data. The data is represented in form of GML, another OGC standard for exchanging geo-information (OGC, 2003a). Both, WMS and WFS, are based on the HTTP protocol for transferring data. Among others, GML3 is including 3D geometry and therefore suitable for Web 3D GIS. Besides, there is an implementation specification regarding 3D terrain scenes (Web Terrain Service). Altmaier and Kolbe realized that there is no specification or standard to describe interactive 3D worlds. Therefore, they introduced the W3DS portrayal service for 3D spatial data (Altmaier and Kolbe, 2003). OGC standards or others like the ISO/TC211 are important for the communication between components within complex GIS – especially Web-GIS. Therefore systems can be extended easily by additional components confirming to the standards (Vries and Zlatanova, 2004).

Another critical aspect is the performance of the system. If there is one bottleneck, the whole system will be affected. Therefore, system architects have to think about any – at first stage even unimportant– aspect. First, the base of a system should be state-of-the-art computer hardware and proved applications or environments, e.g. powerful 3D visualization techniques. Because of large data amounts, the data transfer between the components should be reduced to a minimum. Because of low band-width, there can be a critical bottleneck between the client and the server. Streaming techniques, which are allowing the data transfer in parts, are becoming very popular should be in favour. In order to achieve acceptable system performance, spatial analysis has to be done on top of a reasonable concept of storing data. Consequently databases have to largely employed, preferably with maintenance of topology (see Section 3). In Relation to 3D, issues can be further 3D object reconstruction and real-time navigation (Stoter and Zlatanova, 2003). In many cases, bottlenecks have to be solved for each system individually.

3. MANAGEMENT OF 3D SPATIAL DATA

In order to manage 3D geo-information, at least the use of databases and their managements systems (DBMS) is required. Object-relational modeling is most common since relational databases are not very appropriate for storing spatial data. The object-oriented database approach faces the problem that the general acceptance and knowledge is not available so far (Connolly and Begg, 2002). The field of Geo-information adopts both approaches and comprises them into Object-Relational DBMS (Shekar and Chawla, 2003). As stated in Section 2 the additional integration of spatial extensions is compulsory for GIS applications. Furthermore, because operations of 3D functionality are different from 2D, a reasonable concept of data storage is inevitable. Therefore the two aspects of 3D geometry and 3D topology have to be regarded. Geometry is holding the 3D coordinates of objects. In contrast to this, topology is holding their spatial relationships. The OGC is proposing the separation between geometry and topology within databases. The reason for this is to perform certain queries on geometry others on topology (Oosterom *et al*, 2002).

Regarding geometry, there are several DBMS available which already have the ability to handle spatial data types. These are divided in to the geometric primitives of point, line and polygon. The OGC calls them as simple features. However, 3D primitives like polyhedrons are missing and have to be implemented individually. Stoter and Zlatanova showed how to store a polyhedron within Oracle 9i using multiple polygons (Stoter and Zlatanova, 2003).

In contrast to geometry, the topological part is more critical. State-of-the-art DBMS are not offering any support for 3D topology. Shi et *al* (2003) and Zlatanova *et al* (2004) provide a brief overview about developed topological models including additional performance tests. However, recently Oracle announced the integration of topology up to 4D in its database spatial extension of Oracle 10g (Lopez, 2003). Besides, the corresponding OGC specification (complex feature specification) is not finished yet - in terms of implementation specifications for complex features. However, topology is the base for reasonable querying of 3D spatial data. Since there is no unique topological model available topology has to be implemented individually. Van Oosterom *et al* (2002) are giving an overview about available approaches. How to choose an appropriate model for a system is querying, application dependent (Zlatanova *et al*, 2002a). Moreover the technique of visualization is another factor for the question of selecting a topological model. There is no general rule of selecting in favour. Topological models should fulfil tasks like covering all possible relationship and extensibility (Oosterom *et al*, 2002). Beside the geometry and topology, the spatial querying language for the third dimension is challenging the database community as well. Güting concluded in addition to SQL, a spatial query language has to provide fundamental spatial operations and reasonable ways of representing the result (Güting, 1994). Here, 3D operators on top of an ingenious data model are not available so far. For representing the result, tables are not appropriate. A standard-based way in order to illustrate the query result can be found in the GML3 standard.

Furthermore, spatial indexing is one main key to improve querying performance on geometric data. Several different indexing methods are common while mainly R-tree, Quad-tree and P-tree are used.

Furthermore, indexes are often used in conjunction with LOD implementations (Coors, 2003; Kofler,1998).

4. GUI FOR 3D VISUALIZATION AND EDITING ON THE WEB

4.1 Basic Concepts

In order to interact and communicate with information, a Graphical User Interface (GUI) has to be designed and created. Because geographic information is usually very complex, this task is difficult to achieve. Moreover, the user interface is most critical due to the fact that this is the "main gate" to the application. If a GUI is implemented poorly, an application will not be accepted by critical users. In contrast to user interaction in 2D, a GUI for the third dimension is different (Cöltekin, 2002).

To develop a GUI for 3D Visualization, different aspects are important. First of all, the virtual world has to be sufficient. To do so, core features of creating a 3D world are needed. This means appropriate modeling of physical objects, lighting and shadowing, definition of viewpoints, photo-realistic texturing. As soon as interaction has to be involved, using events, linking and internal/external scripting are becoming more important. In fact, 3D worlds including real-time interactive navigation like walkthrough, flying, panning and sliding are requirements today – similar techniques are widely used in computer games. In order to examine singular objects, rotating is another important real-time navigation attribute. More advanced characteristics of virtual worlds are the maintenance of Levels of Detail (LOD) or multi-resolution texturing implementation are improving the performance. Furthermore, culling algorithms should be provided in order to make sure that invisible back-faces will not be rendered. Overall, the amount o rendered polygons is a factor for the smooth navigation. Any technique which is reducing the amount while keeping the world realistic should be used (Kofler, 1998).

Intuitive editing of 3D data is much more complicated than visualization. In order to provide a human readable GUI for editing, high efforts have to be done. This is the reason why mainly common CAD or GIS software products are used as front-ends at the moment (Stoter and Oosterom, 2002; Zlatanova *et al*, 2002b)

4.2 3D Visualization Techniques for the Web

VRML/X3D

VRML (Virtual Reality Modeling Language) respectively its successor X3D (Extensible 3D) were introduced by the Web3D Consortium to distribute interactive virtual worlds on the web. Both are mark-up languages and standardized. Whereby X3D is fulfilling the concepts of XML. Besides X3D is specified more modular. The rendering concept is mainly based on a scene graph definition and a node structure (Web3D Consortium, 2004). VRML andX3D are accomplishing the basic concepts for a 3D GUI (Dykes *et al*, 1999). To list all the features would take too long. Concepts of constructing a core virtual world and especially the external authoring interface (EAI) grading the possibilities around X3D/ VRML up. By using the EAI, one can add individual functionality to virtual worlds. Developed either by scripting or higher programming languages, 3D scenes can get highly interactive. One good example is accessing a database from VRML worlds in order to retrieve new data (Zhu *et al*, 2003). Realized VRML clients in combination with HTML have already proven their ability to react as GIS user agents in many examples and prototypes (see Chapter 5). However, no well-known commercial implementation is available. The most common use of VRML is within a client-side browser/plug-in implementation. Unfortunately plug-in vendors are hesitating with shipping X3D browsers.

Java3D

Another instrument for creating 3D world on the Web is Java 3D. The Java3D library is a freely available API for developing Virtual Worlds in Java (Sun Microsystems, 2004). Therefore Java3D classes can be used by Java Applets within HTML pages. Java3D's functionality is almost the same as VRML/X3D are providing. Savarese introduces them briefly (Savarese, 2003). One big advantage compared to plug-in based solutions is that developers have more control about rendering and user interaction. Another is the transformability. Compiled Java3D classes can either be used as standalone application or applet. In contrast to the mark-up languages of VRML or X3D, Java3D requires much more programming knowledge (Diehl, 2001). This is probably one reason, why only a few solutions have been realized using Java3D. One example for implementing Java3D within a geo-related application is the DEMViewer by Taddei (Taddei, 2003).

5. REVIEW OF CURRENT WEB 3D SYSTEMS

As mentioned above, recent 3D GIS implementations are mainly covering 3D visualization and simple interactive components like accessing additional information. Other general GIS principles, like data analysis are still missing. The reason for this is that the related data management is not suitable for real 3D functionality (Nebiker, 2003). However there are a couple of prototypes available which are pointing towards real 3D GIS. The following brief descriptions are introducing browser based and standalone front-ends.

5.1 Realized browser based solutions

As stated in Chapter 2, browser based solutions are almost represented by some kind of browser + plug-in approaches. These have the big advantage of good availability to the user. However, sometimes applications are developed just for one specific plug-in while other fail. Even if different plug-in's can handle the virtual world, almost all of them have a different GUI in terms of real-time navigation. This is the reason why they can be difficult to use for inexperienced users (Kofler, 1998). The following examples are almost using VRML embedded in HTML based web pages.

A prototype system of 3D GIS (Zlatanova, 2000)

The developed system is a typical example of a very thin client, i.e. based on HTTP, CGI scripting (realized in Perl), VRML and HTML documents which are created on-the-fly. The VRML delivers the 3D graphics information obtained as a result of spatial queries or/and provides means to query graphically the objects observed in the 3D scene (by standard VRML nodes). HTML documents are used to visualise text and images, to specify SQL queries or introduce new values for edited elements. Web and VR browsers on the client stations are utilised to interact with the 3D model(s) and specify queries. The data are structured according to the topological model SSM are maintained in a RDBMS, namely MySQL

Requesting information about a particular object can be done either by typing its ID in a HTML form or by clicking on the corresponding object in VRML (its graphical representation). For example, a click with the mouse on a building activates a CGI script, which delivers a “Query-Result” section (HTML). The user selects the needed information from “pull-down” menu that is created on the fly with all the information available for the object in the database.

Extracting a group of objects according to a criteria is completed by directly typing SQL query at the “Query” section. The result of the query is displayed either in an HTML or in a VRML document. These documents are created on the fly only with the information related to the objects of interest. The same mechanism is used to create DELETE, UPDATE, and INSERT forms to edit data. The free access to the database provides a mechanism to specify and display a wide range of spatial queries. Examples of such queries are “which is the highest building?”, “show the buildings in a particular area”, “show all the streets”, “show all the administrative buildings”.

An advantage of the system is that clients practically do not use any specific software besides Web browser and VR plug-in. The system also does not have a specific GIS component since the SQL queries are directly sent to the database. The spatial functionality is provided by operations at data-base level. The major disadvantage is eventual overload of the server in case of many users. The performance of the system has not been tested for multi-user access. Another disadvantage is increased complexity of the VRML file if elaborated point-and-click operations are needed. To be able to work with freeware VR browsers, all the interaction with objects is incorporated in the VRML (using special VRML nodes). Therefore, in many cases the size of the VRML file can increase drastically.

GOOVI 3D (Coors and Jung, 1998)

The system architecture is a medium client-server where most of the functionality is provided at the server side but some functionality is also kept at the client side. The components of the system are VRML, HTML, Java and warehouse. The warehouse consists of files organised on the server. The interface to the data warehouse is done by COBRA IDL and is based on IIOP protocol.

The two kinds of queries, i.e. obtaining additional information about a selected object and extracting several objects as a result of specific queries, are also implemented. In the first case this is done by attaching to the objects in the VRML files hyperlinks to a HTML page (the pages are stored in the warehouse) or, more dynamically, by Java script nodes. In the second kind of data queries (objects, which meet specific conditions), the server has to access at database in order to perform the queries. The results are represented by highlighting the objects of interest in the current VRML scene using Java and IIOP protocol. Thus no new VRML file is created. Since the system is indented for discussing urban plans, editing/modification operations are not implemented.

The authors make a suggestion for SQL node in VRML that can be directly used to connect to DBMS and extract information. First implementations of the system use RDBMS to store objects as VRML nodes and information about them as HTML pages. Later implementations made use of more generic representations in Oracle, using the topological model UDM (Coors, 2003).

The advantage of the system is that it is a relatively thin client-server system, allowing implementations without large resources at the client. Part of the functionality (data query) is performed at the server but highlighting of the objects of interest is at the client. In this respect the system is better balanced than the previous one. The system however is a bit dependent on the file organisation in the warehouse (i.e. mixture between files and DBMS storage). The major disadvantage is that the extended protocol IIOP is used (not available overall).

SALIX (Lammeren and Hoogerwerf, 2003; Wachowicz *et al*, 2002)

SALIX is a typical example of a thick client. The system is intended for interactive landscape planning, i.e. planning trees and bushes and simulating their growing. The GUI is based on the Cortona environment, using VRML and java to provide all the functionality. DBMS is used only to store the objects of interest (a variety of tree and bush). The objects are manually placed in the field of view. A large number of toolbars give the users the possibility to inspect certain constraints, the distance between the planted trees in different stage of their life, to simulate growing, to create conglomerates of objects from the same type, etc.

The significant aspect of this system is the extended functionality in terms of interaction and manipulation. There are still more improvements necessary toward making real use of functionality available at DBMS (currently used only for object storage).

Accessing Geo-DBMS Using Web Technologies (Vries and Stoter, 2003)

Vries and Stoter (2003) described two prototypes using a web environment to query 3D spatial data and their attributes. Moreover the implemented applications are focusing on reasonable ways to visualize the query results within a web browser. Because the operations are hosted server-side, the system is represented by a thin client and thick server. The realized prototypes can be differentiated by the implementation technologies as follows.

- **VRML and Microsoft-specific technologies**
  This implementation uses common web technologies to achieve a 3D GIS. Geo-data is already available within VRML files, whereas its attributes can be queried dynamically. These are stored in Microsoft's Access database system. Active Sever Pages (ASP) technology combined with the Internet Information Server (IIS) as web server environment is used to offer interaction with the database. The served VRML world is embedded within the main frame of the HTML Page. User interaction is possible in form of querying each objects attribute data. If the user clicks on an object in the VRML world a request is sent to the server. After connecting to the database, ASP is creating an appropriate HTML fragment which is holding the requested attribute data in a table. This is supposed to be embedded in the second frame of the application. This approach is vendor specific. It is only working properly on MS components in favour.

- **X3D, Java Servlets, XSQL and Oracle9i**
  This prototype system is based on an integrated database architecture. The underlying DBMS hosts 3D spatial data as well as their attributes.Oracle9i and its spatial extension are used in favour. Server-side, the system is based on a Java Servlet Container, like Apache Tomcat,

and the Apache HTTP server. In detail, the prototype uses XML specific Java libraries to query (XSQL) and exchange data. The libraries are part of Oracle's XML Developer Kit's (XDK) which are integrated in Tomcat here. Among the XSQL servlet and others, the XDK is providing a XML parser and XSLT processor. In order to visualize the queries, the XML response of the database is transformed to X3D using XSLT style sheets on-the-fly. On the client the browser window is separated into three frames. The main frame for showing the virtual world, another for displaying the object's corresponding attributes using HTML tables. The third frame is offering HTML forms in order to query the database for spatial objects. Once a query is performed, the main frame will visualize the new scene.

This state-of-the-art implementation is demonstrating the advantages a fully XML based system nicely. Furthermore, it can be integrated into any platform which is supporting the Java programming language. Fig. 3 shows the prototype's client interface.

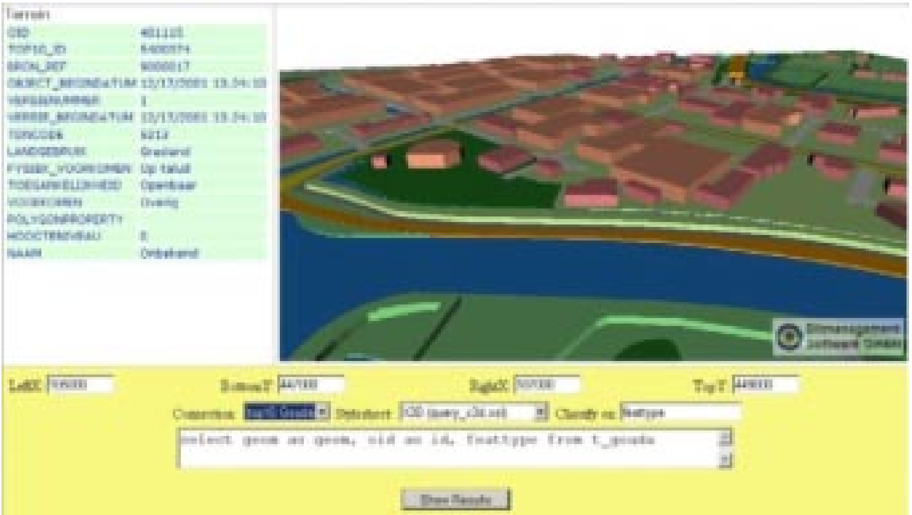

Fig. 3: A prototype system using web technologies to access Geo-DBMS

Pilot 3D of the GDI NRW

The Special Interest Group (SIG) 3D of the Geo-Data Infrastructure North-Rhine Westphalia, Germany (GDI NRW) proposes their first prototype. The 3D city model is based on the geometrical objects point, line, surface and body and has been presented in Gröger *et al*. The corresponding application logic – realized in Java programming language - is offering a standard based (OGC and ISO19107) solution to visualize 3D urban data (Gröger *et al*, 2004). The proposed data model is used in 3D city models, virtual flights and other projects which are able improve planning processes. For interactive 3D visualization, VRML is used at the moment. A first published result has been presented by the SIG 3D and is available online (SIG 3D, 2004).

Overall, the "Pilot 3D" project can be seen as a prototype scenario in order to prove the value of a standard-based Spatial Data Infrastructure. Most important here is that the SIG 3D is proposing their own extension of the Web Terrain Service called Web 3D Service (W3DS).

5.2 Standalone Solutions

Most CAD or GIS can be integrated into a web environment. They can be used as a user agent on the client. Stoter and Zlatanova are describing approaches using ESRI's ArcScene and Bentley's GeoGrapics iSpatial to visualize and edit data. These examples are not covering the integration into a web environment (Stoter and Zlatanova, 2003). However, one can do so. Because mean software products are difficult to use, they are not very suitable for inexperienced users. Therefore, different institution/companies have created special 3D applications. Geonova's Digital Landscape Server (DILAS) product line is one promising approach. The following paragraph is giving a brief description about the application and its components.

DILAS 3D (Nebiker, 2003)

Geonova's commercial product line DILAS offers a large variety of modules which can be seen as 3D Web-GIS. The DILAS server and manager are the system's main components. They are responsible for characteristics like data storage, -management, representation and scene reconstruction. The DILAS modeler is an extension on Bentley's Microstation V8. This component integrates the creation and edition of new 3D objects and their corresponding styles. Moreover, the modeler benefits from the possibilities of Microstation due to the fact it is using its Java API. The server module is the connection for the database at this. In order to publish 3D worlds on the web, the DILAS scene generator is the key component. In conjunction with the visualization product G-VISTA it is generating complex 3D scenes like city models. These can be served by any web server. Most recently Geonova announced the new OGC conform Web Map Service. Therefore any client which is supporting this specification can be used (GEONOVA, 2003).

The whole concept and the already implemented features are looking very promising for the use in urban planning. Based on a state-of-the-art object-relational DBMS, DILAS offers managing, editing, reconstructing/visualizing and publishing virtual worlds. However, editing and managing of 3D scenes is only possible within an intranet network. Furthermore there is no 3D functionality offered by default. Nevertheless the shown examples are impressing.

GIERS (Kwan and Lee, 2003)

Kwan and Lee (2003) describe a developed GIS-based intelligent emergency response system (GIERS) which is implementing 3D routing features up to the inside of buildings for rescue teams in real-time. As a result, a navigable 3D GIS which is including building internal navigation as well the association to ground transportation possibilities of a city is presented. The underlying 3D data concept comprises a topological node-relation structure which is used for the routing operations. It has been transformed in to relational database model. On the technological side of the implementation, mainly Microsoft specific technologies are used. Furthermore, depending to its purpose, they system is able to communicate with mobile devices as well as through the Internet (Kwan and Lee, 2003).

6. CONCLUSIONS AND OUTLOOK

This paper presented an overview on system architecture, data management and GUI visualization for Web 3D GIS. Due to the fact that there are not truly Web 3D GIS systems available, further developments and research is still needed. The paper outlined the following important directions:

In Web 3D GIS the client can try to access the system from different devices (desktop computer, laptop, pocket PC, telephone, etc.). Therefore, it might worthy to consider thin clients and concentrate most on the functionality on the server side or in middleware implementations. However, the system has to be aware of the device type used by the client. In this respect, an important research direction is an intelligent automatic simplification (generalisation) and adaptation of the 3D vector data for the different clients. The client has to be able not only to request and visualise but also identify sufficiently itself. In addition, standards are necessary in order to improve interoperability.

Another critical question which has to be addressed is the edition of 3D data over the Web. Most of the systems discussed here focus on 3D visualisation and navigation as few or no tools are provided for modifications of data (both thematic and geometric). 3D editing requires a GUI extended with tools for pointing and selecting objects, parts of objects and constructive elements (vertices, edges, polygons) and a corresponding interface for editing. The currently provided 3D tools for navigation within the 3D model and querying their attributes are only the first step.

The most challenging 3D topic remains the maintenance of data. Implementation of true 3D primitive (e.g. polyhedron) is the first urgent development. Research on 3D primitives with curved surfaces and curved edges has to be initiated in short terms to be able to maintain urban objects created in CAD systems (e.g. complex buildings and bridges). 3D topology still requires a lot of developments, implementations and agreements on standards.

3D functionality has to be made available. This means that, first, advanced means towards specifying queries and analysis has to be provided and, second, algorithms for 3D spatial analysis have to be developed (i.e. 3D buffering, 3D navigation, etc.). Important improvements on performance of querying, analysing and visualising of 3D data are needed. An efficient organisation of LOD and images for textures will definitely speed up visualisation and navigation of 3D data.

Finally, further research should target the field of 3D standards (especially on the Web). Many standards are already available but still the third dimension is not in the focus.

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GEOGRAPHIC INFORMATION STANDARDISATION: THE WAY FORWARD TO SPATIAL DATA SHARING

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Abstract

With the advancement of technology, geographic information systems have become powerful mechanism to combine data from various sources and to produce extra information for planning and spatial analysis.

However, spatial data are being produced by various agencies and from various sources. In order to ensure that these data can be shared easily, there is a need to standardised various aspects of the data to support data sharing among producers and users of spatial data.

At the international level, the body that coordinates standardisation in the field of geographic information is ISO/ TC 211.

This paper provides the overview of geographic information standardisation activities in Malaysia, the works of ISO/TC211 and the ISO documents that have been adopted as Malaysian Standard.

Keywords: geographic information, standards, data sharing

1. INTRODUCTION

Spatial data are items of information related to a location on the Earth, particularly information on natural phenomena, cultural and human resources. Examples are topography, including geographic features, place names, height data, land cover, hydrography, cadastre (property-boundary information), administrative boundaries, resources and environment, socio-economic information including demographics. Spatial data are critical to promote economic development, improve stewardship of natural resources and to protect the environment.

In most of the developed countries, it is widely acknowledged that spatial data is part of the national infrastructure and extensive efforts are being expended on this. Many organisations in all levels of government, private and non-profit sectors and academia throughout the world spend billions of dollars, each year producing and using spatial information.

Geographic Information Systems (GIS) are common tools used to store, manage and utilise digital spatial data. GIS benefits are increased by data sharing among organisations. Often the spatial data produced for one organisation can be applied in others, thus saving money and resources by sharing data.

For many organisations, building and using a GIS requires large quantities of current and accurate digital data. They can save significant time, money and effort when they share the burden of data collection and maintenance. This is important, not only to the organisation looking for the data, but also for the organisation with the data. The more partners there are, the more the saving and the greater the efficiency.

However, in order to ensure that spatial data can be shared easily, there is a need to standardised various aspects of the data to support data sharing among producers and users of spatial data.

2. ORGANISATIONS AND COMMITTEES

In Malaysia, various committees are collectively involved in designing, drafting, scrutinising and approving the Malaysian geographic information standards, namely: National Mapping and Spatial Data Committee, Malaysian Centre for Geospatial Data Infrastructure, MAMPU, National Committee on Geographical Names, TC2/ SIRIM and Department of Standards Malaysia.

At the international level, ISO/TC211 coordinates and develop a family of international standards that will support the understanding and usage of geographic information.

2.1 National Mapping and Spatial Data Committee

This committee (formally known as National Mapping Committee) was formed in March 1965 by the Cabinet and chaired by the Director General of Survey and Mapping to coordinate mapping and spatial data activities in the country. In June 1994, it formed 5 Technical Committees as follows:

- Technical Committee on Land Resources and Environmental Management
- Technical Committee on Standard and Data Transfer
- Technical Committee on Human Resource Management
- Technical Committee on Automated Mapping and Facility Management
- Technical Committee on Policies and Institutional Issues.

The Technical Committee on Standard and Data Transfer and Technical Committee on Automated Mapping and Facility Management are directly involved in the development of GIS standard.

2.2 Malaysian Centre for Geospatial Data Infrastructure (MaCGDI)

MaCGDI (formally known as NaLIS) was launched on January 2, 1997 by the Chief Secretary to the Government through the issuance of the Public Administration Development Circular Number 1 of 1997. Its objectives is to support the sharing of information among producers and users of land data which will enable:

- On-line access to land data in land related agencies;
- Avoid wasteful duplication of effort in the collection and production of land data; and
- Ensure the accuracy, timeliness, correctness and consistency of land information used in planning, development and management of land resources.

The Secretary General of the Ministry of Natural Resources and Environment chairs the MaCGDI Coordinating Committee. Three main committees were established namely: the Clearinghouse Technical Committee, the Standard Technical Committee and the Framework Technical Committee.

The MaCGDI Standard Technical Committee is given the role to lead and coordinate the development of the Malaysian GIS Standard.

2.3 TC2/ SIRIM

The Technical Committee 2 (TC2), formerly known as Working Group 12 (WG 12) was formed in 1991 by SIRIM to initiate, promote and coordinate the drafting of the Malaysian GIS Standard. This committee is also authorised to represent the country for communication with international bodies and to participate in the international conventions.

The mission of TC2 is to develop the Malaysian GIS Standard, which will be used by all the spatial data providers and users in the country. Its mission is also to take part actively in ISO/TC211 by commenting the drafts and attending meetings. Its policy is to adapt and adopt the suitable international standard as a basis for developing the Malaysian GIS Standard.

Since ISO is recognised as a sole international organisation for standardisation, this committee has taken part actively in ISO/TC211 meetings. The development of the Malaysian GIS Standard has been tailored towards this Standard.

2.4 ISO/TC211

ISO (International Organisation for Standardisation) which was founded in 1946, is a worldwide federation of national standards bodies from some 100 countries.

ISO/ TC211, established in 1994 is an international organisation for standardisation in geographic information/ geomatics. Malaysia was accepted as a member and certified with the status O-Member (O-Observer). In November 1996, Malaysia membership was up-graded to P-Member.

This international standard is currently in various stage of development. In drafting the Malaysian GIS Standard, the development in the international level is being closely monitored in order to be in tandem with the international standard.

The geographic information/ geomatics standards being developed by ISO/TC 211 are as in Appendix I.

3. GI STANDARDISATION ACTIVITIES

Presently, standardisation activities in the field of geographic information in Malaysia are concerted on the following:

- Standardisation of codes for land administrative boundaries;
- Standardisation of Feature and Attribute Codes;
- Development of the Malaysian metadata standard;
- Quality Information of geographic dataset;
- Standardisation of street addresses; and
- Standardisation of geographic names.

3.1 Standardisation of codes for land administrative boundaries

Codes for land administrative boundaries such as the State, Division, District, Mukim, Town and Section are being standardised to ensure that all agencies adopt the same codes that will facilitate data exchange between agencies.

There still exist differences between codes used by the two main data providers for land parcels in Peninsular Malaysia, i.e. the Department of Survey and Mapping which provides the spatial data and the Department of Land and Mines which provide the textual data. Efforts are now being undertaken to ensure a standardised code being used by all land data producers and users especially before the implementation of the e-tanah project.

For the states of Sabah and Sarawak, the Department of Land and Survey Sabah and the Department of Land and Survey Sarawak play the pivotal role in coordinating and standardising the codes for land administrative boundaries.

3.2 Standardisation of Feature and Attribute Codes

The MS 1759:2004, Geographic Information/ Geomatics - Feature and Attribute Codes provides a system for feature and attribute coding by which producers and users of geographic information may use in structuring their digital spatial data. This standard represents a major improvement over MS 1074:1992, Malaysian Standard Code of Practice for the Exchange of Digital Feature Coded Mapping Data.

In MS 1759:2004, each feature is identified by a unique six-character code. The first character corresponds to the feature category and can have an alphabetic value from A through Z. Currently there are twelve feature categories, including one category, X, which has been reserved for special use (dataset-specific) features. The categories are as follows:

CODE	CATEGORY
A	Aeronautical
B	Built Environment
D	Demarcation
G	Geology
H	Hydrography
R	Hypsography
S	Soil
T	Transportation
U	Utility
V	Vegetation
X	Special Use (Dataset-specific)
Z	General

Each major category is further divided into subcategories which are identified by the second character of the six–digit code, containing an alphabetic value from A through Z. Examples of the subcategories are as follows:

A - Aeronautical

AA Air Space
AB Aerodrome

B - Built Environment

BA Residential
BB Commercial
BC Industrial
BD Institutional
BE Educational
BF Religious
BG Recreational
BH Cemetery
BJ Built-up

The third, fourth, fifth and sixth characters of the six-character feature code are a numeric value from 0000 through 9999. This value provides unique feature identification within categories yet allows flexibility.

Attributes are used to describe characteristics of a feature. Each attribute is described by using attribute codes to represent the category of information. Each attribute is identified by a unique three character alphanumeric code. For example, the attribute 'Planted Forest Type ' has the code PFT and 'Residential Building Type' has the code RET. Attribute value format statements provide a computer interpretation for the attribute value data type (e.g. real, alphanumeric) and attribute values give quantitative/ qualitative meaning to the attribute code. There are two types of attribute values: coded and actual.

3.3 Development of the Malaysian Metadata Standard

Metadata or 'data about data' describe the origins of geo-spatial data and track its changes. Metadata allows a producer to describe a dataset fully so that users can understand the assumptions and limitations and evaluate the datasets applicability for their intended use.

Typically, geographic data is often produced by one organisation and used by others. Proper documentation will provide those unfamiliar with the data with a better understanding, and enable them to use it properly. As geographic data producers and users handle more and more data, proper documentation will provide them a keener knowledge of their holdings and will allow them to better manage data production, storage, updating and reuse.

The ISO/TC211 metadata standard defines an extensive set of metadata elements, typically only a subset of the full number of elements is used. However, it is essential that a basic minimum number of metadata elements be maintained for a dataset.

The development of the Malaysian Metadata Standard is currently being carried out based on the ISO/TC 211 core metadata elements, which includes mandatory and recommended optional element.

Listed below are the core metadata elements required to describe a dataset. An 'M' indicates that the element is mandatory. An 'O' indicates that the data element is optional. A 'C' indicates that the element is mandatory under certain conditions.

- Dataset title (M)
- Dataset reference date (M)
- Dataset responsible party (O)
- Geographic location of the dataset (C)
- Dataset language (M)
- Dataset character set (C)
- Dataset topic category (M)
- Spatial resolution of the dataset (O)
- Abstract describing the dataset (M)
- Distribution format (O)
- Spatial representation type (O)
- Reference System (O)
- Lineage (O)
- On-line resource (O)
- Metadata file identifier (O)
- Metadata standard name (O)
- Metadata standard version (O)
- Metadata language (C)
- Metadata character set (C)
- Metadata point of contact (M)
- Metadata date stamp (M)

An online metadata search module has been developed in the MaCGDI application as an initiative to facilitate online search of geographic information available at various agencies. The MaCGDI metadata details can be assessed at http://www.macgdi.gov.my

3.4 Quality Information of geographic dataset

Geographic dataset are increasingly being shared, interchanged and used for purposes other than their producers' intended use. Information about the quality of available geographic datasets is vital to the process of selecting a dataset in that the value of data is directly related to its quality.

Data users confront situations requiring different levels of data quality. Extremely accurate dataset is required by some data users for certain needs and less accurate data are sufficient for other needs. Information about the quality of geographic data is becoming a decisive factor for its utilisation as technological advances allow the collection and use of geographic datasets whose quality can exceed that which is needed and requested by data users.

Data quality is part of metadata. At present, data producers are encouraged to collect information about the quality of their datasets, which consists the following data quality elements:

- completeness: presence and absence of features, their attributes and relationship;
- logical consistency: degree of adherence to logical rules of data structure, attribution and relationships;
- positional accuracy: accuracy of the position of features;
- temporal accuracy: accuracy of the temporal attributes and temporal relationships of features;
- thematic accuracy: accuracy of quantitative attributes and the correctness of non-quantitative attributes and of the classifications of features and their relationships.

3.5 Standardisation of Street Addresses

A Working Group has been established under TC2/ SIRIM to coordinate the standardisation of street addresses in this country. This Working Group is being chaired by the Public Works Department with the cooperation of the Road Engineering Association of Malaysia (REAM) and other related agencies.

3.6 Standardisation of Geographic Names

In this digital era, there is a pressing need for geographic names to be standardised. The establishment of the National Committee on Geographical Names (NCGC) have been approved in 2002 to coordinate the geographical naming activities in Malaysia. This committee is being chaired by the Director General of Survey and Mapping with members from the state governments and other agencies. The responsibilities of the Committee include:

- Publishing a national Guidelines on Standardisation of Geographical Names
- Developing a National Geographical Names and Gazetteer Database
- Promoting the use of official names
- Coordinating input to international activities, including liaison with the United Nations Group of Experts on Geographical Names (UNGEGN), particularly at the regional level.

4. ISO DOCUMENTS ADOPTED AS MALAYSIAN STANDARD

The ISO documents, which have been adopted as Malaysian geographic information standards are as follows:

- MS ISO 19101:2003, Geographic Information - Reference Model

  Defines the framework for standardisation in the field of geographic information and sets forth the basic principles by which this standardisation takes place.

- MS ISO 19107:2003, Geographic Information - Spatial Schema

  Specifies conceptual schema for describing the spatial characteristics of geographic features, and a set of spatial operations consistent with these schema.

- MS ISO 19108:2003, Geographic Information - Temporal Schema

  Defines concepts for describing temporal characteristics of geographic information; Provides a basis for defining temporal feature attributes, feature operations, and feature associations and for defining the temporal aspects of metadata about geographic information.

- MS ISO 19111:2003, Geographic Information - Spatial Referencing by Coordinates

  Defines the conceptual schema for the description of spatial referencing by coordinates; Describes the minimum data required to define one, two or three-dimensional coordinate reference systems; Describes the information required to change coordinate values from one coordinate reference systems to another.

- MS ISO 19113:2003, Geographic Information - Quality Principles

  Establishes the principles for describing the quality of geographic data and specifies components for reporting quality information.

- MS ISO 19115:2003, Geographic Information - Metadata

  Defines the schema required for describing geographic information and services; Provides information about the identification, the extent, the quality, the spatial and temporal schema, spatial reference and distribution of digital geographic data.

5. CONCLUSION

The activities involving the development of geographic information standards in this country are being carried out in phases. The cooperation and support from all geo-spatial information producers and users are very much needed especially in providing comments during the development of standards for geographic information and also to implement the standards being developed.

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5. ISO 19114: 2003, Geographic Information - Quality Evaluation Procedures
6. ISO 19115:2003, Geographic Information - Metadata
7. MS 1759:2004 Geographic Information - Feature and Attribute Codes

Department of Survey and Mapping Malaysia
9 December 2005

Paper presented at the Geographic Information Standard Seminar, Kota Kinabalu, Sabah, 15 December 2005

Appendix I

GEOGRAPHIC INFORMATION/ GEOMATICS STANDARDS BEING DEVELOPED BY ISO/TC211

ISO 6709	Standard representation of latitude, longitude and altitude for geographic point locations
ISO 19101	Reference model
ISO /TS 19103	Conceptual schema language
ISO 19105	Conformance and testing
ISO 19106	Profiles
ISO 19107	Spatial schema
ISO 19108	Temporal schema
ISO 19109	Rules for application schema
ISO 19110	Methodology for feature cataloguing
ISO 19111	Spatial referencing by coordinates
ISO 19112	Spatial referencing by geographic identifiers
ISO 19113	Quality principles
ISO 19114	Quality evaluation procedures
ISO 19115	Metadata
ISO 19116	Positioning services
ISO 19117	Portrayal
ISO 19118	Encoding
ISO 19119	Services
ISO 19120	Functional standards
ISO 19121	Imagery and gridded data
ISO 19122	Qualification and certification of personnel
ISO 19123	Schema for coverage geometry and functions
ISO 19125-1	Simple feature access Part 1: Common architecture
ISO 19125-2	Simple feature access Part 2: SQL option
ISO/TS 19127	Geodetic codes and parameters
ISO 19128	Web map server
ISO 19130	Sensor and data models for imagery and gridded data
ISO 19131	Data product specifications
ISO 19132	Location based services possible standards
ISO 19133	Location based services tracking and navigation
ISO 19134	Multi-modal location based services for routing and navigation
ISO 19135	Procedures for item registration
ISO 19136	Geography Markup Language
ISO 19137	Profiles for spatial schema
ISO 19138	Data quality measures
ISO 19139	Metadata – Implementation specifications
ISO 19140	Technical amendments for harmonisation and enhancements
ISO 19141	Schema for moving features
ISO 19142	Web feature service
ISO 19143	Filter encoding

DEVELOPMENT OF MS 1759

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INTRODUCTION

The advent of computer and Information and Communication Technology (ICT) has brought about tremendous change as well as providing users with significant leverage. Capitalizing on the enormous potential of modern ICT, land related agencies in Malaysia have developed computerized systems to carry out more rapidly the processing of land related data. However, these standalone systems, exist as isolated pockets in an 'island of information system', failing thereby to use the vast potential offered by modern ICT, and making it difficult for users of land information to get access to them. In order to circumvent these issues, JUPEM together with other related agencies have taken the tasks in helping to develop and then implement a few geospatial data standards; and the important one is the MS 1759.

BACKGROUND AND HISTORY

The ISO Technical Committee 211 (ISO/TC 211) is responsible for the ISO geographical information series of standards. Since November 1996, Malaysia has progressed from being a mere observer member (O-member) to a full participating member (P-member) in ISO/TC211.This acceptance was conveyed to the Department of Standard Malaysia (DSM), representing the 'point of contact' for standard activities in Malaysia. DSM has subsequently nominated the Department of Survey and Mapping to represent Malaysia at all meetings of ISO/TC 211.

As a major producer and provider of digital spatial data in Malaysia, JUPEM initiated, created and now maintains the National Topographic Database (NTDB) and the Digital Cadastral Database (DCDB), and handles the dissemination of digital spatial information to end users. With the widespread proliferation of GIS and the role played by Malaysian Centre for Geospatial Data Infrastructure (MaCGDI), these databases, which form the basic building block of a GIS, are becoming increasingly significant. Consequently, standardisation of the data format and structure is vital to ensure portability, compatibility, as well as liberty in data exchange. It was thus logical for this department to assume the leading role in the development of GI standards and infrastructures in the country.

The first standard for digital geographic information was the Malaysian Standard Code of Practice for the Exchange of Digital Feature Coded Mapping Data also known as MS 1074. It was endorsed by The Standards and Research Institute of Malaysia (SIRIM) in April 1987. This standard governs the transfer format of digital map data that is not machine-dependent. The demand for GIS-compliant type of spatial data resulted in the need for more advanced standard that facilitates efficient transfer between spatial data suppliers and users, and the existing standard proved to be inadequate and outdated. In response to this, SIRIM established a working group (WG 12) in its IT standards committee to come up with the appropriate standards. As the chair of this working group, JUPEM plays a major role in its activities. WG 12, then, which had initially been given the task of reviewing the MS 1074 and developing one of the many niches of spatial data exchange standard, namely the feature/attribute dictionary leading to the development of the MS 1759:2004 Geographic Information – Features and Attributes Codes

WHAT IS MS 1759?

MS 1759 was developed by the Technical Committee on Geographic Information/Geomatics under the authority of the Information Technology, Telecommunication and Multimedia Industry Standards Committee based on the working draft prepared by the Technical Standards Committee of the Malaysian Geospatial Data Infrastructure (MyGDI). MS 1759 supersedes MS 1074:1992, Code of Practice for The Exchange of Digital Feature Coded Mapping Data and represents a major improvement over the latter. It contains some 2000 additional features that are organized into twelve main categories.

MS 1759 is intended to be used widely in mapping activities especially in the Geographic Information System (GIS) industry in Malaysia. It provides the method for encoding of geospatial data and provides the description of features and their associated attributes for the exchange of digital geographic information.

MS 1759 is intended for use by all businesses that produce, distribute or utilize geospatial data, either alone or in conjunction with non-geospatial data. These range from geographic information systems, decision support systems, data mining, data warehousing, to modelling and simulations. Application areas include but not limited to resource planning and management, automated mapping, geo-engineering, construction, communication, transportation and utilities.

The development of MS 1759 is based to the International Standard to ensure that it can be used internationally. The normative references which are indispensable for the application of this standard includes ISO/DIS 19104 -*Geographic Information – Terminology,* ISO/DIS 19110 - *Geographic Information – Methodology for Feature Cataloguing,* DIGEST Part 4 – Feature and Attribute Coding Catalogue (FACC), United Nation Convention on Laws of the Sea (1982), National Land Code (1965), Laws of Sarawak, Land Code and Sabah Land Ordinance (1930). For the purposes of this Malaysian Standard, the terms and definitions given in ISO/DIS 19104 are applied.

FEATURES AND ATTRIBUTES

MS 1759 describes the encoding of the world in terms of features and attributes. Features are real world objects while attributes are properties or characteristics associated with the objects. MS 1759 has not been developed to the requirements of any single application or level of resolution. This standard is also not meant to support any specific digital product.

There may be more than one ways to encode spatial objects. For example, the airport is listed as feature AB0010 – Aerodrome (A defined area on land or water intended to be used either wholly or in part for the arrival, departure and surface movement of aircrafts). The same object could also be coded as feature BD0010 – Institutional Building with attribute INU (Institutional Usage) with a coded value of 001 (Airport Terminal). The choice is entirely up to the user's own application and interpretation: to code only the terminal building or the entire aerodrome area.

If a feature does not reside within this standard, it is allowed for user-designated features and associated attributes. Otherwise, features and attributes shall be encoded using this standard.

- **Coding structure for Features**

All features are identified by unique six-character code. The first character can have an alphabetic value from A through Z which corresponds to the feature category. There are twelve major feature categories as shown in **Table 1**.

Table 1: Major Categories of Feature

CODE	CATEGORY	CODE	CATEGORY
A	Aeronautical	**S**	Soil
B	Built Environment	**T**	Transportation
D	Demarcation	**U**	Utility
G	Geology	**V**	Vegetation
H	Hydrography	**X**	Special Use (Dataset-specific)
R	Hypsography	**Z**	General

Each major category is further divided into subcategories. All the subcategories are identified by the second character of the six-digit code, once again represented by an alphabetic value from A through Z. The subcategories that have currently been defined for each major category are as shown in **Table 2**.

Table 2: Subcategory of Feature

A-Aeronautical		
AA - Air Space	AB - Aerodrome	
B-Built Environment		
BA - Residential	BD - Institutional	BG - Recreational
BB - Commercial	BE - Educational	BH - Cemetery
BC - Industrial	BF - Religious	BJ - Built-up
D-Demarcation		
DA - Topographic	DB - Maritime	DC - Cadastral
G-Geology		
GA - Geolithology	GD - Mining	GG - Geoscience
GB - Mineral	GE - Exploration	
GC - Fossils	GF - Geological Features	
H-Hydrography		
HA - Coastal Hydrography	HE - Navigation Aids	HJ - River Structure
HB - Shoreline Structures	HF - Danger and Hazard	HK - Offshore
HC - Fishing Facilities	HG - Depth Information	HL - Miscellaneous
HD - Ports and Harbours	HH - Inland Water	
R-Hypsography		
RA - Relief Portrayal		
S-Soil		
SA - Histosols	SE - Vertisols	SJ - Inceptisols
SB - Spodosols	SF - Ultisols	SK – Entisols
SC - Andisols	SG - Mollisols	
SD - Oxisols	SH - Alfisols	
T-Transportation		
TA - Land Transportation	TB - Water Transportation	
U-Utility		
UA - Electricity	UD - Oil and Gas	UG - Waste Management
UB - Telecommunication	UE - Broadcasting	UH - Meteorological
UC - Water Supply	UF - Sewerage	
V-Vegetation		
VA - Cropland (Perennials)	VC - Cropland (Cash-Crops)	VE – Natural Vegetation (Wetland)
VB - Cropland (Annuals)	VD - Natural Vegetation (Dryland)	VF – Natural Vegetation (Miscellaneous)
X-Special Use (Dataset specific)		
XA - Terrain Analysis Dataset	XB - Meteorological Dataset	
Z-General		
ZA - Control Points		

The third, fourth, fifth and sixth characters of the six-character feature code are a numeric value from 0000 through 9999. This numeric value represents feature number within a particular subcategory. However, the block of feature code values from 8000 through 8999 has been reserved for special usage, e.g. usage within a particular agency or a group of users. A few sample feature codes are as shown in **Table 3**.

Table 3: Sample Feature Codes

Feature Code	*Feature Name*	*Description:*
TA0060	Road	An established surface on the right of way in areas meant for exclusive use of vehicles
TA0080	Slip Road	A short one-way road at junction connecting adjacent road to ease traffic flow
TA0090	Road Junction	A point where two or more roads cross or meet
BJ0090	Power Station Complex	A power station including its supporting structures and facilities
DA0030	State Boundary	A line defining the limit of a state or federal territory
GA2000	Sedimentary Rock	Rocks resulting from the consolidation of loose sediments.

- **Coding structure for Attributes**

Attributes are used to describe characteristics of a feature. Each attribute is described by using attribute codes to represent the category of its characteristics. Each attribute is assigned with a unique three character alphanumeric code. For example “Parking Area Type” has a code “PAT” and the attribute “Pump House Usage” has the code “PHU” and etc. Attributes also provide information as to the units, formats, ranges, increments and maximum text characters typically associated with each actual value attribute.

Each attribute code should not be duplicated. For example, the attribute “Power Line Characteristics” has the code “PLC” while the attribute “Power Line Category” has the code “PLA” (not “PLC” to avoid duplication in the use of code). An attribute can be used by any feature, but only meaningful attributes are chosen for a particular feature. A list of possible attributes for each feature has been provided for the convenience of users.

Attributes are divided into two types of attribute values: Actual and Coded. Actual values are typically real measurements like Depth, Area Measured, Street Name, Post Code and etc. in numerals or text string. Coded values represent either nominal, ordinal, interval or ratio scale, and may range from 0 to 999. Each value has an associated definition.

DOCUMENTING NEW FEATURES AND ATTRIBUTES

MS 1759 can be modified and updated in response to dynamism of the technology and evolving requirements. If MS 1759 does not contain the required features, the standard allow for amendments to incorporate extensions and additions. Any proposed changes to MS 1759 are coordinated by the TC2 SIRIM and must be based on the rules stipulated for documenting new features and attributes. In addition, the proposer should seek inter-organisation cooperation and coordination in the development of new feature and attribute. All extensions and additions shall follow these rules:

a) Feature and attribute names should be precise and unambiguous;
b) Attribute values should be self-describing;
c) A feature and attribute should not have the same name;
d) A feature or attribute can have multiple names but only one definition;
e) A feature or attribute name should not be used in the description of the feature or attributes;
f) A feature name or definition should not specify if the feature is an area, a point or line feature;
g) A feature should be relatively permanent;
h) A feature should not be duplicated between categories;
i) All attribute values are positive unless otherwise stated;

j) A boundary is just a spatial object that can be considered as a line feature and not a perimeter or solid surface of an area or spatial feature; and
k) The systematic structure of the coding schema should be permanent.

ACTIVITIES RELATED TO THE DEVELOPMENT OF MS 1759

The development of MS 1759 involved various activities and processes to fulfil all requirements from agencies which are involved in GIS field, especially the needs of agencies which have participated in National Infrastructure for Land Information System (NaLIS). Hence participation and contribution of ideas from the related agencies are of vital importance to ensure that MS 1759 will benefit all GIS users. Activities related to the development of MS 1759 are as follows:

- **Research on Existing Feature Coding**

MaCGDI together with related parties have carried out a research and analysis with emphasis on geographic data GIS related activities in Malaysia. The finding shows that various type and format of features and attributes have been used by various agencies. In some cases, there is also an agency which only uses feature names without associate codes. Hence from this analysis, a standard format for feature coding and description has been proposed.

- **Proposal of Description and Coding Structure**

The standard format for feature coding structure has been identified on the basis of the existing feature codes and in compliance with GIS industry in Malaysia. Twelve major feature categories have been decided to replace the existing eight categories of MS 1074 while an attribute shall be represented by three characters of alphanumeric code, the value of which is further divided into two types : Actual and Coded.

- **Verifying Description and Data Structure**

The feature description and organisation of MS 1759 have been discussed and presented in various related workshops and MaCGDI Technical Committee series of meetings. The workshops and meetings have resulted in a major improvement over MS 1074 with the incorporation of some 2000 additional features; and more systematic categorisation of features.

- **Development of MS 1759**

The first and second drafts of MS 1759 were tabled to the TC2 SIRIM committee in January and February 2003 respectively. Comments and suggestions presented during both meetings were incorporated into MS 1759 draft. Eventually MS 1759 was published and reserved for accepting public comments during the period from 1st January 2004 to 31st March 2004. After taking into account of all comments, MS 1759 received the all-important SIRIM's accreditation in July 2005.

CONCLUSION

As Malaysia brace itself to leapfrog into the Information Age with the implementation of the world class Multimedia Super Corridor project, it is imminent and inevitable that the used of ICT and GIS will increase at an unprecedented rate. Consequently, the demand for GIS-compliant spatial data is expected to increase accordingly also. That being so, it is of vital importance that digital geospatial data produced by JUPEM and any other supplier, for that matter should conform to a national standard.

LAPORAN TAKLIMAT KESELAMATAN DAN PENGENDALIAN DATA GEOSPATIAL DAN BENGKEL PENENTUAN HARGA DATA GEOSPATIAL

HOTEL NEW PACIFIC, KOTA BHARU, KELANTAN
6 DAN 7 DISEMBER 2005

Oleh
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Selaras dengan perkembangan bidang teknologi yang pesat dimana melibatkan penggunaan data-data samada dalam bentuk tekstual, grafik dan data geospatial maka pengetahuan tentang keselamatan data-data khasnya data geospatial perlu diterapkan terutama di kalangan pegawai-pegawai kerajaan bagi menjaga kesahihan dan kerahsiaan data tersebut supaya ianya tidak didedahkan kepada pihak yang tidak sepatut menerimanya. Sehubungan dengan itu, Bengkel Taklimat Keselamatan dan Pengendalian Data Geospatial diadakan bertujuan untuk mewujudkan kesedaran terhadap isu-isu keselamatan dan kerahsiaan data geospatial di kalangan pembekal dan pengguna data geospatial

Manakala Bengkel Penentuan Harga Data Geospatial pula bertujuan untuk memberikan panduan kepada jabatan/agensi dalam menentukan harga data geospatial di jabatan/agensi masing-masing yang masih belum mempunyai kadar harga berdasarkan kelulusan mana-mana pihak berkuasa. Pada masa ini, penjualan data geospatial oleh agensi-agensi melalui Infrastruktur Data Geospatial Negara (MyGDI) tidak dapat direalisasikan dengan sepenuhnya disebabkan kebanyakan agensi pembekal data (APD) tidak mempunyai kadar harga bagi produk-produk mereka.

Keseluruhannya, Taklimat Keselamatan dan Pengendalian Data Geospatial dan Bengkel Penentuan Harga Data Geospatial telah berjalan lancar dan berjaya diadakan seperti yang dirancangkan. Taklimat keselamatan telah memberikan pendedahan pengetahuan kepada peserta berkaitan aspek keselamatan data yang kurang diberi penekanan dalam kerja seharian disebabkan kurangnya pengetahuan tersebut.

Semua peserta walaupun terdiri daripada pelbagai jabatan / agensi, telah memberikan komitmen dalam kumpulan bengkel masing-masing sehingga dapat menghasilkan harga data bagi produk keluaran.

Tindakan susulan ialah supaya hasil daripada bengkel ini dihantar kepada jabatan / agensi berkaitan supaya boleh dijadikan panduan dalam proses pengiraan harga data geospatial.

Antara urus setia dan peserta-peserta bengkel yang hadir

Suasana di dalam dewan semasa bengkel berlangsung. Kelihatan para peserta begitu berminat dan memberi komitmen yang tinggi setiap kali sesi pembentangan dijalankan

Sesi penyampaian sijil kepada peserta-peserta bengkel

AWARENESS COURSE ON NATIONAL SPATIAL DATA INFRASTRUCTURE SURVEY TRAINING INSTITUTE, HYDERABAD, INDIA

12th TO 28th OCTOBER 2005

By
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INTRODUCTION

Geospatial data, information, and technologies are becoming more important and more common tools throughout the world because of their capacity to improve government and private sector decision making. Geospatial information is developed, used, maintained and shared in a range of application areas, including: transportation, environment, natural resources, agriculture, telecommunications, mapping, health, emergency services, research, and national security. Sharing geospatial data in such applications helps improve the management of public infrastructures and natural resources and produces numerous other benefits.

Several agencies both in public and private domain collect and maintain enormous amount of spatial data in their day to day activities. However the information on availability of data is not available to the common users, thereby depriving the utility of this precious information at the right place at the required time. The National Informatics Policies envisages to ensure that spatial data generated by various agencies, are made available to the common man for development needs. Accordingly, the National Spatial Data Infrastructure (NSDI) has been established with the main objective to act as a coordinating body to provide information on availability of spatial data collected and maintained by Government bodies, Public enterprises, NGOs and individuals to the user community. Hence it is essential that awareness is created among the stake holders on the role and functioning of NSDI.

ROLE OF PERMANENT COMMITTEE ON GIS INFRASTRUCTURE FOR ASIA AND THE PACIFIC (PCGIAP)

PCGIAP is an autonomous body under the United Nations Regional Cartographic Conference for Asia and the Pacific (UNRCC-AP) to propagate the aims and objectives of creating knowledge on Spatial Data Infrastructure among the member countries in the Asia-Pacific Region. Considering the progress made by India, in developing NSDI, PCGIAP has approached to conduct this course. Decision was taken by the Executive Committee of PCGIAP at Chengdu, China in September 2004, to conduct a two weeks course in India on awareness on NSDI for benefit of member countries. As a follow up action on the decision taken by PCGIAP, a course is required to be conducted in India. The Chairman of the Committee being Surveyor General of India, Survey of India has been entrusted the responsibility of conducting this course. Survey Training Institute at Hyderabad has the expertise and has been organizing short duration courses on NSDI since the inception of NSDI for participation by various stake holders. Hence it is decided to conduct a short duration course in October 2005 in Survey Training Institute at Hyderabad.

PARTICIPANTS

The participant in the course is limited to sponsored candidates from member countries in Asia Pacific region and one officer from different national organizations in India who are stakeholders in NSDI.

	Name	Country
1	D.L.B.L. Kumar Asst. Director, Survey & Land Records, Vizianagaram Dist., Andhra Pradesh	India
2	Ch. Venkateswara Rao Superintending Surveyor, National Geospatial Data Centre	India
3	P.K. Sinha Geologist, Geodata Div., Southern Region, Geological Survey of India	India
4	Hyunhee Ju Korean National Geographic Information Institute	South Korea
5	Romano Reo Land Management Division	Kiribati
6	Won Kuk Lee Korean National Geographic Information Institute	South Korea
7	Soubanh National Geographic Department	Laos
8	Mohamad Nizar Damis Malaysian Centre for Geospatial Data Infrastructure (MaCGDI)	Malaysia
9	Altansetseg Purevsuren Administration of Land Affairs, Geodesy and Cartography (ALAGaC)	Mongolia
10	Mereoni Buatoka Fiji Land Information System Support Centre, Department of Land and Surveys	Fiji
11	Victor Khoo Hock Soon Singapore Land Authority	Singapore
12	Dr. Y.V.S. Murthy Head, Geoinformatics Division, RS & GIS Application Area, National Remote Sensing Agency	India
13	S. Ramamurthy Geologist, Project Indigeo, GSI Training Institute	India
14	Suffian Mohd. Yusoff Malaysian Centre for Geospatial Data Infrastructure (MaCGDI)	Malaysia
15	Ganesh Prasad Bhatta Survey Officer, Survey Department, Ministry of Land Reform and Management	Nepal
16	S. Sivanantharajah Supt. Of Surveys, Survey Department	Sri Lanka
17	V.V.R.M Narayana Rao Scientist, AP State Remote Sensing Application Cantre	India
18	K.L.N Sastry Scientist, Space Application Centre (SAC-ISRO)	India

Except for the travel course, the course was conducted at the expense of the State as a gesture of goodwill to the community of PCGIAP.

COURSE CONTENTS AND DURATION

The course was conducted from 12^{th} to 28^{th} October 2005 i.e. 13 working days plus 4 weekend days. Course content was divided into three modules, i.e. theory, practical exercises/case study/hands on and field visits.

	Topics	Hours
A	**THEORY**	
1	Arrival, Inauguration and Introduction	8
2	SDI – Background, Concept, Nature, Overview	4
3	Global and Regional SDI Initiatives	8
4	National SDI Initiatives	8
5	State and Local SDI Initiatives	4
6	SDI – Vision, Mission, Design and Strategy	4
7	SDI – Partnership Approaches and Applications for Decision Support	6
8	Marine SDI	4
9	Financing SDI and its challenges	4
10	SDI Development – Technical Aspects	4
11	SDI – Information processing models	6
12	SDI – Capacity Building, Policy and Privacy Issues	4
13	SDI – Land Administration	4
14	SDI – Future Directions/Feedback	4
		72 hrs
B	**PRACTICAL EXERCISE/CASE STUDY/HANDS ON**	
1	National, State and Local Perspective	8
2	Global/Regional/National/State/Land (Different Groups)	24
		32 hrs
C	**FIELD VISITS**	
1	Local visits to facilities of NRSA and Centre for E-Governance	
2	Visit to Survey Camp at Nagarjunasagar and other spatial data collection centres	

Field visit to Survey Camp at Ibrahimpatanam

Inauguration ceremony on 14th October 2005
at Survey Training Institute, Uppal, Hyderabad

Lectures and training conducted during the course

KALENDAR GIS 2006

TARIKH	TAJUK	LOKASI	PENGANJUR	TALIAN PERTANYAAN
23 Januari 2006	Kursus Penyebaran dan Keselamatan Data Geospatial (Sesi 1)	INSTUN Behrang, Perak	MaCGDI	Cik Zafirah Bt. Mohd. Mansor Tel : +03 88861157 Fax : + 603 88894851 E-mail : zafirah@macgdi.gov.my
13-16 Februari 2006	Workshop: Towards 3D Positioning: MyRTKnet and MyGEOID	Cinta Sayang Golf and Country Club Resort, Sungai Petani	ISM, UTM, JUPEM, LJT	Dr. Azhari bin Mohamed/ Miss Rajeswary Tel : +603 79551773/ 79569728 Fax : +603 79550253 E-mail : lsdiv@ism.org.my
9-10 Mac 2006	The Sixth International Conference on ASIA GIS (ASIA GIS 2006)	UTM Skudai, Johor	Asia Geographic Information System Association (AGISA)	Prof. Dr. Ahris Yaakup (b-haris@utm.my) Mrs. Haibenarisal Bajuri (asia_gis2006@yahoo.com) Tel : (+607) 5537360/ (+607) 5516584 Fax : (+607) 5537360/ (+607) 5566155
Mac 2006	Mesyuarat Jawatankuasa Pemetaan dan Data Spatial Negara (JPDSN) ke 57	Akan ditentukan	Bahagian Pemetaan, JUPEM	Encik Teng Chee Boo Tel : +603 26924034 Fax : +603 26970140 E-mail : cbteng@jupem.gov.my
Mac 2006	Persidangan/ Konvensyen NGIS 2006	PWTC, Kuala Lumpur	MaCGDI	Encik Abdul Manan bin Abdullah Tel : +603 88861209 Fax : +603 88894851 E-mail : manan@macgdi.gov.my
Mac 2006	'*Awareness Campaign*' Untuk Pengurusan Atasan – Luncheon Talk, Seminar, Courtesy Call, "Ad-Hoc".- Agensi Persekutuan dan Negeri	Akan ditentukan	MaCGDI	Encik Abdul Manan bin Abdullah Tel : +603 88861209 Fax : +603 88894851 E-mail : manan@macgdi.gov.my
April 2006	Seminar Sehari MyGDI di Negeri Selangor	Akan ditentukan	MaCGDI	Encik Abdul Manan bin Abdullah Tel : +603 88861209 Fax : +603 88894851 E-mail : manan@macgdi.gov.my
April 2006	Bengkel dan Latihan GIS	INSTUN dan negeri-negeri yang terlibat	MaCGDI	Tn. Hj. Hashim bin Hamzah Tel: +603 88861206 Fax : +603 88894851 E-mail : hashim@macgdi.gov.my
Mei 2006	Seminar Sehari MyGDI, di Negeri Sarawak	Akan ditentukan	MaCGDI	Encik Abdul Manan bin Abdullah Tel : +603 88861209 Fax : +603 88894851 E-mail : manan@macgdi.gov.my
Jun 2006	Mesyuarat Jawatankuasa Teknikal Framework & Clearinghouse MyGDI Bil. 1 tahun 2006	Akan ditentukan	MaCGDI	Encik Rahim bin Hj. Mohammad Saleh Tel : +603 88861250 Fax : +603 88894851 E-mail : rahim@macgdi.gov.my

TARIKH	TAJUK	LOKASI	PENGANJUR	TALIAN PERTANYAAN
Jun 2006	Program Pameran bersama Pusat Sains Negara (PSN) di Sarawak	Akan ditentukan	MaCGDI	Encik Abdul Manan bin Abdullah Tel : +603 88861209 Fax : +603 88894851 E-mail : manan@macgdi.gov.my
Julai 2006	Taklimat Keselamatan dan Pengendalian Data Geospatial	Akan ditentukan	MaCGDI	Tn. Hj. Mazlan bin Ashaari Tel : +603 88861253 Fax : +603 88894851 E-mail : mazlan@macgdi.gov.my
Julai 2006	Bengkel Penentuan Harga Data Geospatial	Akan ditentukan	MaCGDI	Tn. Hj. Mazlan bin Ashaari Tel : +603 88861253 Fax : +603 88894851 E-mail : mazlan@macgdi.gov.my
Julai/Ogos 2006	Persidangan Pemetaan Kebangsaan dan Pelancaran Geo-Portal JUPEM	Akan ditentukan	JUPEM	Encik Teng Chee Boo Tel : +603 26924034 Fax : +603 26970140 E-mail : cbteng@jupem.gov.my
Julai 2006	Program Pameran bersama Pusat Sains Negara (PSN) di Pahang	Akan ditentukan	MaCGDI	Encik Abdul Manan bin Abdullah Tel : +603 88861209 Fax : +603 88894851 E-mail : manan@macgdi.gov.my
7-8 Ogos 2006	International Workshop on 3D Geoinformation 2006 (3DGeoInfo'06)	Kuala Lumpur Convention Centre, Malaysia	UTM	Dr. Alias Abdul Rahman Dept. of Geoinformatics Universiti Teknologi Malaysia Tel : +60 (0) 7 5530563 Fax : +60 (0) 7 5566163 E-mail : alias@fksg.utm.my or 3dgeoinfo06@utm.my
Ogos 2006	Program Pameran bersama Pusat Sains Negara (PSN) di Perak	Akan ditentukan	MaCGDI	Encik Abdul Manan bin Abdullah Tel : +603 88861209 Fax : +603 88894851 E-mail : manan@macgdi.gov.my
18-20 September 2006	The International Symposium and Exhibition On Geoinformation (ISG 2006)	Subang, Sheraton Hotel	ISM	Encik Abdul Hadi bin Abdul Samad Tel : +603 79551773/ 79569728 Fax : +603 79550253 E-mail : Isdiv@ism.org.my
September 2006	Program Pameran Bersama Pusat Sains Negara(PSN) di Kedah	Akan ditentukan	MaCGDI	Encik Abdul Manan bin Abdullah Tel : +603 88861209 Fax : +603 88894851 E-mail : manan@macgdi.gov.my
September 2006	Mesyuarat Penasihat Teknikal Pembangunan dan Perlaksanaan MyGDI	Akan ditentukan	MaCGDI	Tn. Hj. Mazlan bin Ashaari Tel : +603 88861253 Fax : +603 88894851 E-mail : mazlan@macgdi.gov.my

TARIKH	TAJUK	LOKASI	PENGANJUR	TALIAN PERTANYAAN
6 November 2006	Penyebaran dan Keselamatan Data Geospatial (Sesi 2)	INSTUN, Behrang, Perak	MaCGDI	Cik Zafirah Bt. Mohd. Mansor Tel : +03 88861157 Fax : + 603 88894851 E-mail : zafirah@macgdi.gov.my
13 November 2005	Penyebaran dan Keselamatan Data Geospatial (Sesi 3)	INSTUN, Behrang, Perak	MaCGDI	Cik Zafirah Bt. Mohd. Mansor Tel : +03 88861157 Fax : + 603 88894851 E-mail : zafirah@macgdi.gov.my
20-21 November 2006	Sectoral Based Workshop (Session 1)	INSTUN, Behrang, Perak	MaCGDI	Cik Zafirah Bt. Mohd. Mansor Tel : +03 88861157 Fax : + 603 88894851 E-mail : zafirah@macgdi.gov.my
November 2006	Program GIS Week bersama UTM Skudai	UTM Skudai, Johor	MaCGDI dan UTM	Encik Abdul Manan bin Abdullah Tel : +603 888611209 Fax : +603 88894851 E-mail : manan@macgdi.gov.my
18-20 Disember 2006	Sectoral Based Workshop (Session 2)	INSTUN, Behrang, Perak	MaCGDI	Cik Zafirah Bt. Mohd. Mansor Tel : +603 88861157 Fax : + 603 88894851 E-mail : zafirah@macgdi.gov.my

SUMBANGAN ARTIKEL/ CALL FOR PAPER

Buletin GIS diterbitkan dua (2) kali setahun oleh Jawatankuasa Pemetaan dan Data Spatial Negara. Sidang Pengarang amat mengalu-alukan sumbangan sama ada berbentuk artikel atau laporan bergamba mengenai perkembangan Sistem Maklumat Geografi di Agensi Kerajaan, Badan Berkanun dan Institusi Pengajian Tinggi.

Panduan Untuk Penulis

1. Manuskrip boleh ditulis dalam Bahasa Malaysia atau Bahasa Inggeris

2. Setiap artikel yang mempunyai abstrak mestilah condong *(italic)*

3. Format manuskrip adalah seperti berikut:

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Saiz huruf artikel	: 10
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Langkau	: *Single*
Margin	: Atas, bawah, kiri dan kanan= 2.5cm
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5. Segala pertanyaan dan sumbangan bolehlah dikemukakan kepada:

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