VOL. 11, NO. 4, FEBRUARY 2016 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

GIS TECHNOLOGY AS A TOOLS TO PREDICT LANDSLIDE

Mohd. Zulkifli Mohd. Yunus and Fatimah Shafinaz Ahmad
Faculty of Civil Engineering, Universiti Teknologi Malaysia, UTM Skudai, Johor Bahru, Malaysia
E-Mail: mzul@utm.my

ABSTRACT

This research had been carried out in Paya Terubung, Penang, Malaysia. The objective of the study is to determine and classify potential area for landslide, produce map for potential area and build a user interface. The research aims to monitor landslide using Geographical Information System (GIS). There are eight factors that contribute to landslide such as rainfall, river flow, soil type, slope, underground water, land use, erosion and mineral. A rating system with marks is given for each factor. The methodology of the study begin from data collection, transferring and processing, developing database, spatial analysis and finally result and discussion. The verification method is performed by a comparison of existing landslide. The validation result shows satisfactory between the susceptibility map and existing landslide location. Landslide Information System has been developing for user to access into the system. The proposed system will improve monitoring process and safety potential areas that involve landslide.

Keywords: geographic information system, civil engineering, landslide prediction.

INTRODUCTION

The revolution of information has brought comprehensive and dramatic changes to the way of living, working and viewing the world. One of the most talk-about topics is Geographic Information System (GIS), which is a very sophisticated system that could connect Geographic data to attribute data. Since computer and Information Technology is the trend of today's lifestyle, it is time that GIS replaces all the previous procedures that are still being performed conventionally. Thus, as the government effort to implement Multimedia Super Corridor and electronic government, it is found that the utilisation of GIS is vital.

What is GIS? GIS is used in cadastre, land-use planning, demolition planning, emergency-response planning and management, navigation and routing, delivery of goods and services, etc. (ESRI, 2008)

In context, the theory of GIS could be defined as " A system which contains tools, software and procedures that are designed to support input, management, manipulation, analysis, modeling and screening of geographical data in order to solve complex planning, controlling, monitoring and management problems" (AGI, 1994).

Why GIS is important and needed? The technology of GIS is the basis, which is needed to solve problems that have become defiance and obstacles to all the discipline that use geographical data. GIS technology integrates spatial data with information within one system. Map and information come in form of digital data that enables users to manipulate and screen geographical knowledge in a new creative way.

The fast increase of the population and the rapid development of the economy have caused the number of engineering projects at hills area to grow. Hill areas are exposed to the threat of landslide, which is normally caused by the instability of the slope especially after raining. As a result, method to stabilize the slope at hills areas is very important. Among the examples of lost connected with the incident of landslide are:

- December 1st, 1993 – One of the three blocks of Highland Tower Condominium in Taman Hill View, collapsed. This incident is caused by the shift of the underground water's direction. As a consequence, the structure of the soil of the condominium site moved. 48 were died and more than 1000 of its residents to evacuate their home (Berita Harian, 1999).
- November 28th, 1998 – Landslide occurred at the housing area of Sun Moon City in Paya Terubong, Penang. The landslide which contained block of bricks had damage the public vehicles parked nearby. This incident has it source from the movement of the underground water due to heavy rain (The New Straits Times, 1998).
- November 20th, 2002 – eight families of Jeneral (B) Tan Sri Ismail Omar were died in tragedy after his bungalow cover with landslide. This happen at Taman Hillview, Ampang, Kuala Lumpur 300 meter from Highland Tower (Utusan Malaysia, 2002).
- 29 Dec 2012 - 88 residents of bungalows, shophouses and double-storey terrace houses in the Puncak Setiawangsa, Kuala Lumpur were ordered to move out because of soil movement. Resident Siti Mahfudzah Shahril, 34, said she was shocked at the sound of a siren and rushed out to see a landslide of about 50m high (The New Straits Times, 2012).

Due to these problems and incidents, the local authorities such as Ministry Of Housing and Local Government with the cooperation of Department of Environment, Department of Rural and Urban Development, Department Of Investigation On Ecology, Drainage and irrigation Department, Institut Kerjaraya Malaysia (IKRAM) have discussed on the suitable criteria in order to control the implementation of the development activities at hill areas.

Resulting from the discussion, a guideline on how to control housing development at hill areas have

been improved. One of the criteria, which have been highlighted, is to protect the natural topography of a construction project in order to ensure the stability and the structure of the soil at hill areas is protected.

PROBLEMS

Nowadays, the knowledge and realisation on the importance of studies in information on geology before a project is developed are always ignored. Not only the geological information are not being utilised during planning but the failure to understand the correct method in determining the suitability of the basis to a development project are also ignored (ESRI, 2008).

Areas, which have high potential and possibility for the occurrence of landslide, are not identified before they are developed for housing project. Normally, landslide could occur before, during and after the construction. This will definitely lead to heavy lost on the construction. Moreover, the loss of innocence live is even worst (Berita Harian, 1999).

The monitoring of the landslide areas will become difficult if the planning, management and implementation of a project is not carried out in a very effective method. In the era in which technology is developing in fast pace, the most fundamental asset is the information, which is the most recent, accurate and precise. Utility and infrastructure is the most important asset, which could produce valuable information for the local authorities involved in the development. It is time that the parties involved take positive steps to develop the efficiency of the data management and acquirement of information.

The utilisation of GIS is still lacking in engineering works especially in geotechnical engineering where the method of making decision on the analysis is still carried out using conventional method. This is due to the fact that most data on landslide is still kept in a form that could not be connected with geographical data. Apart from that, ordinary users could not comprehend data on landslide except the parties involved in incident of landslides.

OVERVIEW

The Objective of this study are to develop a database for study area in Penang, to determine and classify potential area for landslide, to produce a map for the potential area of landslide and to build a user interface to ensure that the information on the studied area could be achieved easily.

The scope of this research covers several aspects, for example to design and build spatial and attribute database for the studied area using ARC/INFO, to determine the area which have the possibility for the occurrence of landslide and to implement spatial analysis on the studied area using GIS software. The spatial analysis will be carried out using spatial data that containing in the database.

Propose of the research is to monitor the potential areas for landslide using the GIS software. There are many factors that should be considered in determining the area of landslide namely level of water, development of infrastructure, type of soil, utilised of land, natural occurrence and environmental factors. This study is carried out to enhance the ability of GIS software compared to the conventional method.

CASE STUDY

This case study is operated with five phases examples:

1. Phase of data collection
2. Phase of data transferring and processing.
3. Phase of developing database.
4. Phase of spatial analysis to studied area.
5. Result and discussion.
6. Conclusion

The gathering of data started with the Department of Rural And Urban Planning to obtain land use map for the research area. The map for soil type in the research area is obtained from the Agriculture Department, Butterworth. There are certain type of soil that can be found in Penang such as Rengam, Local Alluvium, Holyrood and others. Base map a taken from Centre for Geographical Information & Analysis (CGIA). All the spatial data in different scale are then overlay to base map for getting standard scale maps

All spatial data must be in the Autocad (DWG) format in order to make editing more easier to be performed. The scale for each data ought to be the same in order to enable the overlay process to perform spatial analysis later. Data in DWG format have to be changed into DXF format, which are readable by ARC/INFO software. These data then be exported to ARC/INFO software by layers, which were predetermined for analysis purposes.

PHASE OF DEVELOPING DATABASE

Data are the raw facts, which are processed to produce information. Database is a set of files, which related logically arranged to make one or more programs easily achievable. Database exists to eliminate data redundancy, incorporate data files and sharing data. Apart from that, it does reduce data management cost and increases the data effectiveness as well as coordinated the usage and data management. The existing spatial data will be integrated with the attribute data. There are two type of designing database which are conceptual design and logical design.

PHASE OF SPATIAL ANALYSIS

In this research, a rating system was developed to classify landslide occurrence. Marks were given to each eight parameter that contribute to landslide that are rainfall, river flow, soil type, slope, underground water, land use, erosion and mineral. Marks are given into three categories base on contribution to landslide which is 0 values for spatial data that very stable, 1 value for moderately stable and 2 value for the most unstable

VOL. 11, NO. 4, FEBRUARY 2016 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

spatial data. In this research, landslide classification is based on 4 categories that are 0 to 3 marks for low risk hazard, moderate (4 to 7), moderately high (8 to 12) and high potential are of landslide (13 to 16). Classification criteria are based on Table-1. Result of analysis are shown in Figure-1 and Figure-2.

Table-1. Overall marks in classification of landslide.

Category	High		Moderately High		Moderate		Low	
	Max	Min	Max	Min	Max	Min	Max	Min
Rainfall	2	2	2	1	1	1	1	0
River Flow	2	2	2	1	1	1	1	0
Soil Type	2	2	2	1	1	1	1	0
Slope	2	2	2	1	1	1	0	0
Underground Water	2	2	1	1	1	0	0	0
Land Use	2	1	1	1	1	0	0	0
Erosion	2	1	1	1	1	0	0	0
Mineral	2	1	1	1	0	0	0	0
Total	**16**	**13**	**12**	**8**	**7**	**4**	**3**	**0**

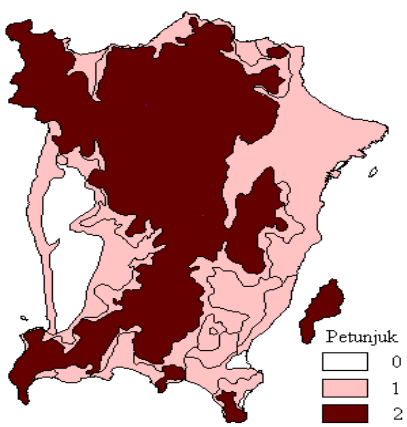

Figure-1. Soil type analysis result.

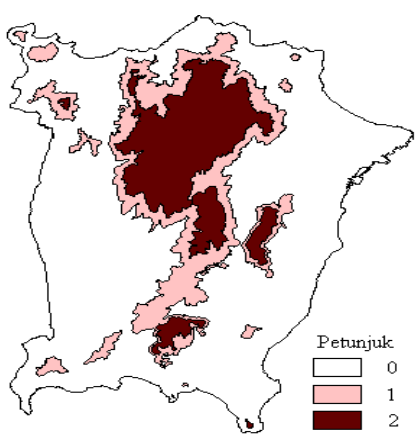

Figure-2. Slope analysis result.

Overlay is used in data integration and is a technical process, the result of which can be used in realistic forms of spatial analysis. Polygon overlay is a spatial operation in which a first thematic layer containing polygons is superimposed onto another to form a new thematic layer with new polygons. This technique may be likened to placing map overlays on top each other on a light table. Figure-3 shown after all parameters are overlay and dissolve process.

RESULTS AND DISCUSSION

The verification method is perform by comparison of existing landslide (in Sun Moon City, Paya Terubung, Penang) and 12 final result map. The validation results show satisfactory between the susceptibility map and existing landslide location. From the study that has been perform GIS proof that landslide prediction is accurate and exact (Figure-4).

User interface development process is used to make user achieve the database easily for the purpose of achieving valid, up-date and efficient information. The program language is Avenue, which already exist in the ArcView Software. Figure-5 is some example of interface in Landslide Information System.

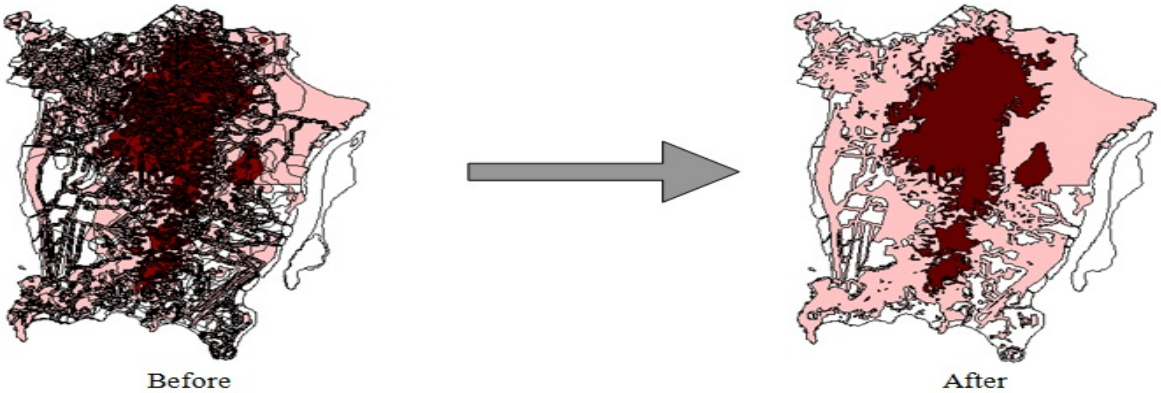

Figure-3. Before and after dissolve.

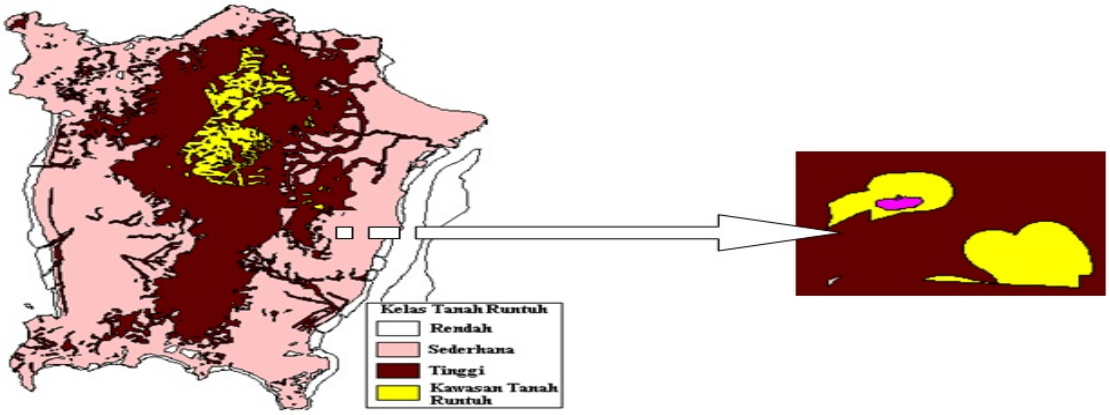

Figure-4. Landslide map in November.

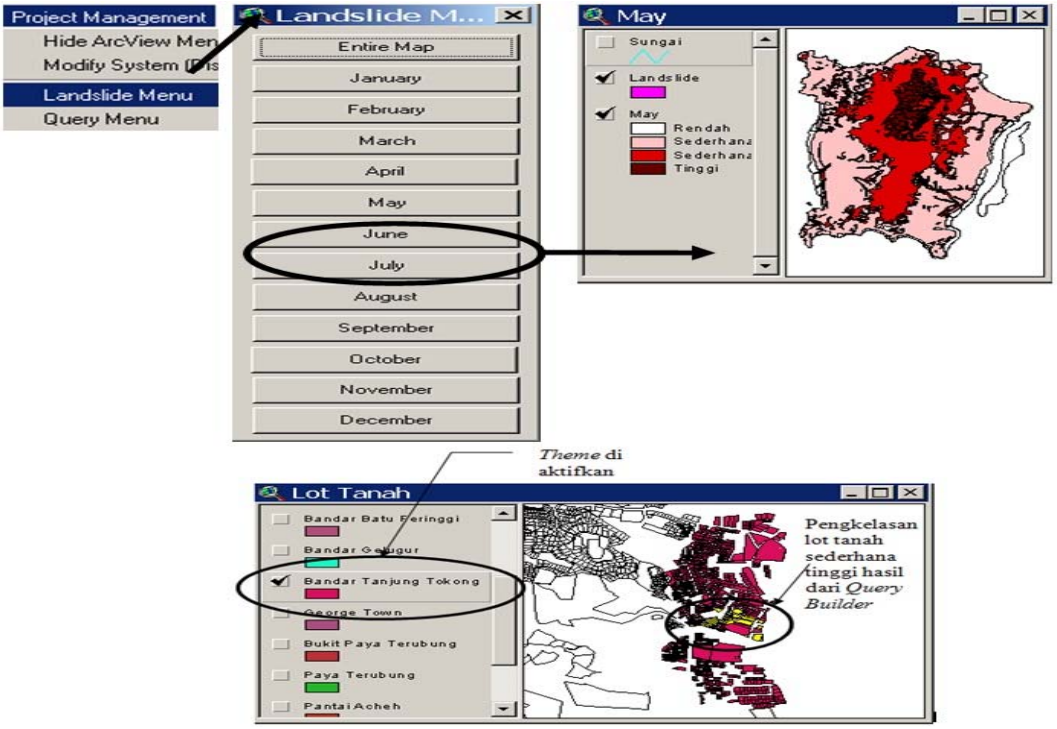

Figure-5. Landslide menu.

CONCLUSIONS

This research are successfully develop, based on the existing result. It will benefit and upgrade the monitoring of landslide incidents by the parties involved such as the civil engineering, rural and town planners, local authorities and also the other agencies involved. Its produce useful guidelines to the government and non-government sector in the techniques of determining potential areas of landslide using GIS. GIS usage is able to provide and contribute to cost-benefit effectively in the form of database and spatial data handling.

REFERENCES

[1] Association for Geographic Information (AGI) (1994). "Geographic Information and Geographic Information System Standards." CCTA the Goverment Centre for Information, Rosebery Court, St Andrews Business Park, Norwich, NR7 0HS.

[2] Berita Harian (1999). Pusat Awasi Projek Lereng Bukit.18 Mei 1999.

[3] Berita Harian (2001). Mayat Ibu, Anak Berpelukan. 9 Januari 2001.

[4] Enviromental System Research Institute Inc. (ESRI) (2008). "GIS Solution for Civil Engineering-The Modern Platform for Civil IT". ESRI Redland CA.

[5] Fatimah Shafinaz Ahmad and Mohd. Zulkifli B. Mohd. Yunus (2001) "Aplikasi Sistem Maklumat Geografi Dalam Pemilihan Tapak Laluan Lebuhraya.", paper for Seminar Perisian Kejuruteraan II, presented at UTM Johor Bahru, 15 July, 2001 – University.

[6] Fatimah Shafinaz Ahmad and Mohd. Zulkifli B. Mohd. Yunus (2002), "Application Of Geographical Information System In Landslide Investigation In Paya Terubung, Pulau Pinang.", paper for National Science Fellowship (NSF) Annual Seminar, presented at Vistana Hotel, Kuala Lumpur, 17-18 December 2002 – National.

[7] Foster, M. J. And Shand, P. J. (1990). The Association for Geographic Information Yearbook 1990. London: Taylor and Francis Inc.Gerrard, A. J. (1981). Soil and Landforms-An Integration of Geomorphology and Pedology. Department Of Geography, University Of Birmigham.

[8] Goodchild, M. F., and Kemp, K. K. (1990) "Introduction to GIS: Core Curriculum:" Berkeley, Calif.: National Center for Geographic Information and Analysis.

[9] Jabatan Perancang Bandar Dan Desa (1990), "Laporan Penyemakan Rancangan Struktur (Pengubahan) MPP 1990-2000": Pulau Pinang, Malaysia.

[10] Jabatan Perancang Bandar Dan Desa (1995), "Akta Perancangan Bandar Dan Desa (pindaan)": Akta A933, Malaysia.

[11] Jabatan Kerja Raya (JKR) (2000) Pemeriksaan Cerun Jabatan Kerja Raya Malaysia. Disediakan Oleh : Unit Senggara Pengurusan Cerun, Cawangan Jalan IP, JKR Malaysia, Kuala Lumpur.

[12] Kendall, K. E. and Kendall, J. E. (1999). System Analysis and Design. 4th ed. Upper Saddle River, N. J: Prentice Hall.

[13] Mohd Zulkifli Mohd. Yunus and Fatimah Shafinaz Ahmad Is GIS A Useful Tool For Landslide Investigation?, paper for The GEOTROPIKA 2001 Conference On Geotechnical Engineering, presented at Hilton Hotel Kuching Sarawak, 5-7 November, 2001 – International.

[14] Mohd. Zulkifli Mohd. Yunus and Fatimah Shafinaz Ahmad (2002), "GIS: Solutions For Spatial Problems In Civil Engineering", paper for CoGRAMM '02 National Conference On Computer Graphics And Multimedia, presented at Equatorial Hotel, Melaka, 7-9 October 2002 – National.

[15] Mohd. Zulkifli Mohd. Yunus, Fatimah Shafinaz Ahmad and Munzilah Bte Rohani (2002), "GIS for Civil Engineers: Application in Landslide Investigation" paper for International Symposium and Exhibition on Geoinformation 2002, Global Trends: Geoinformation for the New Economy, presented at Nikko Hotel, 22-24 October 2002 – International.

[16] Ong Wee Seck (1993). Map Report 7 – The Geology and Engineering Geology of Pulau Pinang. Geological Survey Of Malaysia, Published by and obtainable from :

[17] Penyiasatan Kajibumi Malaysia and Makmal Penyiasatan Kajibumi.Roslan ZainalAbidin (1995). "Tanah Runtuh – Ciri-ciri, Ramalan Dan Teknologi Kawalan", Isu-isu Semasa Sains Dan Teknologi 1995, Petaling Jaya, Selangor, Malaysia.

[18] The New Strait Times (1998). "On the Edge of Disaster." 28 November 1998.

[19] The New Strait Times (2012). Setiawangsa Landslide Tragedy 29 November 2012.

[20] Utusan Malaysia (2002). Banglo Jeneral Ismail ranap – Lapan termasuk isteri, anak, menantu, cucu terkorban menjelang subuh di Taman Hillview. 20 November 2002.

[21] Wang Shu-Quiang dan D. J. Unwin, (1992), "Modelling Landslide Distribution on Loess Soils in China: An Investigation", Department Of Geography, University Of Leicester, England.