



UNIVERSITI PUTRA MALAYSIA

***EMPOWERING COMMUNITY FOR SLOPE INFORMATION
CROWD-SOURCING AND MONITORING BASED ON WEB GIS***

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By

FARAH HIJANAH BINTI EDDIE

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfilment of the Requirements for the Degree of Master of Science**

January 2018

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

EMPOWERING COMMUNITY FOR SLOPE INFORMATION CROWD-SOURCING AND MONITORING BASED ON WEB GIS

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January 2018

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Landslide tragedies occurred in Taman Bukit Mewah, Bukit Antarabangsa on 6th December 2008. This traumatised the local residents and helped trigger awareness on supervision and monitoring of early signs of landslide in the residential area. This study's goal is to facilitate local residents in gaining local knowledge and preparations for possibilities of landslides. This study aims to integrate the GIS web-based technologies with GIS community involvement in the use of the GIS portal. GIS community is a social unit of people living in the same area and at the same time, sharing spatial information among them. The GIS website display online map for Bukit Antarabangsa's area, to facilitate users, especially the local residents to search, view and learn about the area, including the map and attributes information about slopes, hills, residential lots, roads and water drainage. In addition, map can be printed directly through GIS website. The daily rainfall information from Department of Irrigation and Drainage is integrated in the system; the total rainfall for the area is displayed. This is important as rainfall is one of the factors driving to landslide. The GIS website has e-form for users to report incidents or problems that occur; clogged drains, fallen trees and landslides or landslide with function to upload and download the pictures of the incidents. Reports then will be screened in advance and if the reports relate to landslides, it will be forwarded directly to local authorities. User requirement analysis was conducted using interview sessions, and the respondents were from committee member of the local resident communities and local authorities. From the analysis, it shows the GIS application in the community is important to display and distribute maps with attribute information. GIS web portal user-friendliness and effectiveness evaluation have been conducted with 20 participants. From the feedback, the web portal are deemed suitable for community engagement in landslide information crowd-sourcing and monitoring. GIS portal with GIS community based information is relevant in empowering GIS among local residents as it will increase efficiency of the residents in monitoring their surroundings and in responding to potential disaster.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

MEMPERKASA KOMUNITI UNTUK MAKLUMAT SUMBER CERUN DAN PEMANTAUAN BERDASARKAN WEB GIS

Oleh

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Tragedi tanah runtuh yang pernah berlaku di Taman Bukit Utama, Bukit Antarabangsa pada 6 Disember 2008 yang lalu menjadikan penduduk setempat trauma dan menjadi lebih prihatin terhadap perubahan yang berlaku di sekeliling kawasan kediaman mereka. Ekoran daripada kejadian tersebut, pelbagai kajian telah dijalankan untuk mengkaji tentang puncapunca berlakunya tanah runtuh. Wujudnya keprihatinan dan kesedaran penduduk tentang pengawasan dan pemantauan tanda-tanda awal berlakunya tanah runtuh ini mencetus idea kajian ini dijalankan untuk membantu penduduk setempat lebih berpengetahuan dan bersedia sedia tentang kemungkinan yang bakal berlaku. Kajian ini bertujuan untuk mengintegrasikan antara teknologi laman web GIS dengan penglibatan komuniti GIS dalam penggunaan laman web GIS tersebut. Komuniti GIS merupakan sekumpulan unit sosial yang tinggal dalam kawasan yang sama dan pada masa yang sama berkongsi maklumat spatial sesama mereka. Laman web GIS ini digunakan untuk memaparkan peta secara atas talian bagi kawasan Bukit Antarabangsa. Paparan peta tersebut membantu pengguna khususnya penduduk tersebut untuk membuat carian bagi sesuatu kawasan yang diinginkan. Selain itu, pengguna juga dapat melihat dan mengetahui tentang kawasan yang mereka diami secara keseluruhan seperti cerun, kawasan bukit, lot-lot kediaman, jalan raya dan saliran air seperti sungai. Melalui aplikasi ini, pengguna boleh mengetahui tentang maklumat atribut bagi setiap layer yang berkaitan seperti nama cerun, nama jalan, maklumat lot perumahan dan nama taman. Dalam laman web tersebut, e-borang disediakan untuk pengguna melaporkan kejadian atau masalah yang berlaku seperti parit tersumbat, pokok tumbang, tanah runtuh kecil dan gelinciran tanah dan boleh memuat turun gambar kejadian. Laporan dan aduan yang dilaporkan dalam laman web tersebut akan ditapis terlebih dahulu dan sekiranya aduan yang berkaitan dengan tanah runtuh akan diajukan terus kepada pihak berkuasa tempatan. Maklumat penting yang lain seperti laporan ramalan kajicucu mingguan turut dipaparkan untuk makluman pengguna. Maklumat ini penting sekiranya berlaku tanah runtuh, penduduk dapat bersedia sedia untuk berpindah ke tempat lain. Info berkaitan hujan harian juga tidak terkecuali dalam laman web tersebut. Info ini menunjukkan jumlah taburan hujan bagi kawasan tersebut yang diperolehi dari Jabatan

Pengairan dan Saliran. Info hujan sangat penting kerana hujan merupakan faktor pendorong berlakunya tanah runtuh. Sebelum aplikasi ini dibangunkan, analisis keperluan pengguna telah dijalankan iaitu sesi temubual telah dilakukan untuk beberapa orang, termasuk ahli jawatankuasa komuniti penduduk dan pihak berkuasa tempatan. Hasil temubual tersebut, didapati bahawa aplikasi GIS dalam komuniti sangat diperlukan untuk penyebaran dan paparan maklumat seperti peta dan maklumat atribut. Penilaian keberkesanan dan mesra pengguna laman web GIS telah dijalankan bersama 20 responden. Pembinaan laman web GIS untuk komuniti penduduk bagi kawasan berpotensi untuk tanah runtuh tersebut sangat relevan dalam memperkasa GIS di kalangan penduduk setempat di samping proses aduan yang lebih cekap.

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LIST OF ABBREVIATIONS

GIS	Geographic Information System
WebGIS	Web-based Geographic Information System
SQL	Structured Query Language
PHP	Hypertext Preprocessor
QGIS	Quantum Geographic Information System
HTML	Hypertext Markup Language
GUI	Graphical User Interface
SIAPAD	Andean Information System for Disaster Prevention and Relief
SDI	Spatial Data Infrastructure
WKMP	EU Water Knowledge Management Platform
UI	User Interface
SA	Sentinel Asia
APRSAF	Asia-Pacific Regional Space Agency Forum
CoBARA	Coalition of Bukit Antarabangsa Residents Associations
RS	Remote Sensing
GNSS	Global Navigation Satellite System
NGO	Non-government Organization
JKR	Department of Work Malaysia
MPAJ	Ampang Jaya Local Authority
DID	Department of Irrigation and Drainage
XAMPP	PHP development environment
PGIS	Participatory GIS
PPGIS	Public Participatory GIS

NCGIA	National Center for Geographic Information and Analysis
NPO	Non-Profit Organization
API	Application Program Interface
SNS	Social Networking Service
PDA	Personal Digital Assistant
GPS	Global Positioning System
QGIS	Quantum GIS
SyNaRMa	Information System for Natural Risk Management
ENVI	Exelis Visual Information
GRASSGIS	Geographic Resources Analysis Support System (GIS)
ArcIMS	Arc Internet Map Service
VB	Visual Basic
WKMP	Water Knowledge Management Platform
NDMS	Natural Disaster Management Systems
SDI	Spatial Data Infrastructure
RAM	Random Access Memory
WWW	World Wide Web
OL	OpenLayers
OL2	OpenLayers 2
CIS	Community Information System
SHP	Shapefile
Jpeg	Joint Photographic Expert Group
ESRI	Environmental System Research Institute
WGS84	World Geodetic System 1984

OSM	Open Street Map
WMTS	Web Map Tile Service
WCS	Web Coverage Service
WFS	Web Feature Service
WMS	Web Map Service
GML	Geography Markup Language
KML	Keyhole Markup Language
GEORSS	Web feed
DI	Dynamic Integrity

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Asia and the Pacific Report (2014) reviewed that 79.6 million people were affected by natural disasters. A total 119 disaster events were recorded in the Asia-Pacific Region; 6,050 people lost their lives; US\$59.6 billion total cost of economic losses; 45+ million people were affected by floods and storms; tropical cyclones in Hudhud (India), Lingling and Kajiki (Japan) and Hagupit (Philippines) caused US\$16.3 billion in economic losses; floods resulted in the most fatalities (3559 people) and the highest economic losses about US\$26.8 billion; and landslides resulted in 657 fatalities and affected approximately 177,781 people as shown in Figure 1.1.

Disaster type	Occurrences	Deaths	Total Affected	Economic Losses (US\$)
Flood	52	3559	28.6 million	26.8 billion
Storm	37	730	16.3 million	25.8 billion
Earthquake	7	733	1.9 million	6.7 billion
Volcanic activity	5	101	0.17 million	186 million
Drought	5	180	31.5 million	18 million
Landslide	9	657	0.18 million	Not recorded
Extreme Temperature	3	88	1 million	Not recorded
Wildfire	1	2	168	25 million
Total	119	6050	79.6 million	59.6 billion

Data source: D. Guha-Sapir, R. Below, Ph. Hoyois - EM-DAT: International Disaster Database - www.emdat.be - Université Catholique de Louvain - Brussels - Belgium.
Data accessed: 9 February 2015

Figure 1.1 : 2014 Asia-Pacific Losses by Disaster Type
(Source: Disaster in Asia and The Pacific 2014)

Based on Figure 1.1, disaster in Asia – Pacific region in 2014 cause the loss of lives as well economic loss. The type of disaster that are involved and recorded are flood, storm, earthquake, volcanic activity, drought, landslide, extreme temperature, and wildfire. Sentinel Asia (SA) was proposed by Asia-Pacific Regional Space Agency Forum (APRSAP) in November 2004 to help the disaster agencies in handling the disaster-related information in affected countries via Internet and satellite (Kaku & Held, 2013). SA is a voluntary body with the collaboration between regional space agencies and disaster management agencies created for humanity purpose, remote sensing data application and web based GIS technologies to assist disaster management in the Asia-Pacific region. This study deals with alerting community about potential hazard such as landslide. This research is based in Bukit Antarabangsa where a tragedy occurred in 2008. This study focuses on building web, with friendly user interface for the public.

1.2 Problem Statement

After the tragic landslide tragedy in December 2008 in Taman Bukit Mewah, Bukit Antarabangsa, Selangor, the communities of Bukit Antarabangsa or CoBARA wanted to aware to monitor the situation and create awareness for their residence from potential recurrence landslides. Currently, they do not have any system to monitor, maintain and report complaints and report on slope safety in their community. Therefore, there is a need to utilize technology such as Geographic Information System (GIS), Remote Sensing (RS) and Global Navigation Satellite System (GNSS) to get more relevant and useful information especially information regarding the landslides. There is a potential system for non-expert in GIS to be able to read, retrieve, and plot the map relevant to their surroundings. Although spatial and Internet technologies have advanced, communities generally are unable to tap on the full potential of these technologies for local needs, so that there is a pressing need for community to have friendly web based GIS systems that can aid communities in monitoring their local areas and to aid them in disaster preparation.

1.3 Justification of Study

By doing this research, there are some benefits that can be detained. A community management system based on web-based GIS provides useful information especially regarding landslides to local community. Other than that, the system can manage and handle reports or complaints from the public and resolve the problems based on the priority and administrator can take an action on the report/complaint, which is forwarded to local authorities for action.

In Malaysia, disaster preparedness becomes more critical among the residents who live in potential areas for natural disaster especially for landslides. The NGO's agency, SlopeWatch in co-operation with Slope Unit, Department of Work Malaysia (JKR) and Engineering Unit, Ampang Jaya Local Authority (MPAJ) organizes many programs such as talk on emergency preparedness, learning about landslides and monitoring slopes, campaigns about awareness among the locals and education program. Consequently, the locals become more sensitive to the environment changes in their area.

The systems helps create greater awareness among the user community. The community information system based on web-based GIS helps to provide them in handling and managing their residents become more systematic and friendly. Residents can gain new knowledge about GIS itself because GIS is still new for them to explore. Nevertheless, with this system, residents can explore GIS functions especially in displaying map and spatial information. With information from Department of Irrigation and Drainage (DID) and weather information from weather website, residents can follow local environment data more closely. Given these points, the local community exposed to GIS and can have an interesting, information and fulfilling learning experience in addition to them in the alert to any potential hazard.

1.4 Objectives

The objectives of the study are as follows;

1. To design and develop a community friendly web GIS based information system for slope management
2. To integrate the web site with data from metrological and other relevant sources to produce updated map that can be viewed by the community
3. To empower the community to crowd-source and share relevant slope information
4. To evaluate the user-friendliness and the effectiveness of the developed web based GIS portal

1.5 Scope of Research

This research develops a community friendly web GIS based information system for local community management. The scope of this study is to create an application which can display the map of the study area. From the application, the community will be more empowered and trained with the GIS tools and application of GIS itself. In this situation, community awareness of the landslide prevention is more important to help the community achieve the scope of the study become successful.

The web-based community information system provides and gathers all the information related to the disaster preparedness, which includes information such as rainfall data, weather info, any additional information extensively for preparedness and disaster. In this study, the scope of data is more on secondary data that are provided from local authority for residence map and government department such as Drainage and Irrigation Department for rainfall data and river, Agriculture Department for soil map, Mineral and Geology Department for geology, and JUPEM (Land and Survey Department) for cadastre lot data. The rainfall data that has been used base on just one station which is available on that time. Through the web-based GIS, the main part is interactive mapping that allows displaying the map of the study area that can prepare the local community with spatial information. Besides, all the complaints and report can be submitted through the online form. The main target of this research is limited to local community awareness and engagement rather than on technical slope's landslide incident prevention especially for Bukit Antarabangsa area.

1.6 Outline of Thesis

This thesis organized in five (5) chapters.

Chapter 1 introduces the background of research, problem statement, research justification, objectives and the scope of research.

Chapter 2 consists of literature review that describes the background of the disaster management worldwide and especially in Malaysia, issues on landslide in Bukit Antarabangsa, the development of community based systems and explanation on web based GIS and the usage of Open Source Web-based GIS software in disaster management among community based.

Chapter 3 presents the methodology of research and development of web-based GIS for community information system. The development of the database described in this chapter. All data and methodology of the research included in this chapter. The requirements of the hardware and software, which used in this research, also described and the user requirement analysis identified. The development of graphical user interface also included in this chapter and followed by user testing for the system.

Chapter 4 shows the results of the graphical user interface (GUI) for the whole website. In this chapter, validation of the system is described. The results of the analysis statistics of the user testing is displayed in this chapter. The findings from the study are included in this chapter.

Chapter 5 is the conclusion of this research. It discusses the significance of the system developed. In this chapter, the limitation and recommendations are made for future research.

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