Integrated Geo Hazard Management System in Cloud Computing Technology

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Abstract. Geo hazard can result in reducing of environmental health and huge economic losses especially in mountainous area. In order to mitigate geo-hazard effectively, cloud computer technology are introduce for managing geo hazard database. Cloud computing technology and it services capable to provide stakeholder’s with geo hazards information in near to real time for an effective environmental management and decision-making. UNITEN Integrated Geo Hazard Management System consist of the network management and operation to monitor geo-hazard disaster especially landslide in our study area at Kelantan River Basin and boundary between Hulu Kelantan and Hulu Terengganu. The system will provide easily manage flexible measuring system with data management operates autonomously and can be controlled by commands to collects and controls remotely by using “cloud” system computing. This paper aims to document the above relationship by identifying the special features and needs associated with effective geo-hazard database management using “cloud system”. This system later will use as part of the development activities and result in minimizing the frequency of the geo-hazard and risk at that research area.

Keywords: Cloud Computer, Technology, Managing, Geo Hazard and Risk

Introduction
Sustainability is an attribute of dynamic, adaptive systems that are able to flourish and grow in the face of uncertainty and constant change. While the geo hazards are major threats to sustainability. Geo hazard are hard to predict and become even worse while global climate changes. Geo hazard management is one of the key issues for achieving sustainability, which will require innovation, foresight, and effective partnerships among researchers, governments, corporations, citizens, and other groups. Utilizing the concepts of sustainability to Geo hazard management system requires the development of strategies to facilitate the efficient dissemination of information and response. Through this concepts many authors such as Goodchild et al., (1992 [1], 1993 [2], 1996 [3]); Fotheringham and Rogerson (1994)[4]; Fischer et al., (1996) [5]; Longley and Batty (1996) [6]; (David Pullar & Darren Springer, 2000) [7]; (I. Zacharias, et al., (2005) [8] and Takayama. S et al (2013) [9] , Pascla et al (2013) [10], N. Yunjia & Y. Huan (2014)

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[11] and Evangelidis et al., 2015 [12] have use Geographic Information System (GIS) technology for data management, query and visualization for geo hazard risk analysis and decision support systems for managing geo hazard risk. However this current system management mostly using the GIS Desktop which have restricted in term of publishing and usage of data especially for early warning system management that normally involved client and public. To enhance the capabilities of the existing early warning system and data management, “CLOUD SYSTEM” are introduce as part of the aid of a network for real time continuously monitored web enable landslide.

Cloud system technology in managing landslide risk in this paper will explain a fundamental for locating a real time monitoring system in remote area, receiving and data storage, evaluation and prediction of landslide and managing the resilient of people surround the hazard zone.

**UNITEN Integrated Geo Hazard Management System**

Integrated Multi Hazard Management System which can be an effective disaster management scheme which could system become the part of the development activities and result in minimising the frequency of the geo-hazards and risk associated with them. The system consists of four major component which are Geo-Hazard Cloud System (MuGHCS), Multi Criteria Antenna Placement System (MiCAPS), Integrated Local Sensing Node Networks System (ILSNNS) and Integrated Environment, Economic & Social Decision Support System (IEESDSS). Figure 1 shows the system construction of Integrated Hazard Management System network to monitor geo hazard.

![Cloud System Diagram](image)

**Figure 1.** Integrated Hazard Management System network to monitor geo-hazard in UNITEN

UNITEN Integrated Geo Hazard Management System presents usefulness to access the system from everywhere and the flexibleness to communicate data/information and command between Integrated
Local Sensing Node Networks System (ILSNNS) and Integrated Environment, Economic & Social Decision Support System (IEESDSS).

Multi Criteria Antenna Placement System (MiCAPS) presents the monitoring of network planning to determine the best possible antenna location of landslide prone in rural areas. The significance of positioning the antenna is to ensure the integrity of the data. This is because the antenna receives outputs from various sensors that will be transmitted to the data center via wireless communication. In order to do this, the invention is based on integration of Analytic Hierarchy Process (AHP) as a multi criteria decision making with the extensive use of Geographical Information System (GIS) data.

An autonomous monitoring system using Integrated Local Sensing Node Networks System (ILSNNS) presented with wireless sensor networks together with early warning system, geotechnical database, geospatial information and prediction model taken from an external geographic information system (GIS), has been integrated into the monitoring system. The monitoring system provides real-time geo-hazard information and supports human individuals in assessing hazard and risk of multi geo-hazard.

Integrated Environment, Economic & Social Decision Support System (IEESDSS) is a system that will support planning and decision making in the context of the project review and implementation cycle. This system will integrate all the information from policy, planning process and the community in term of environmental management plan, social and economic impact study. This application will demonstrate how standardization and integration of environmental, social and economic information enables improved better analyses, reporting and communications at all stages of geo-hazard management and implementation. This system will provide the foundation from which environmental safeguards can be better assess and implemented. However, this system will not be explain in this paper.

Geo Hazard Cloud System and Multi Criteria Antenna Placement System (MiCAPS)
Cloud computing is a type of computing that relies on sharing computing resources rather than having local servers or personal devices to handle applications. It also used as a metaphor for the internet which means serves, storage and application are delivered to an organization’s computers and devices through the internet. Base on cloud computing system concepts, Geo-Hazard Cloud System has been developed using ArcGIS Online Map. Geo Hazard Cloud System that have been developed will act as Risk Management System that comprise storage system, response system, recovery system, alert threshold management system, alarm system, alert preparedness system and mitigation system as shows in Figure 2.

This paper aims to establish the methods that are used in storage system and publishing the data to client (local government and related agencies) and public (community or local people at selected study area). Example of development landslide hazard maps and early warning system data in storage system will be explained as a case study to shows the workability of geo hazard cloud system.

Geospatial data including landslide hazard and landslide risk map from Batu Melintang and Kenyir are uploaded into cloud computing after rectification using ArcGIS Desktop. Figure 3 explains the process of uploading and access of landslide hazard map in ArcGIS Online. It starts with browsing ArcGIS Online webpage (http://www.arcgis.com), create an account and signing up ArcGIS Online account. Landslide hazard map can be uploaded after geospatial data in *.shp format being compressed into *.zip file. After uploading the landslide hazard map data, the data will be added into the My Content menu, which is one of the main components that provided in ArcGIS Online. My Content menu can function as a place for data keeping and sharing.
Final step is viewing the landslide hazard map in ArcGIS Online by opening the Map menu in ArcGIS Online and then adding the landslide hazard map layer. The landslide hazard map will appear and overlay on the ArcGIS Online base map. To make landslide hazard map more interesting for displaying, the map graphic can be changed using the Symbol tool. Besides that, to make map of landslide hazard more unique, histogram chart and picture also can be added by using the Symbol tool. After editing the landslide map, the map is saved into My Content and then the map can be shared to the selected people, group or an organization or to the public.
These multi geo-hazard cloud systems are designed as manifold features to ensure easily access to internet-based remote access. As an example in this study, retrieving landslide risk maps will give some information such as location of the prone area, percentage of the area are in risk toward landslide, the slope information and it also work and allow (authorized) users communicating with the systems to request measurement for a specific area as Figure 4.

**Figure 4.** Geo-Hazard Cloud System in ArcGIS Online webpage shows landslide risk assessment

The landslide hazard maps as Fig.4 are used to determine the best possible antenna in the landslide prone especially at the remote area using Analytic Hierarchy Process (AHP). AHP were integrated with Geographical Information System (GIS) to determine the best possible antenna in the landslide prone area using landslide hazard map as shown in Fig. 4. The significance of positioning the antenna is to ensure the integrity of the data. This is because the antenna receives outputs from various sensors that will be transmitted to the data center via wireless communication. The Antenna Placement using Multi Criteria Antenna Placement System (MiCAPS) in ArcGIS Online system shows as Figure 5.

**Figure 5.** The Antenna Placement as part of Geo-Hazard Cloud System in ArcGIS Online Webpage
Alert System through Geo Hazard Cloud System

The alert system are develop after finalise the suitable location for antenna placement and landslide monitoring equipments. The systems are developed to recognize geo-hazard events that occur in the monitoring area and will notify the client at control center in near to real time. Thus, it provides a control center with an opportunity to evaluate the situation and take preventive action if necessary. Sensors that be part of an autonomous monitoring system using Integrated Local Sensing Node Networks System (ILSNNS) will response and will notify through the cloud gateways. The cloud gateway extracts meaningful data from raw sensor data and processes the extracted data for specific tasks on a real time alert system will notifying the client for the abnormal event as in Figure 6.

The raw data from site located near to Jeli-Batu Melintang and Kenyir will transmit the data to geo hazard cloud system in 30 minutes interval. The raw data are process through the Integrated Local Sensing Node Networks System (ILSNNS) at the office. The system will notified the authority the situation of the site through cloud alert system. Later authority will disseminate early warnings prevention to public in term of color code i.e red, orange and yellow. The definition of color code are red for high risk, orange for moderate risk and red low risk. Desimination warning in red color code means there are abnormal slope movements at that area, while if orange means in standby condition and green it safe for the public.

Security of Geo-Hazard Cloud System

Security should be considered as an important thing to ensure data that is stored in the cloud computing server are always safe and protected. The security that is provided in ArcGIS Online is divided into two main levels that are secure operation and retain ownership. Secure operation ensure that only selected people, group or an organization that are allowed to access, explore and save the landslide hazard map data in ArcGIS Online. To access the data, they also need to sign in ArcGIS Online webpage. In Geo Hazard Cloud System

Retain ownership is a security level that ensure all data that stored in ArcGIS Online server always in protected and only allow admin or data owner are able to control the data such as deleting, extracting and downloading, retaining and adding the data into ArcGIS Online.

Concluding Remarks

Cloud computing technology gives many benefits to users especially in managing and mapping geo-hazard GIS data. Besides having useful ArcGIS tool for analysis and map editing, this cloud computing
also provided some security level for user in making sure that the data that is stored in the cloud computing database are safe from exploitation and stealing by unknown user. The other benefit when using cloud computing, all map that have been published can be shared to all selected people, group and organization and also to public. The data that is stored in the cloud computing database can be access in every time as well as internet connection or WIFI coverage is available. Beside that the cloud computing technology allow to design and implemented a real time alert system on top of the cloud infrastructure.

In brief multi geo-hazard cloud system for landslide management can provide client and public:

i. Monitoring information and visualization modules: display the information such as point distribution of landslide monitoring, network structure, the overall displacement of landslide, groundwater monitoring, single-point deformation curve using digital graphics and text data.

ii. Input of monitoring dynamic information and module management: input the field collected and indoors processed data, and conduct sort management to obtain various result charts.

iii. Module of landslide prediction model

iv. The parameter setting module: provide the function of various parameter settings

v. Results viewer module: provide the function to browse the data of generating results

vi. Module of threshold value and alert system

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