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A GIS-Based Approach for Data Management in Universiti Tun Hussein Onn Malaysia (UTHM), Batu Pahat, Johor, Malaysia

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Abstract: A Geographical Information System (GIS) used in fields to gather, store, process, interpret and view any spatial and geographic data. Data management is a system for managing information, organizing, visualizing maps, data, and analyzing relationship and patterns over any geography. GIS data management allowed data to be stored in various forms for the convenience of the user. In order collect soil data, surveying, census and soil investigation need to be done. This is time-consuming, inefficient and makes very difficult for people to gather information in a short period. In fact, to obtain information such as soil investigation report is very difficult as not every report publicly accessible. GIS was used as it is easier and shorten time consume to gather information compared to traditional methods and then manage data collected accordingly. For study area which is in Universiti Tun Hussein Onn Malaysia (UTHM) Johor, GIS should be done to provide resources information about the area by creating data management based on GIS. The first objective of this study is to develop data management based on GIS for UTHM. The second objective is to analyze, manage and present all types of geographical data that collected from the mapping in the study area. The flow process for this study, started from collection of data from previous study to create database, soil classification and produced mapping for study area using QGIS. The soil data has been analyzed, managed and presented based on four main soil properties. The soil group were determined from these parameters and it was found that all soil in study area was in the same soil group. This research can be use as future guides to get more information regarding GIS in this location from the data management developed.

Keywords: Geographical Information System (GIS), Data Management, Universiti Tun Hussein Onn, Mapping

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1. Introduction

Maps has paved the road to many greatest discoveries in history to world. Geographic associations, variations, and patterns may also be shown. In several ways or uses, most businesses need maps [1]. With advances in technology, GIS technology introduced intelligent digital maps. This makes information management much simpler. GIS reflects Earth features to help imagine, interpret and comprehend environment and human activity data [2]. GIS is a technique that encodes, analyses, and displays multiple data layers derived from different sources, including hardware, software, and graphics. Analyses can be represented in tabular or graphic form and, most importantly, in mapping format that is geographically organized [3]. GIS mapping used in various industries as it applies geographic science with more understanding, which give consumer answer to questions about various kind location-related data with ease. Data management in GIS is currently widely used as a validated technique for environmental, demographic, and topographic data analysis [3].

The current manual system to gather information is hard because some of information is difficult to access. Manual system also cannot keep up information throughout time because separated from each other as changing one does not change the other and also neither has complete information about a given map feature. Some of the organizations have needed to maintain authoritative records about the status and change of geography. In order collect that data, surveying, census and site investigation need to be done. This is time-consuming and inefficient. Many adjustments to the Principles and Recommendations for Population and Housing Censuses illustrate the need for modern technology to collect information more conveniently [4]. Therefore, it emerges the importance to develop data management using GIS. In order to estimate the spatial distribution of soil groups and soil properties, the digital soil maps can be created and and has been proven to help create more quantitative, detailed and reliable soil maps [5].

This study focused on objectives which is to develop data management based on Geographical Information System (GIS) in UTHM. A soil map for land use management usually has two levels. The first is an inventory of soil properties, which explains the state of the soils after been mapped.The second level is made up of interpretations [6]. Data obtained from Department of Survey and Mapping Malaysia. Once data are collected from mapping, it was analyzed and managed in a suitable format. Data can be analyzed to determine the location of features, relationships between features, location of feature exist the most or least, situation in the location or nearby [7]. With the help of GIS mapping software, it is easy to assort specific category of data according to the location.

2. Materials and Methods

The methodology process for this research, starting from data collection, database design, processing with analysis, then visualization and data management.

2.1 Location of the study area

The study area is at Universiti Tun Hussein Onn Malaysia (UTHM) main campus at Parit Raja, Johor, Malaysia. The town spans over an area of 19.6 km^2 in recent years. Soil investigation report for this area was taken to get the overall process for the collection of information and data.

2.2 Database Design

Once the datasets have been collected, it is necessary to organize and manipulate them for use in the GIS. Database design is typically undertaken in this stage to ensure data needed presented in suitable format, so that readable by any GIS software and mapping. As for this study, Microsoft Excel was used to created database in form of Comma Separated Value (CSV) format. Microsoft Excel can be a direct data source as Excel has feature that allow Excel table can be joined to attribute tables to improve information for map features [8].

2.3 Data Input in QGIS

Quantum GIS (QGIS) selected as most suitable software that can be used for this study. It is an open sources GIS software that focuses on spatial data analysis and can discover valuable insights by analyzing and designing spatial patterns. QGIS can hold up diverse data in variety of formats. To be able to manage data, project need to be set up in QGIS. Then, to have a background layer, spatial data which is the coordinates of borehole was used. This is important to locate each of the borehole in study area precisely. In this study, Open Street Map (OSM) used for background data as it can be retrieved easily from the QGIS. This map appeared as background data and layer.

Next, to zoom in the map to study area which is UTHM. Databases need to be added by creating new layer. The point coordinate of each borehole should be correct based on latitude and longitude. The result from adding layer will show the borehole location and each borehole need to be label accordingly as in Figure 1. It shows the location of six boreholes based on SI report appeared in QGIS. The attribute data table that provides geographic features from SI report shown in Figure 2.

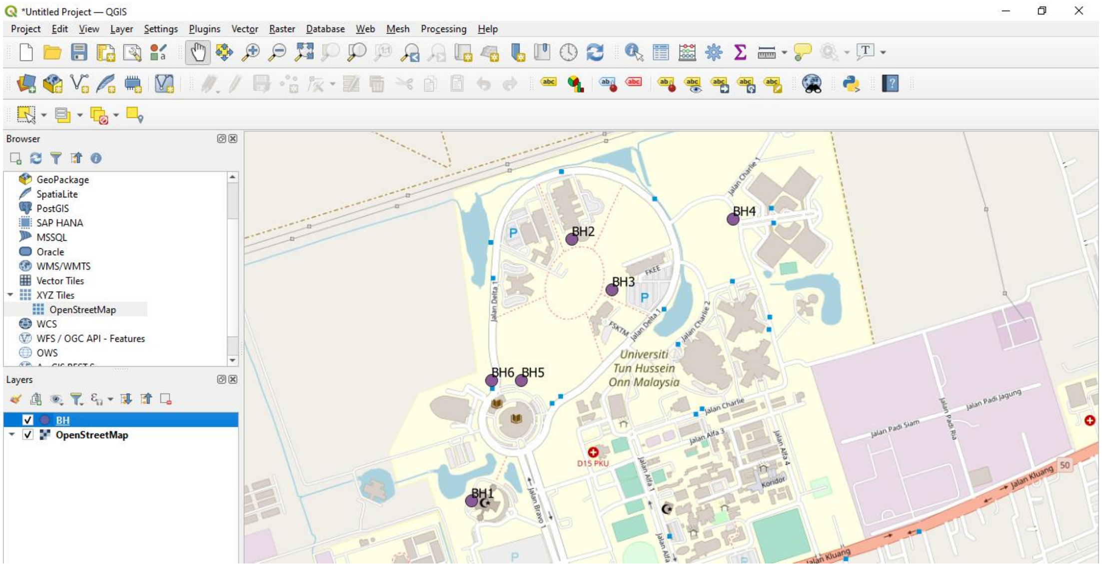
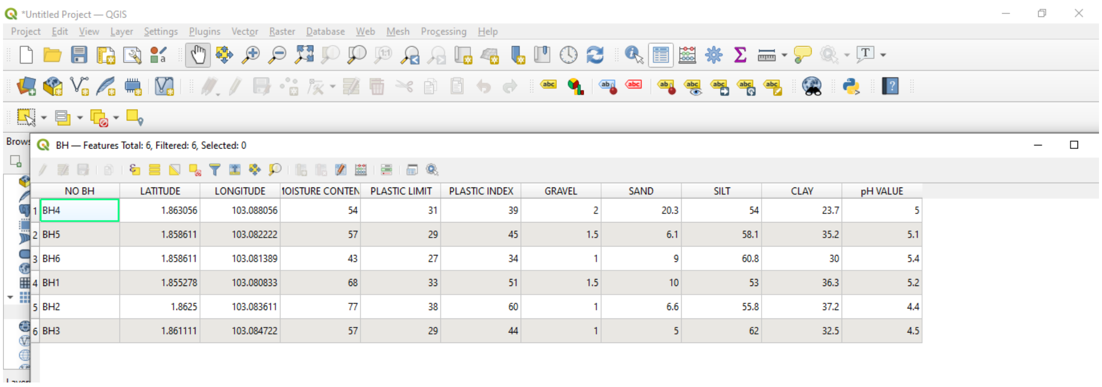


Figure 1: Location of boreholes in UTHM



	NO BH	LATITUDE	LONGITUDE	IOISTURE CONTEN	PLASTIC LIMIT	PLASTIC INDEX	GRAVEL	SAND	SILT	CLAY	pH VALUE
1	BH4	1.863056	103.088056	54	31	39	2	20.3	54	23.7	5
2	BH5	1.858611	103.082222	57	29	45	1.5	6.1	58.1	35.2	5.1
3	BH6	1.858611	103.081389	43	27	34	1	9	60.8	30	5.4
4	BH1	1.855278	103.080833	68	33	51	1.5	10	53	36.3	5.2
5	BH2	1.8625	103.083611	77	38	60	1	6.6	55.8	37.2	4.4
6	BH3	1.861111	103.084722	57	29	44	1	5	62	32.5	4.5

Figure 2: Attribute data for six boreholes in UTHM

2.4 Cartographic Visualization

In QGIS, a style is a way of cartographic visualization that takes into account of layer individual and thematic features. A well chosen style give more understanding and readability to user. It can show the relation between layers. For this study, rule-based symbology renderer used to represent the quantitative information which is the soil data. Using the rule-based symbology renderer, the quantitative values for soil data grouped into ordered class. Expression String Builder function filtered data from borehole that only satisfied with the rule decided. Pie chart was also used to symbolize soil data. As pie chart can present a quantity that can be divided by parts also amounts or percentages. For soil classification gravel, sand, silt and clay, the pie chart was used to visualize the percentage of each soil particles in the borehole location.

3. Results and Discussion

The soil classifications done involved soil properties that have been obtained from soil investigation report. The distributions of soil moisture content, plastic limit, plastic index, soil content and pH value of soil are depicted. From the data analysis in GIS, the soil data are classified based on four main group of soil classification which are moisture content, soil texture, consistency limit and pH level of soil. Once soil classification of soil carried out, then the soil mapping generated as final output.

3.1 Soil Classification

Malaysian Meteorological Department, MMD (2007) classifies soil moisture content into several categories. Table 1 show distributions of soil moisture in the study area fall in very wet (>30%) conditions with accordance to MMD [9]. The distributions of soil moisture in the study area are in the range of 43% to 77% with an average of 59%.

Table 1: Classification based on soil moisture content

Borehole	Soil Moisture Content (%)		Condition of soil
	Soil data	Classification	
BH1	68		
BH2	77		
BH3	57	> 30%	Very wet
BH4	54		
BH5	57		
BH6	43		

For soil classification, the predominant soil texture was assessed according to the United States Department of Agriculture (USDA) soil textural classification. The texture of a soil refers to its relative content of clay, sand and silt particles. The soil classification of soil texture based on USDA [10], along with the respective percentages of clay, silt and sand shown in Table 2. From the classification, the soil texture in study area was grouped as silty clay loam according to the percentage of clay, silt and sand content.

Table 2 : Classification based on soil texture

Borehole	Soil content (%)			Soil texture
	Clay	Silt	Sand	
BH1	36.3	53	10	Silty clay loam
BH2	37.2	55.8	6.6	Silty clay loam
BH3	32.5	62	5	Silty clay loam

BH4	23.7	54	20	Silty clay loam
BH5	35.2	58.1	6.1	Silty clay loam
BH6	30	60.8	9	Silty clay loam

The consistency of soil is largely influenced by the water content of the soil. In Table 3 the soils were classified by Atterberg limit, shows the correlations between the plasticity index, soil type, degree of plasticity and degree of cohesiveness based on value of plasticity index.

Table 3: Types of soil, degree of plasticity and degree of cohesiveness based on plasticity index

Plasticity Index (%)	Soil type	Degree of plasticity	Degree of cohesiveness
0	Sand	Non-plastic	Non- cohesive
< 7	Silt	Low plastic	Partly cohesive
7 – 17	Silt clay	Medium plastic	Cohesive
> 17	Clay	High plastic	Cohesive

Based on the value of plasticity index was obtained from soil data, the degree of cohesiveness tabulated in the Table 4. The plasticity index of soil in study area ranged from 34% to 60% which more than 17% and result in high degree of plasticity and cohesive type. As plasticity and cohesion reflect the soil consistency and workability of the soils.

Table 4 : Soil classification based on plasticity index

Borehole	Plasticity index (%)		Soil type	Degree of plasticity	Degree of cohesiveness
	Soil data	Classification			
BH1	51	> 17%	Clay	High plastic	Cohesive
BH2	60				
BH3	44				
BH4	39				
BH5	45				
BH6	34				

The pH soil in the study area obtained from soil investigation report and soil are classified based on their acidity or alkalinity shown in the Table 4.8. According to pH value, the soil in the study area classified as acidic soil. The soils also has pH less than 5.5 which considered strongly acidic soil.

Table 5: Soil classification based on pH value of soil

Borehole	pH value of soil		Condition of soil
	Soil data	Classification	
BH1	5.2		
BH2	4.4		
BH3	4.5	< 6.5	Acidic
BH4	5		
BH5	5.1		
BH6	5.4		

3.2 Soil Maps Based on Soil Classifications

By using QGIS, various soil map at borehole location was created. Based on analyzing, present data and soil classification, four soil mapping was created in QGIS. From the Figure 3, it show the soil condition based on moisture content mapping. As appear in the map, all the soil in UTHM was found in very wet condition. The map in Figure 4 shows that all samples from boreholes in UTHM consist mostly of silty soil and clay. The gravely soil are relatively less in percentage compared to other type of soil. Soil type map are also useful in locating possible sources of clay, silt, sand, gravel, or topsoil.

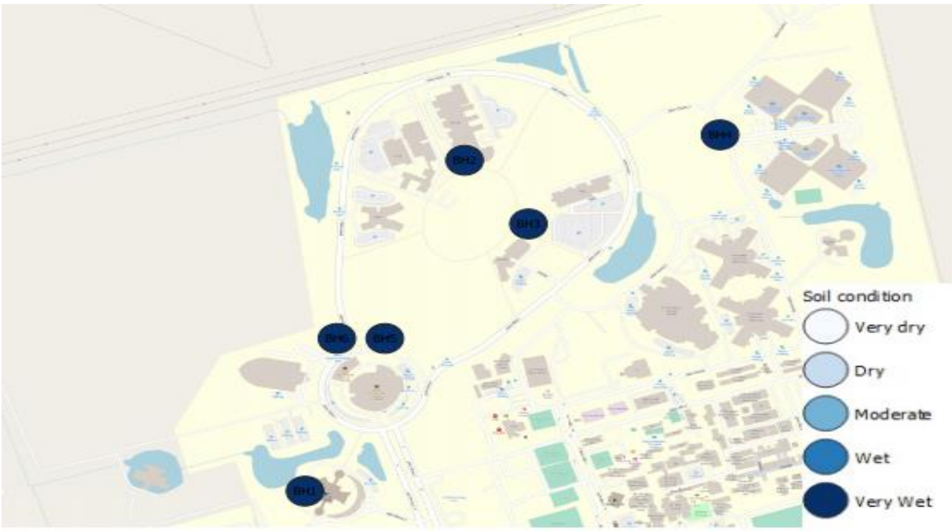


Figure 3: Soil Condition based on Moisture Content Mapping

Figure 4: Soil Texture Mapping

In the Figure 5, soil cohesiveness mapping show that soil in UTHM was classified as cohesive soil. Cohesive soil means clay or soil with a high clay content, which has cohesive strength. Cohesive soils include clayey silt, sandy clay, silty clay, and organic clay. For the soil classification map based on pH of soil, most of the soil in UTHM was categorized in acidic soil group. Soil pH map shown in Figure 6, indicated that none of the soil pH in study area classified as neutral or alkaline. This is because of pH of soil in every borehole in this study area has value less than 6.5.

Figure 5: Soil Cohesiveness Mapping

Figure 6: Soil condition based on pH value

4. Conclusion

The data management based on GIS has been developed in UTHM. The soil data from soil investigation report has been analyzed and presented in the form of maps and table. The soil data has been analyzed, managed and presented based on four soil properties which are moisture content of soil, Atterberg limit, soil texture and pH level of soil. The soil group w ere determined from these parameters and it was found that all soil in study area was in the same soil group. GIS is very suitable for project with large number of data that need to be classified. The map created from QGIS resulting consistent and practicable spatial data to end users. All this soil map and data can be retrieved easily either in shapefile or attribute file. Capturing data electronically eliminates the need to later key the data values into the computer. This greatly increases work efficiency and eliminates a possible source of data entry error.

Acknowledgement

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