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Data Management System in Geographic Information System (GIS) Application Based on the GIS Map Layout of Forest City, Tanjung Kupang, Johor

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Abstract: A geographic information system (GIS) integrates computer-aided mapping with database management and research functionality. GIS offers deeper insights into knowledge such as trends, experiences, and circumstances that help to make better choices. The objectives of this study are to develop data management based on geographical information system (GIS), and to analyze, manage, and present all types of geographical data at Forest City, Tanjung Kupang, Johor are using GIS application. The chosen study area is at Hotel and Golf Course Forest City, Gelang Patah, Johor Bahru with coordinates 1° 24' 53.784" N and 103° 33' 27" E. QGIS software is the main platform to find the location of data and to store the data information collected. Microsoft Excel is used to insert the data from report and import them into QGIS in form of comma-separated value file. In the report, there are a total of 19 Boreholes (BH) with different data information such as pH value, plasticity index (PI), and moisture content. The data information was inserted in excel worksheet then transferred into a comma-separated value (CSV) file so that the information can be imported into the QGIS software. Georeferencing method is used to get the correct coordinates. From the data information, the soil classification can be identified. As result, data of PI shows the soil are mostly high plasticity, data of pH shows the soil are acidic and neutral, and data of moisture content shows the soil are mostly very moist.

Keywords: Geographic Information System, Database Management, Geographical Data, QGIS Software, Borehole

1. Introduction

The location and uniqueness of a place were considered to be all-important before the implementation of geographic information systems (GIS) to the world and academic geography [1]. People have collected and processed information about the space around them from the beginning, and nowadays it would be difficult without geographic information systems because of the large volume of

data [2]. Nowadays, many people can obtain specific data from GIS maps only [3]. Due to the very rapid growth of information technology, GIS systems have found broad application in urban planning, real estate management, administration, infrastructure management, and many other areas of life [2]. GIS can allow for an advance from traditional descriptive mapping to prescriptive mapping and help users with no cartographic skills with its high-quality cartographic output. In geotechnical, before construction works start, site investigation works must be done through site or lab tests to collect data such as strength or types of soil at the site. The data needs to be stored in a suitable system so that it can be updated and referred to in the future. GIS can create the information or data collected in other forms such as tables and maps. A visual display data can help the users to understand better as there is much information to analyze. GIS mapping enabled the user to produce more accessible and understandable information for the clients [4]. A site map should be the highest quality, and the map is assumed to be the precise position of the exact geographical coordinates for the quality map [5].

GIS can assist to integrate the hardware, software, and data for analyzing, expressing and managing. Data management is appropriate to distinguish between the terms of data and information [6]. According to Richta [7], GIS software is designed to conserve data in accordance with its geographical location. GIS tends to record the spatial information of shape data of distinguishable geographical features, location of objects, and attached attributes [8]. Spatial analysis helps to recognize data patterns, create new data relationships, view complex data-set relationships, and make informed decisions that make the GIS system unique from other information systems [9]. The beginning of the process of data management is defining a link between map data and attribute data [2]. Database management system is the main system in GIS in which the graphic map data is stored and the attribute data is recorded and manipulated [8]. The database management system can help in access for digital files which allows the user to supplement, search, update, and organize data [2]. For map planning or presentation graphics generation, GIS can be seen as a tool that is more than a simple mapping tool [10].

2. Materials and Methods

In producing a map, some data are needed to illustrate the value and location of the site. In this study, a process of data management is required to achieve the objectives of this study. As the data was classified the type of soil of each location with the same color, it is quite difficult to earn the information at certain locations. Therefore, with data management, this problem can be solved in a short time. Presentation of the map also can be easily understood.

2.1 Study Area

The chosen study area is at Hotel and Golf Course Forest City, Gelang Patah, Johor Bahru, Johor Darul Takzim with coordinates 1° 24' 53.784" N and 103° 33' 27" E as shown in Figure1. Johor Bahru district is the state capital of Johor which is in southern peninsular Malaysia and separated from Singapore by the Johor-Singapore Causeway.

Figure 1: Location of Hotel and Golf Course Forest City (Source: Google Maps)

2.2 Quantum GIS (QGIS) Software

QGIS is a GIS software which edit and analyze spatial information in the form of graphical maps. This software allows the development of data management for Hotel and Golf Course in Forest City based on map layout. In the report, there are a total of 19 Borehole (BH) with different data information such as pH value, Atterberg limit, particle size distribution, and moisture content. This data can help in classified the soil at each point. The data information was inserted in excel worksheet then transferred into a comma-separated value (CSV) file so that the information can be imported into the QGIS software. The location of the BH from the site can be determined from the coordinate that stated in the report. Figure 2 shows the databases from SI report which consists of 19 features with longitude and latitude for each feature. The types of maps that are used in this study are OpenStreetMap (OSM) and Google Satellite. These maps are the first layer that is needed before inserting data information.
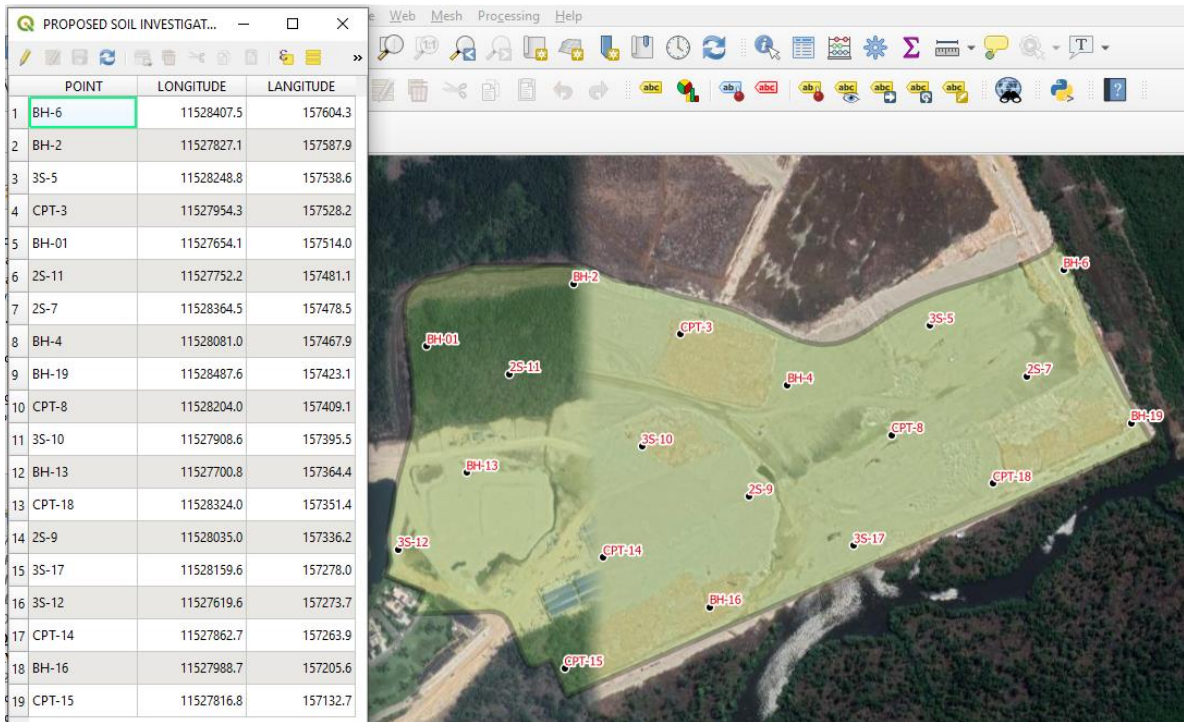
Figure 2: Location of Proposed Soil Investigation

2.3 Georeferencing

In this study, the coordinate was not located at the site's area. Therefore, another method is needed to put the point of BH at the correct coordinate, which is the georeferencing method. Georeferenced is a raster world file generator that allows the user to reference raster to geographic or projected coordinate systems by either creating a new GeoTiff or adding a world file to an existing picture. The primary method for georeferencing a raster is to find spots on the raster for which precise coordinates may be determined. In this study, an image of the plan layout from SI report is taken and saved in jpg or pdf file. From this method, the coordinates of the BH can be obtained through the image which means the coordinates are different from the report. Figure 3 shows the result of georeferencing in GIS software.

Figure 3: The Result of Georeferencing

2.4 Attribute Table

Attribute table is significant because it provides information on geographic features of selected layers, with the rows representing features and the columns representing feature attributes. Attribute table related to spatial data layers. Aside from that, attribute values can be used to query, locate, and represent features. Figure 4 shows the data in attribute table.

Figure 4: Data in attribute table

2.5 Layer Styling

Layer styling is one of QGIS's capabilities that allows users to present data in a meaningful and appealing way. This functionality allows users to more easily alter symbology and style, as well as copy and paste style settings to other layers. This method is a time saver that supports users in getting the job done correctly, and it is frequently used on multiple layers with similar parameters. Figure 5 and Figure 6 shows the database for Boreholes (BH) and Penetration Vane Tests (PVT) which consist of 12 features and 7 features respectively.
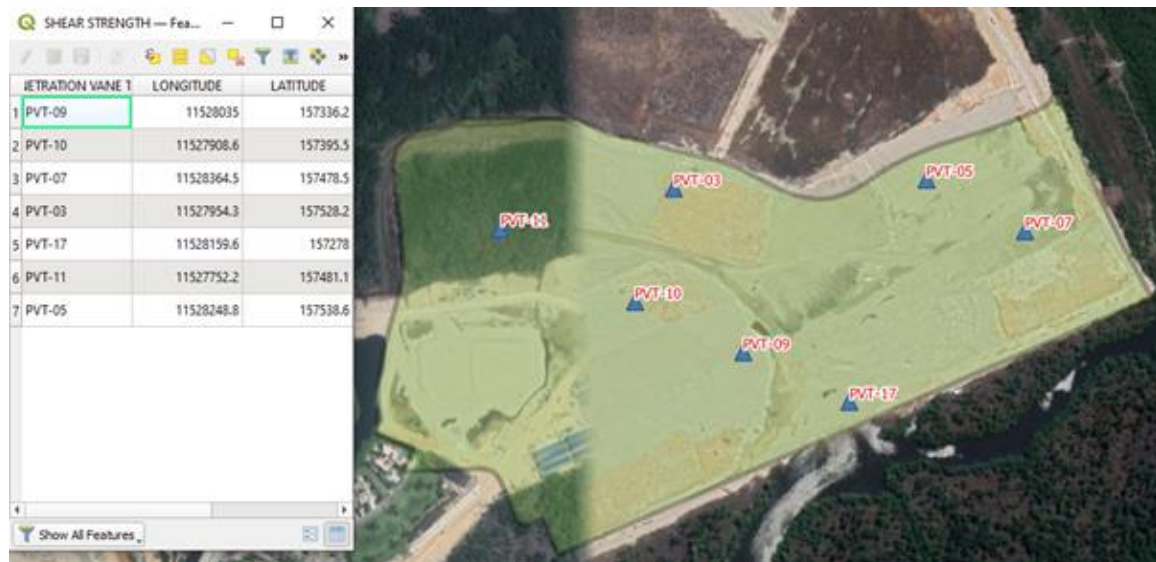

Figure 5: Location of Borehole

Figure 6: Location of Penetration Vane Test

3. Results and Discussion

From this GIS software, the user can determine some classification of soils such as soil properties from plasticity index, pH condition of soils based on pH value, and moisture content which determine condition soils.

3.1 Plasticity Index (PI)

Plasticity index is reported as a percentage of the soil sample's dry weight. The plasticity index is mostly determined by the amount of clay present. The difference between the liquid limit (LL) and the plastic limit (PL) is the plasticity index (PI). When PL is more than or equal to LL then value PI is zero. The classification of soil is divided into 4 with the range of PI value 0% (non plastic), less than 7% (low plasticity), between 7% and 17% (medium plasticity), and more than 17% (high plasticity). There are 12 BH that have PI data with only 1 BH is medium plasticity soil whereas the rest of the BH are high plasticity soil. Table 1 below presents the result of soil classification based on PI [11] from SI report and Figure 7 shows the yellow features in QGIS software that are more than 17% which are high plasticity soil.

Table 1: Soil Classification based on PI from SI Report

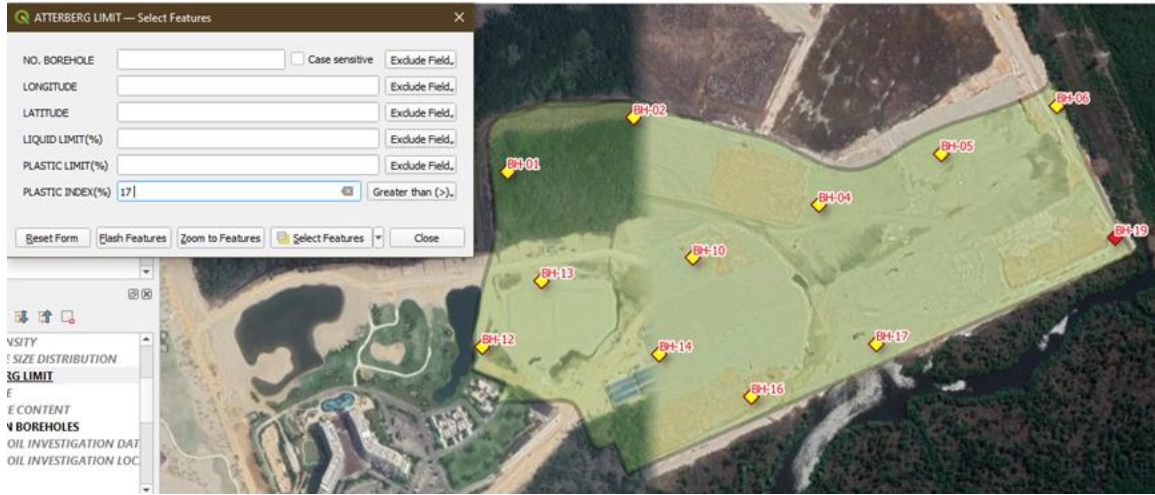| No.BH	PI (%)	Various
BH-01	32.3	High plasticity
BH-02	28.3	High plasticity
BH-04	37.0	High plasticity
BH-05	27.2	High plasticity
BH-06	22.7	High plasticity
BH-10	42.2	High plasticity
BH-12	39.4	High plasticity
BH-13	29.4	High plasticity
BH-14	33.2	High plasticity
BH-16	40.8	High plasticity
BH-17	21.4	High plasticity
BH-19	13.7	Medium plasticity

Figure 7: PI Value More Than 17% in Yellow Features

3.2 pH Value

The pH of soil refers to the amount of acidity or alkalinity in the soil. The pH value for soils mostly ranges between 3.5 to 10 which is acidic if less than 6.5, neutral if between 6.5 to 7.5, and alkaline if more than 7.5 [12]. There are 12 BH that have pH value at site. Most of the pH conditions of soil are acidic and 5 are neutral as can be seen in Table 2 below. There is no alkaline condition of soil. The selected yellow features in Figure 8 shows an acidic soil at site.

Table 2: pH Conditions of Soils

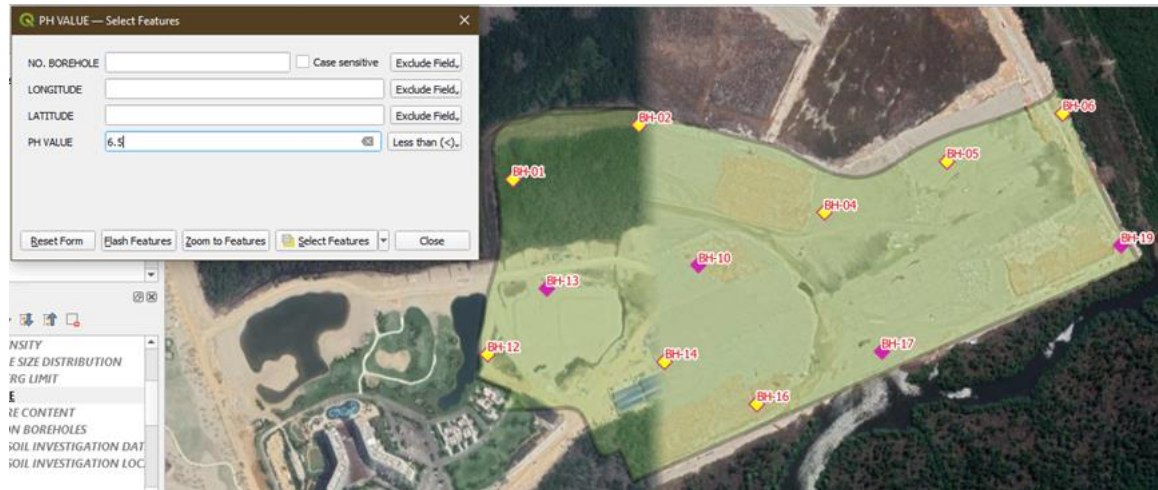| No.BH	pH Value	pH Condition
BH-01	4.0	Acidic
BH-02	4.7	Acidic
BH-04	4.8	Acidic
BH-05	4.8	Acidic
BH-06	4.3	Acidic
BH-10	6.9	Neutral
BH-12	6.4	Neutral
BH-13	7.4	Neutral
BH-14	4.6	Acidic
BH-16	4.8	Acidic
BH-17	6.7	Neutral
BH-19	6.5	Neutral

Figure 8: pH Value Less Than 6.5 in Yellow Features

3.3 Moisture Content

The amount of water in the soil determines the moisture content or water content of the soil. The soil moisture content is determined through percentage with the condition range from very moist (>30%) to very dry (<15%) [13]. From the collected database, 12 BH have moisture content data in which the majority of the soil is very moist and 1 location BH is in moderate soil condition. Table 3 below presents the result of soil condition from moisture content and Figure 9 shows the location of soil that is very moist in yellow features based on QGIS software.

Table 3: Classification of Soil from Moisture Content

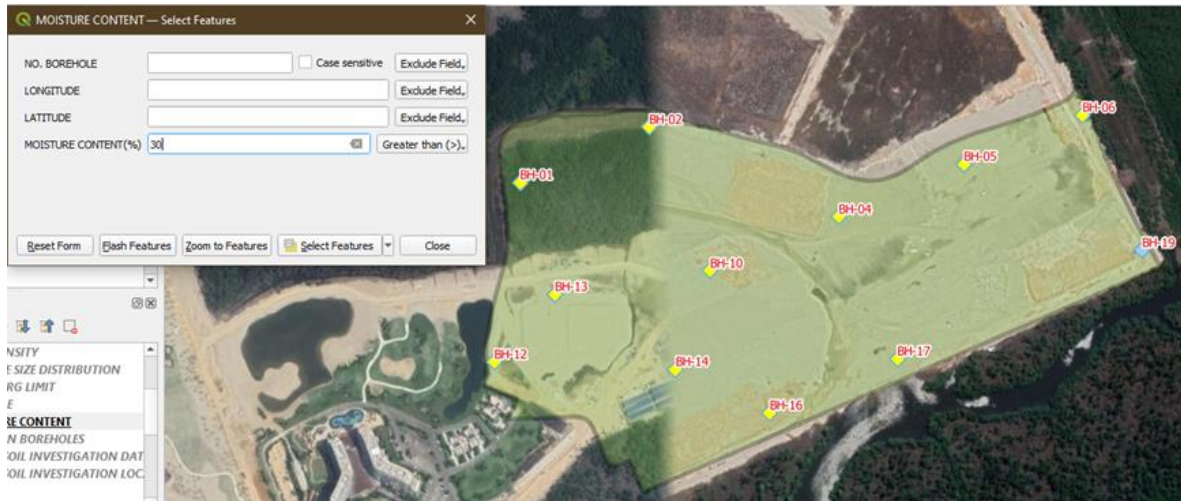| No.BH	Moisture Content (%)	Soil Condition
BH-01	50.3	Very moist
BH-02	40.8	Very moist
BH-04	48.0	Very moist
BH-05	57.2	Very moist
BH-06	42.6	Very moist
BH-10	60.0	Very moist
BH-12	51.4	Very moist
BH-13	30.7	Very moist
BH-14	41.7	Very moist
BH-16	63.0	Very moist
BH-17	40.6	Very moist
BH-19	24.8	Moderate

Figure 9: Moisture Content Value More Than 30% in Yellow Features

4. Conclusion

In conclusion, the database that collected from geographical data for the Hotel and Golf Course in Forest City, Tanjung Kupang, Johor can be managed with a GIS successfully. The data is divided into 2 groups which are BH and PVT as these data are overlapping at certain locations. The data that collected from BH are moisture content, pH value, bulk and dry density, consolidated test, particle size distribution and Atterberg limit whereas PVT has shear strength data. The user can manage, analyze, and present all types of geographical data in GIS software. All the data can be presented in this software with coordinates based on maps. Each type of data is separated in each layer which is easier to analyze and manage.

Acknowledgement

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