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Development of a Database Geographic Information System (GIS) of The Soil Profile At Fringe Villa Forest City, Tanjung Kupang, Johor

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Abstract: In this era of information technology, all data management and information are done online. The purpose of this study is to develop a Geographic Information System (GIS) database with information on the soil profile in Fringe Villa Forest City, Tanjung Kupang, Johor to provide the information needed regarding soil profile of the study area by users for learning, development purposes, and many more. Therefore, a database is built and stored in QGIS software so that information management systems were more effective. The methodology of the study begins with the data collection, selection software, design, and development database, and data analysis. The raw data are obtained from the Department of Mineral and Geoscience (JMG) Johor for soil investigation reports included the plan which is the hard copy and was developed using QGIS software. In this project, Microsoft Excel software was used to store attribute data in a tabular form. QGIS is a GIS software that was used to digitize the study area, obtain the value of coordinate and create a database that enables the mapping of classification of soil profile within a Fringe Villa Forest City, Tanjung Kupang, Johor. The analysis result shows the uses of GIS can assist in the development and reference of soil properties in the Fringe Villa Forest City, Tanjung Kupang, Johor more systematically while saving time and energy.

Keywords: Geographic Information System, QGIS, Soil Profile Database, Fringe Villa Forest City

1. Introduction

In this ever-expanding world, information technology has become a part of our lives. Introducing the use of computers and smartphones in all areas improves development and management efficiency as all data management and information. If want to get the data, need to spend time in the office and more. Besides the fact that there are problems with getting online data, it is still the traditional way to

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go somewhere or walk in to find it. There is no organized system that places such data in a system that is easy to access and obtain the required land information.

With the use of the system GIS, it can also be updated from time to time to store information for future or future use and to enable users to access such current data. The system is capable of analyzing data and information as well as displaying spatial information and attributes. Therefore, many applications use such systems in the field of real estate, defense, water, agriculture, development, and management and administration [1].

The study area is Fringe Villas Forest City Golf Resort in Johor Bahru, Johor with the coordinate of 1°24'45.70"N 103°33'16.75"E. The Gelang Patah residence in Kampung Tanjung Kupang, next to Tanjung Pelepas Port, Forest City is under the management of the Iskandar Puteri City Council. The Forest City is known for its mega projects, development areas that continue to develop with various construction and construction facilities located in the mangrove forest area with peat soil type conditions that require identifying soil status for construction for golf and resort activities.

Also, the importance of this soil profile data can be used as a reference and comparison that can be made for other development projects to identify the conditions of activities that can be done and the type and method of design foundation used. As well as students to learn and study the soil conditions for the rising area of construction with the concept of the ecosystem needed in the future applied in learning and the world of work. Accordingly, the GIS system appears to be used in the search for soil profile information in the Fringe Villa Forest City, Tanjung Kupang, Johor. It is a system that meets the needs and needs to be developed to facilitate reference for every user of the application embedded in the learning process, knowledge, and employment.

2. Application On GIS In Geotechnical Area

The Geographic Information System, or simply GIS, is an information system that relates to geographic information commonly used to resolve space problems. Awareness of spatial information and space problems is therefore critical for ensuring that this information is used efficiently [2].

Developing the latest technologies in computing has created a modern way of living. The information obtained is produced from a variety of sources and is re-supplied from reports and statistical statistics in various formats. Therefore, GIS helps to take decisions faster and more effectively [3].

The Geographic Information System, GIS can therefore be formulated as an information system used to obtain, store, manage, manipulate, analyze and display geographic data references to support it. GIS may also assist in decision-making on land use planning and management, natural resources, the environment, transport systems, urban facilities, and other administrative records [4].

The GIS technologically is an effective method for geo-environmental evaluation to support urban land-use planning [5]. Based on studies by Gouri Sankar Bhunia et al. [6], The goal of this study was to conduct a detailed comparison of GIS-based interpolation techniques to estimate the spatial distribution of SOC in Medinipur Block, West Bengal, India, and to apply cross-validation to assess the accuracy of the interpolation method by measuring root mean square error (RMSE). Pilot research was performed to examine the soil particles under various characteristics of land use. For generating spatial SOC distribution they were five interpolation methods such as local polynomial interpolation (LPI), inverse distance weighting (IDW), ordinary kriging (OK), radial basis function (RBF), and Empirical Bayes kriging (EBK). A comparison was made of the best models from the deterministic and geostatistic methods to find the region's most suitable spatial interpolation process.

According to Pravat Kumar Shit et al. [7], the data for spatial variability was analyzed using a combination of traditional analytical methods and geostatistical methods. These have been commonly used to determine the spatial correlation in soils and to examine the spatial variation of soil properties, such as physical, chemical, and biological properties of the soil [8]. The geostatistical approach is a method of spatial distribution and study of variability which has been developed from classical statistics. The present research indicates that the spatial distribution of soil properties can be directly identified by the OK interpolation, and the sample distance is adequate for interpolation in this analysis.

Based on studies Denton et al. [9], the study was conducted to evaluate the spatial variability of certain physical and chemical soil properties to determine their current situation in the study area. Spatial variability of soil properties has long been established and must be taken into account each time field sampling is performed and its temporal and spatial changes investigated is vital. Use kriging interpolation techniques in a GIS setting, classical statistics were used after the normalization of data to explain the soil properties and geostatistical analysis was used to demonstrate the spatial variability of the soil properties.

3. Methodology

In result of a study, methodology is a very important component as a guide before the study. Methodological studies can provide an overview of a project. This chapter discusses the processes involved in this study to achieve the purpose of the study. Therefore, by looking at the methodology of this study, the research done can be produced smoothly and orderly.

3.1 Data Collection

To facilitate data collection work, relevant information will be divided into different types of information. The development of the database needs to be done carefully for the results of the study to be complete. Problems that may occur during the database development process should be avoided so as not to interfere with future work. The main resource of data collection is from the Department of Mineral and Geoscience (JMG) the soil properties data can be referenced in the hard copy of soil investigation report. Figure 1 shows a database structure.

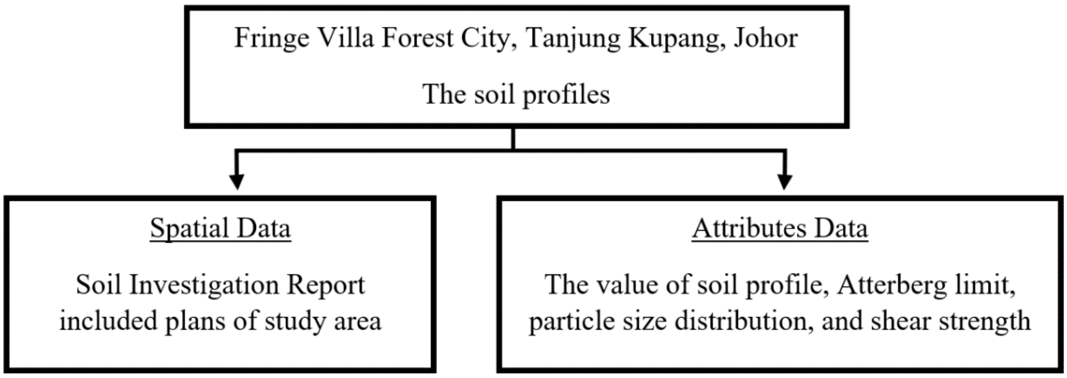


Figure 1: The database structure

3.2 Selection Software

Choosing the right software is essential to making it work and getting good results. In this study, some software was used. Some of them include QGIS and Microsoft Excel. The development of a database can be generated using QGIS software where it is to designing, georeferencing, digitizing, generating space data, attributing data storage, analyzing, and showing results. While Microsoft Excel is used to store and organize soil attribute data [10]. Such as the value of coordinate borehole, soil profile, Atterberg limit, particle size distribution, and shear strength. The tables are a database of attribute data and can be interconnected to facilitate analysis.

3.3 Designing and Developing Database

The database design in this study is based on the concept and importance of GIS which refers to its ability to obtain information such as spatial data and attribute data involved in the selected study building as well as to test the resulting database. In general, the design is initiated by specifying the entity for each soil profile database's attribute details, for example, the information needed by the user. Next, the physical execution starts by entering the spatial data, followed by the attributes acquired in the designed database. Data editing and eventually doing the research in the GIS database is the next step. Figure 2 shows a database design process.

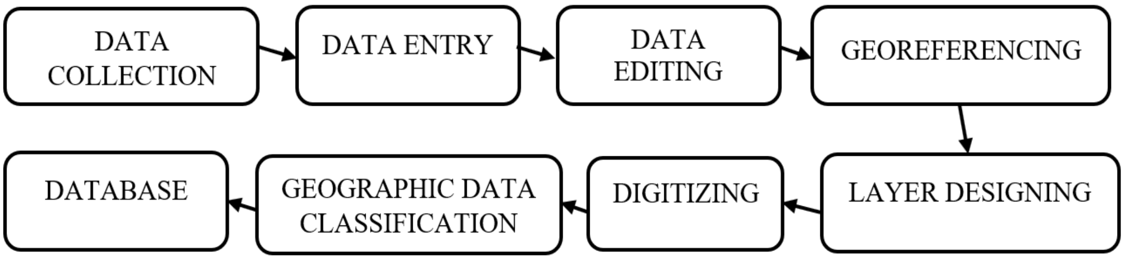


Figure 2: The database design process

i. Design of Database

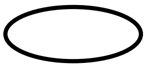
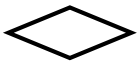
Entering the data that has been collected, including attribute data and spatial data, is the most critical method for constructing a database. As this research is running an information system built for the soil profile database in the study area, numerous unique entities are involved in the design of the database as seen in Table 1.

Table 1: Entities in the database built

No.	Entity	Attributes Data
1	Soil properties	(a) Borehole no. & array, (b) Coordinate in report & by QGIS, (c) Date started & completed of boring test, (d) Soil Profile (SP) depth, (e) Soil Profile (SP) type of soil, (f) Date of test Atterberg Limit (AL) &Particle Size Distribution (PSD), and (g) Value of Atterberg Limit (AL), Particle Size Distribution (PSD), & Shear Strength (SS)
2	The study area	(a) Points borehole and (b) Development lot

The contents of a database are illustrated in conceptual design with an entity-relationship diagram (ER-Diagram). During the method of entering spatial data and attributing data into the database, the ER-Diagram serves as a reference. Table 2 displays the basic elements in the concept design model for the entities diagram.

Table 2: Elements for non-spatial details in the ER-Diagram

Symbol of ER-diagram	Description of operation
	The triangular shape represents Entity
	The ellipsoid shape represents Attributes
	The diamond shape represents Relationships
	The lines represent Links Attributes (s) to Entity set (s) or Entity to Relationship set (s)

For database development, the entities-relationship diagram was developed. Priority will be issued to the entity's database of the position of borehole points. The conceptual design provides a simple illustration of how the database is related to another object between the entities as in Figure 3.

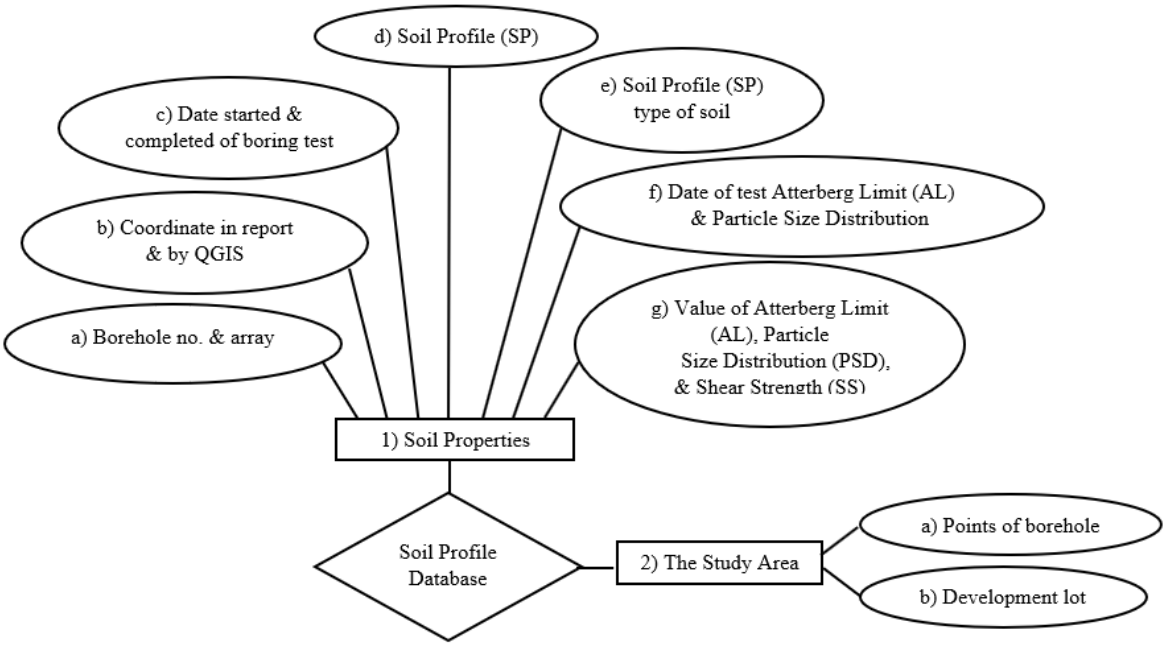


Figure 3: ER-Diagram entity relationship diagram

ii. Developing of Database

It is important to execute the procedure for entering spatial data according to the correct steps. The database development was generated by using QGIS 3.16 software. The QGIS 3.16 software to display, create, design, georeferencing, digitizing, manipulate, and analyze geographic data. The main part of the spatial data entry for this study is to do the method of georeferencing and digitizing the study area to get the value of each borehole point coordinates. Figure 5 shows pictures that have been moved and registered at corrective reference points and shown on a map with georeferenced results.

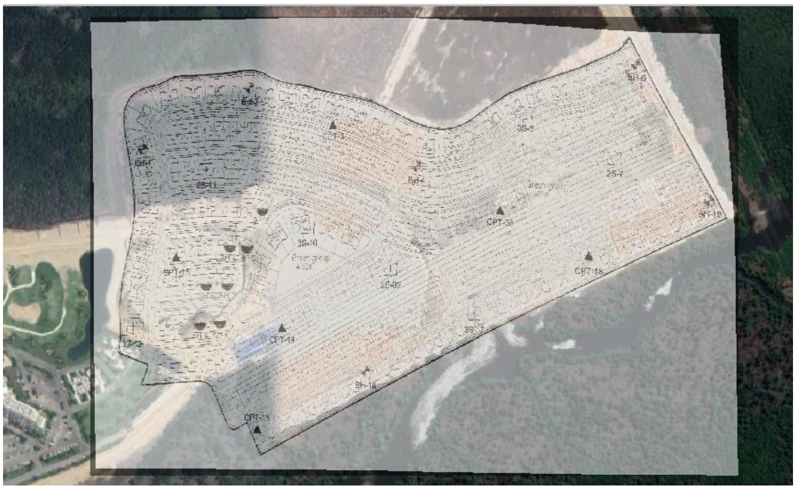
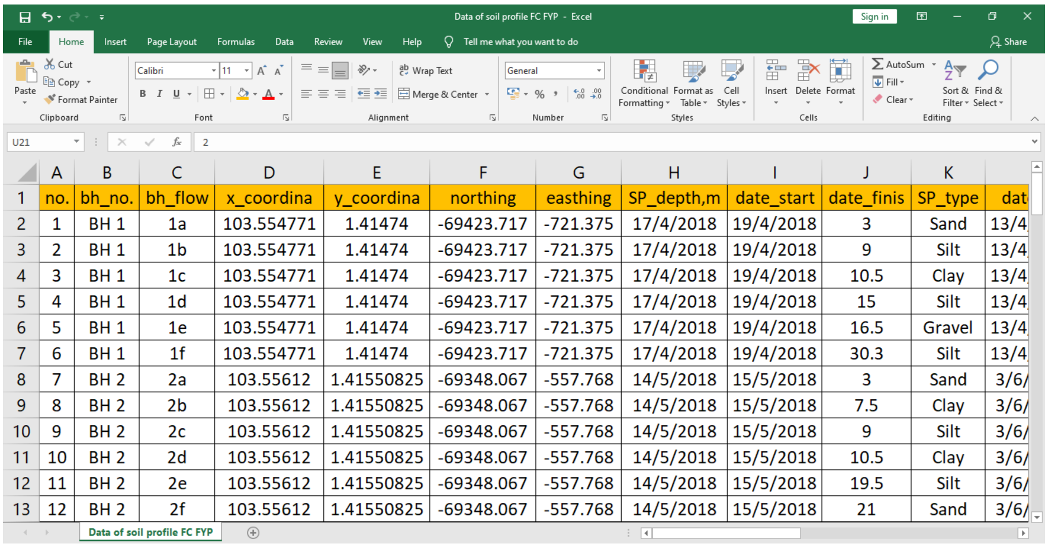


Figure 4: The georeferenced results on scanned plans

The entry of attribute data is an essential aspect. One way to render this new column data included is automated on-screen digitizing, which has to be installed first by providing the desired name and type of entity. Data entry is performed using data contained in an Excel file (Figure 5).



no.	bh_no.	bh_flow	x_coordina	y_coordina	northing	easthing	SP_depth,m	date_start	date_finis	SP_type	dat
1	BH 1	1a	103.554771	1.41474	-69423.717	-721.375	17/4/2018	19/4/2018	3	Sand	13/4
2	BH 1	1b	103.554771	1.41474	-69423.717	-721.375	17/4/2018	19/4/2018	9	Silt	13/4
3	BH 1	1c	103.554771	1.41474	-69423.717	-721.375	17/4/2018	19/4/2018	10.5	Clay	13/4
4	BH 1	1d	103.554771	1.41474	-69423.717	-721.375	17/4/2018	19/4/2018	15	Silt	13/4
5	BH 1	1e	103.554771	1.41474	-69423.717	-721.375	17/4/2018	19/4/2018	16.5	Gravel	13/4
6	BH 1	1f	103.554771	1.41474	-69423.717	-721.375	17/4/2018	19/4/2018	30.3	Silt	13/4
7	BH 2	2a	103.55612	1.41550825	-69348.067	-557.768	14/5/2018	15/5/2018	3	Sand	3/6/
8	BH 2	2b	103.55612	1.41550825	-69348.067	-557.768	14/5/2018	15/5/2018	7.5	Clay	3/6/
9	BH 2	2c	103.55612	1.41550825	-69348.067	-557.768	14/5/2018	15/5/2018	9	Silt	3/6/
10	BH 2	2d	103.55612	1.41550825	-69348.067	-557.768	14/5/2018	15/5/2018	10.5	Clay	3/6/
11	BH 2	2e	103.55612	1.41550825	-69348.067	-557.768	14/5/2018	15/5/2018	19.5	Silt	3/6/
12	BH 2	2f	103.55612	1.41550825	-69348.067	-557.768	14/5/2018	15/5/2018	21	Sand	3/6/

Figure 5: Data in file Excel

3.4 Query

The simple data acquisition operator is split into two, that is queries for qualities and visual questions. For the first form, the output of the query is a table displayed to the user that is running the query. When the user closes the question response window, it will lose the result. It is possible to make such choices dependent on geometric attributes or attribute data relevant to spatial information. This is named in the sense of a visual query by the attribute table collection process that is opened first.

4. Results and Discussions

The database that has been built was analyzed in this chapter to determine the level of productivity in issuing instructions for data access. The aim of this study is to evaluate the system in order to assess the reliability of the database for the collection, retrieval, and display of user data. It was to fix and update all weaknesses and shortcomings in the database.

The end of the results database was provided after both attributed data and spatial data have been inserted into QGIS. The knowledge found in these databases could be accessed by users. Through this, users can conveniently simultaneously access and link to spatial attribute information and displays. Information processing can be achieved effectively, rapidly, and reliably, such as searching, saving, and reviewing information. Moreover, it can also save time and expense and can deter errors in the search for results. Figure 6 displays the observations of a successfully established GIS database.

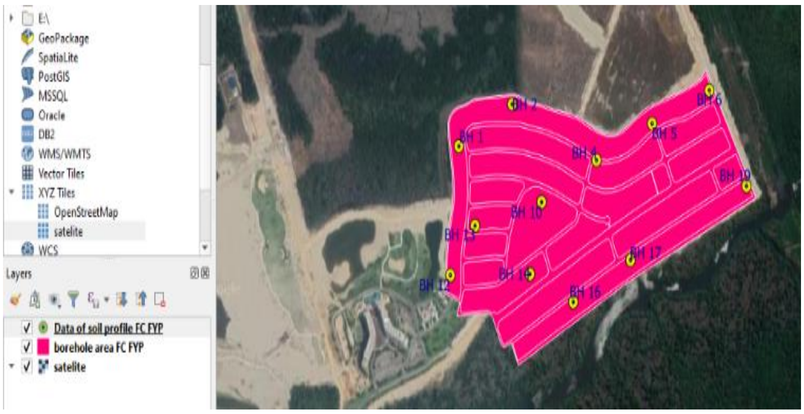


Figure 6: GIS database that has been established successfully

4.1 Analyzing Database

For the first-stage analysis, attribute data is displayed in the form of a table where it is possible to delete the data by right-clicking the appropriate column with the mouse and then clicking the Open Attribute Table as seen in the Figure 7. As for the spatial data, as in Figure 8, the data will be seen in the map box given by the device. By manipulating the view on the map box, users can manipulate the results, for example by marking or unchecking the respective category box in the table of contents.

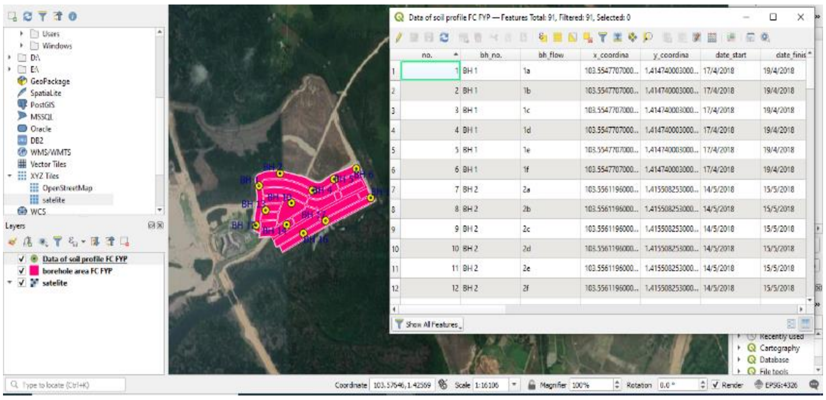
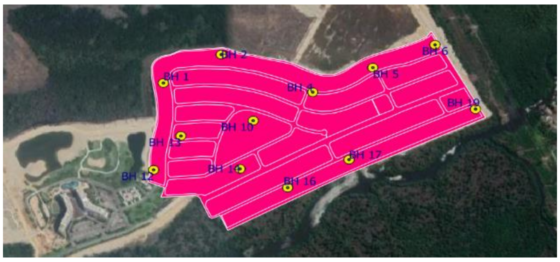


Figure 7: Example of data storage information

Figure 8: Present information in a visual way

For the second stage analysis, as shown in Figure 9 each layer can have distinct information where information management can be implemented independently on each layer. In addition, each category has its own sub-category that focuses more on in-depth information. This strengthens the efficacy of this method and one of the best ways to delivering user-friendly services is the troubleshooting steps to the levels.

(a) (b)



(c)

Figure 9: (a) The base map layers, (b) The Fringe Villa Forest City area layer, and (c) The borehole points of layer

Lastly the third stage analysis, a type of inquiry system has been developed to ensure that the system that has been developed is convenient for users to relate to and understand. To get the certainty of the details, users may make queries in the system or keep track of the appropriate details. There are two types of structures that have been defined as database service systems, namely visual query attributes, and attribute visual queries.

The result of the query desired by the user is the attribute data in tabular form for visual attribute queries. It is possible to connect any visual data on the map box directly to the attribute type according to which category the visual data is. This device can be used by users when space data is available. The result of the use of Identify Features in QGIS (Figure 10).

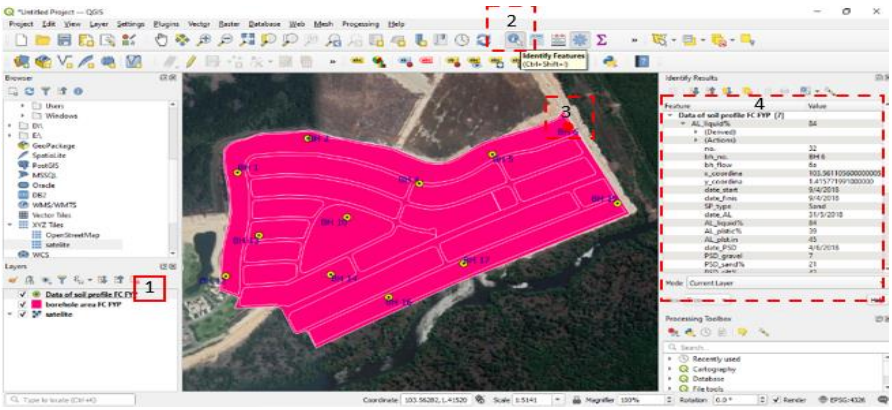


Figure 10: Query of attributes from visuals

The attribute visual query approach consists of using organized queries. The sorting of columns to be shown in a table can be accomplished by this method. It will create queries by choosing the desired layer in the query box and then pressing Select Features. As shown in Figure 11, the data for BH 1 in the findings will be marked on the visual display.

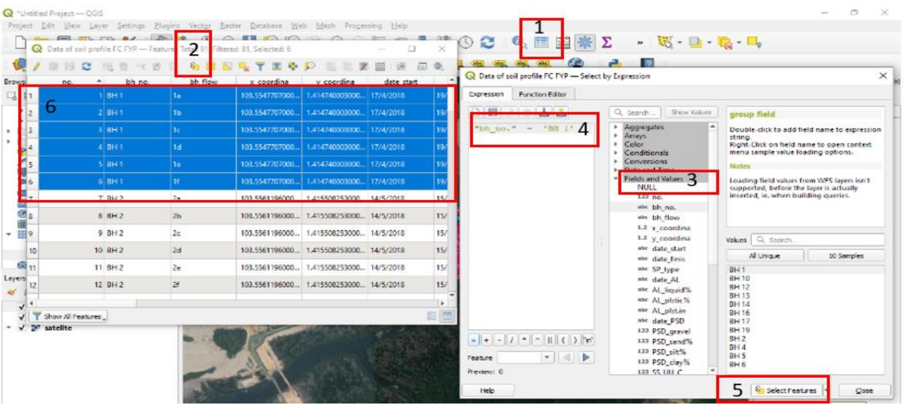


Figure 11: Visual query of attributes

4.1 Discussion

The development of the database in QGIS programs is a benefit of this method where the research aims meet the intended goals. Through data display in the form of attribute data tables and visual data display, users can access the database designed to search for soil profile data in Fringe Villa Forest City more effectively.

Due to the effective development of soil profile database modeling in the GIS framework, management and learning preparation can be performed more explicitly and in-depth. Users can manipulate the soil profile database directly through the region of focus necessary.

Moreover, computer aids and online knowledge processing may have many benefits over previous programs. In the presence of this query method, users can access data in two cases, either for information security reasons or for the purpose of monitoring the data available in the system.

5. Conclusion

It can be inferred, from the results of the analysis obtained, that the purpose of this study is it was successful to build a database through GIS for the development of databases. The resulting GIS system is a database that uses spatial data and attributes data. GIS can store data either in vector form or in raster form. Objects created in the QGIS system, such as map layers, tables, and reports, can be accessed and updated according to user requirements.

GIS can evaluate data from various formats either in Microsoft Excel, raster, or digital format. It can be stored conveniently and arranged for the constructed data storage system. GIS can read a number of data types, but it must be converted into Shapefile in order to interpret and modify data. To conclude, it is possible to assess the valuation of soil properties by means of GIS. Not just that, GIS is a user-friendly program where, by queries contained in GIS, it can communicate with users.

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