Groundwater exploration Using GIS approach (Monywa District)

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Abstract

In today's system, Geographic Information System is a very effective tool in completing many types of analysis and manipulation of data. The use of GIS has grown quickly in groundwater management and research. GIS is now widely used to create digital geographic databases, to manipulate and prepare data as input for various model parameters and to display model output. This hydrogeological mapping program will allow in the near future to meet efficiently the needs for a more considered and effective management of groundwater in GIS with a hydrogeological database. For this reason, it seems very effective to use GIS in hydrogeological database and groundwater exploration of Monywa district. The main'purpose of this paper is to investigate the depth of well to map hydrogeology of the Monywa district.

Keywords: Geographic Information System, database, hydrogeology, groundwater.

1. Introduction

Geographic Information System (GIS) is defined as an information system that is used to input, store, retrieve, manipulate, analyze and output geographically referenced data or geospatial data, in order to support decision making for planning and management of land use, natural resources, environment, transportation, urban facilities, and other administrative records[10,1,2]. Our everyday decisions are dependent on this type of analysis. With the rapid growth of GIS and related technologies over the last two decades, GIS has become a vital element in maintaining and integrating geographic-based information. In today's information society, GIS technology is moving into the mainstream of the Information Technology (IT) industry. The key components of GIS are a computer system, geospatial data and users. A computer system for GIS consists of hardware, software and procedures designed to support the data capture, processing, analysis, modeling and display of geospatial data.

Using GIS tools for management of groundwater modeling can save a great deal of time and is very efficient. GIS is important because it helps user create, edit, and change existing data, and it can ultimately provide a "picture" of the data that is being utilized. People sometimes get overwhelmed when large datasets are presented to them, but with the use of GIS, those numbers can be graphically displayed in a way that is more meaningful to the observer [8].

In this paper sections are organized as follow. Section 1 introduces about the overall system. Section 2 presents basic functions of GIS. Section 3 proposes geographic data. Section 4 presents analysis area of the system. Section 5 implements the system. Section 6 concludes the paper.

2. GIS Functions

There are four basic functions of GIS: data capture, data management, spatial analysis and presenting results.

2.1 Data Capture

Data used in GIS come from many sources, are of many types and are stored in different ways. A GIS provides tools and methods for the integration of data into a format so that data can be compared and analysed. Data sources are mainly manual digitization, scanning of aerial photographs, paper maps and existing digital data. Remote-sensing satellite imagery and GPS are also data input sources.

2.2 Data Management

After data are collected and integrated, a GIS provides facilities that can contain and maintain data. Effective data management includes the following aspects: data security, data integrity, data storage and retrieval and data maintenance[5].

2.3 Spatial Analysis

Spatial analysis is the most important function of a GIS that makes it distinct from other systems such computer aided design and drafting (CADD). The spatial analysis provides function such as spatial interpolation, buffering and overlay operations[6].

2.4 Presenting Results

One of the most exciting aspects of GIS is the variety of ways in which information can be presented once it has been processed. Traditional methods of tabulating and graphing data can be supplemented by maps and three-dimensional image. These capabilities have given rise to new fields such as exploratory cartography and scientific visualization. Visual presentation is one of the most remarkable capabilities of GIS that allows for effective communication of results [9].

3. Geographic Data

There are two important components of geographic data: geographic position and attributes or properties. In other words, spatial data and attribute data. Geographic position specifies the location of a feature or phenomenon by using a coordinate system. The attributes refer to the properties of spatial entities such as identity, ordinal and scale. They are often referred to as non- spatial data since they do not in themselves represent location information [6].

3.1 Raster and Vector Data

Spatial features in a GIS database are stored in either vector or raster form. GIS data structures adhering to a vector format store the position of map features as pair of x, y (and sometimes z) coordinates. A point is described by a set of coordinate pairs and by its name or label. In theory, a line is described by an infinite number of points. In practice, this is not feasible. Therefore, a line is built up of straight-line segments. An area, also called a polygon, is described by a set of coordinate pairs and by its name or label with the difference that the coordinate pairs at the beginning and end are the same[4].

A vector format represents the location and shape of features and boundaries precisely. Only the accuracy and scale of the map compilation process, the resolution of input devices and the skill of the data-inputter limit precision[3].

In contrast, the raster or grid-based format generalizes map features as cells or pixels in a grid matrix. The space is defined by matrix of points or cells organized into rows and columns. In the rows and columns are numbered, the position of each element can be specified by using column number and row number. These can be linked to coordinate positions through the introduction of a coordinate system. Each cell has an attribute value that represents a geographic phenomenon or nominal data such as land-use class, rainfall or elevation. The fineness of the grid will determine the level of detail in which map features can be represented. There are advantages to the raster format for storing and processing some types of data in GIS [7].

4. Analysis Area

In our system, map scanning method is used. In this system, the water supply in this region is problematical, especially for agriculture. The area of dry zone is located between about 19 to 23N and about 94 to 96E. The near-surface rocks are composed essentially of Quaternay to Middle Miocene sediments (Irrawaddy Group), alluvial, shale and sandstone of the tertiary and volcanic rocks. In the dry zone, the fluviatile sediments of the Irrawaddy Group attain thickness of more than 2000m. Near surface groundwater of good quality is encountered locally, but that quantities are small. Major drilling campaigns to find groundwater should be preceded by systematic hydrogeological inventories and geoelectric surveys.

4.1 Hydrology

Hydrology is the study of the movement, distribution, and quality of water throughout the earth, and thus addresses both the hydrologic cycle and water resources. Hydrogeology (hydro- meaning water, and -geology meaning the study of the Earth) is the area of geology that deals with the distribution and movement of groundwater in the soil and rocks of the Earth's crust, (commonly in aquifers). The central theme of hydrology is that water moves thoughout the Earth through different pathways and at different rates.

This system use hydrogeological database and decide depending on the type of the soil in the Monywa district. Monywa district is one the most important district in Sagain Division. There are eight townships namely as Monywa, Yin Ma Pin, Palae, Sar Lin Kyi, A Ya Taw, Bu Ta Lin, Kani and Chaung Oo. So, eight townships are studied for this system. The type of soil in the Monywa district are alluvial, irrawaddian, peguan, eocene, volcanic. Map of soil feature in Monywa, as shown in figure 1, is situated in Myanmar.

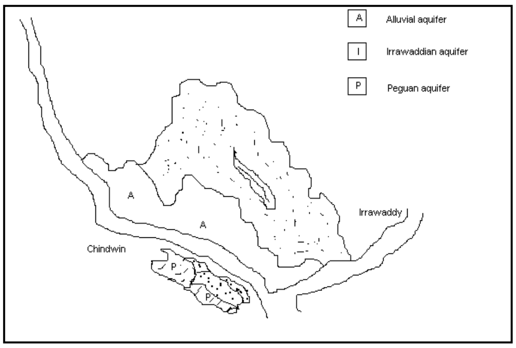

Figure 1. Soil feature in Monywa

Data are stored in many tables which constitutes the database. Each table concerns only either punctual (well, springs,…) or polygonal elements. The main table, called Groundwater (point), contains general information (unique number, geographic position, type, name, depth,…) about wells. The others tables contain more specific information as technical characteristics, qualitative data (hydrochemistry), geological data,… The relationships (one-to–one or one-to-many) between those tables are made in using a unique number. To improve the use of the database, several pre-defined quaries are included, like type of soil query, query based on the depth well, on the topographic map, on the investigated aquifer,… The hydrogeological data stored in the database can be easily updated and represented on the hydrogeological map. All points of the map are linked to the hydrogeological database by their unique number. All information about wells, piezometers…(all points) can be visualized by a sample click on one of the element of the map.

4.2 System Flow

The flow of the system can be seen in figure2. In this system, using GIS function, the user can choose the location about wells in Monywa districts. If the user selects alluvial or irrawaddian or pegu or eocene or volcanic soil type, the system shows the depth of well, the location and the distance of miles from each other. And then the user chooses the depth of well depending on different soil types. And the system will calculate the cost of well. All of information are stored in a database to report the information that the user wants.

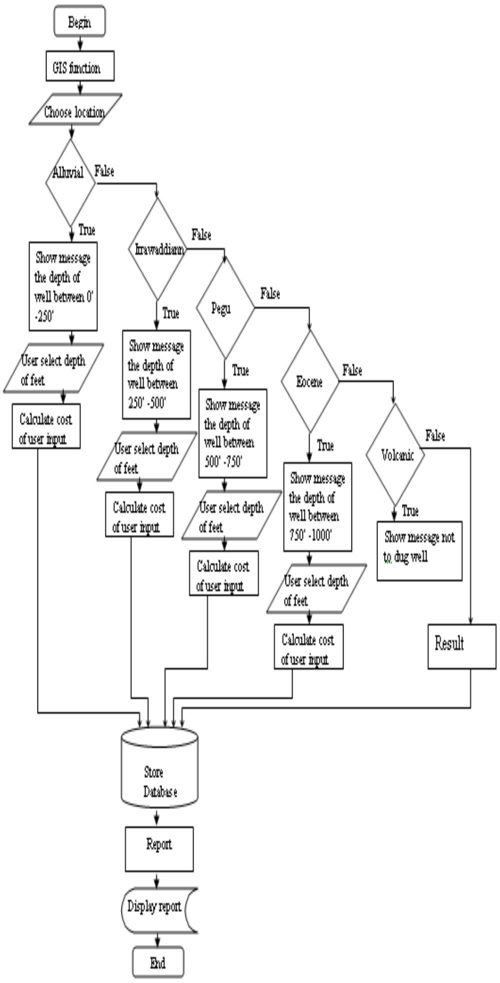

Figure2. Flow of the System

5. Implementation of the GIS system

A user can move anywhere on the map to know the position of map features as pair of x,y coordinates, the type of soil and each of the distance of eight townships can be calculated.

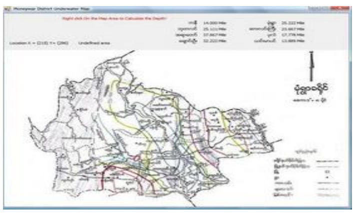

Figure3. Map area to calculate depth of well

If user click on the map that the type of soil is Alluvial, the depth of well is between 0′ and 250′ft. And then, the user inputs the depth of well between 0′ and 250′ft. So, the system will calculate the cost of depth well and can give the information to the user.

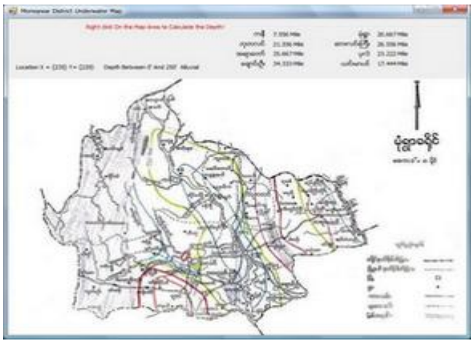

Figure4. Spatial distribution of well

The location where is situated Irrawaddy formation becomes to dug between 250 and 500. Water quality and its yield is good. The user inputs the depth of well and the system can give the information of the township.

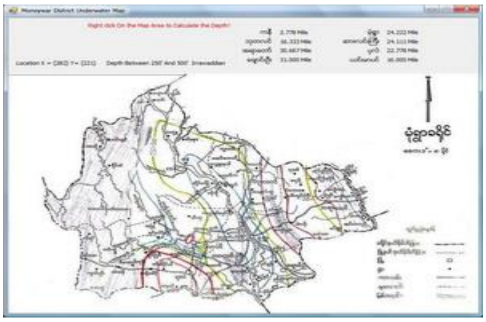

Figure5. Spatial distribution of well

Pague formation can be subdivided into two subgroup. Upper pegu group (Miocene) and lower pegu (Oligocene). The depth of well is 500′ and 750′. Water quality is salt and its yield is less. The user must choose the depth of well and so the system will calculate the cost of well.

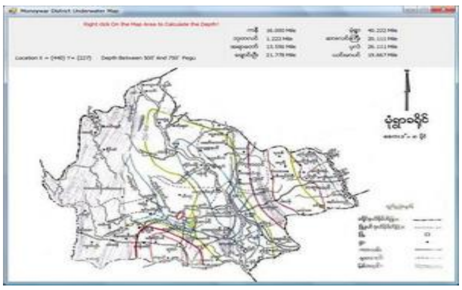

Figure6. Spatial distribution of well

Eocene formation is characterized by sand. Production of tube well is difficult. The depth of well is between 750′ and 1000′. The user inputs the depth of well and so the system can show associate information of well.

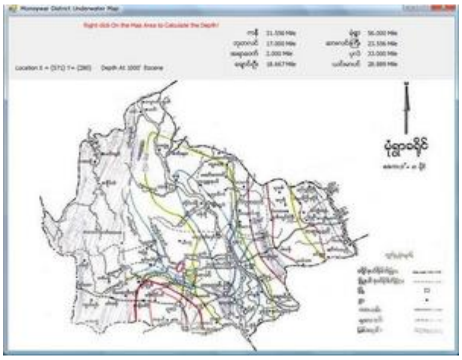

Figure 7. Spatial distribution of well

If user click that the type of soil is volcanic, the place is not suitable to dug well.

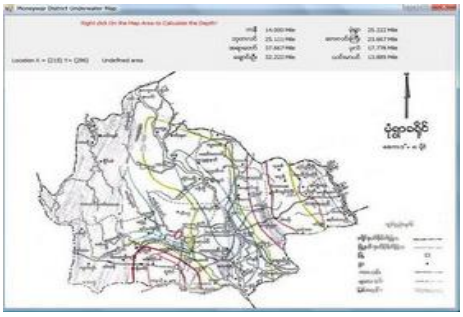

Figure8. Spatial distribution of well

5.1 Result of the system

Geological field works are simple. So, the use of geographic information system with hydrogeological database has grown quickly in groundwater management and research. Geospatial data are better maintained in a standard format, revision and updating are easier, time and money are saved and better decisions can be made. The cost of well is decided on the depth of well and current situation.

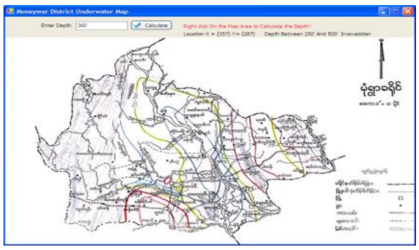

Figure9 .Input the depth of well

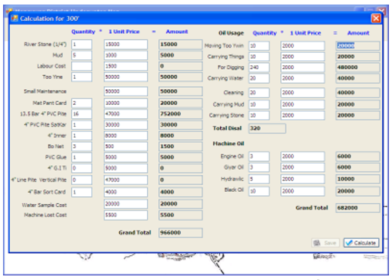

Figure10 .The cost of well

If user choose report button, the final report list is appeared.

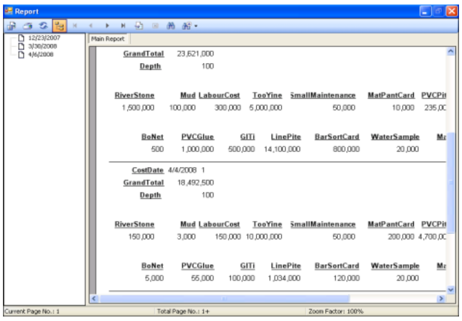

Figure11 .Report list

6. Conclusion

GIS and Its' powerful analytical tools can be used in countless applications. Choosing to use the technology and apply it to the hydrogeological database has shown to be effective in the case of geology study for the Monywa district. The paper has explored various issuses associated with the use of GIS and related hydrogeology database and groundwater exploration in Monywa district. Overall, the use of GIS in this paper such as this would be very beneficial and efficient.

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