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A Case Study of Applied Geographic Information Systems (GIS) in Slope Failure**Muhammad Najib Mohd Zailani¹, Ang Kean Hua²**¹Faculty of Science, Engineering and Build Environment, Deakin University, Australia²School of Biological Sciences, Faculty of Science and Technology, Quest International University Perak (QIUP)

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Abstract

Geographic Information Systems are increasingly popular and fast growing nowadays. GIS is a database system that controls the ability of spatial data as a set of reference data handling operations. Several approaches used to describe the Geographic Information System (GIS) are includes: *Toolbox*, *Information System*, and *Science Approach*. The GIS components can be data, technology, software, tools, and organization. Meanwhile, model-model in database are attribute data model (table model, hierarchy data model, network model, and relation data model), spatial data model (vector data model, raster data model) cartography model, terrain mapping model (DEM model, TIN model) and spageti model data. In conclusion, literature studies on GIS benefits in describe the various forms and methods in this study, whereby researchers have a clearer understanding of the ongoing study and research purposes.

Keywords: Geographic Information System (GIS), components, model, benefits

Introduction

Geographic information systems (GIS) can be defined in multiple meaning as there are many different approaches had been used based on the user applied in the various fields. The diversity of this definition is also significant because of debates and divergent views on Geographic Information System. According to Chang (2008) suggests four approaches to define and distinguish GIS from other information systems, namely through the convergence of process or function, application, or database tool box. According to Rainis and Shariff (1998), in a book entitled Geographical Information System defines GIS as an information system capable to enter, manage, manipulate, analyze, and display data related to geography or space efficiently. In other words, GIS is a system that involves the handling and processing of data and of information and connected with the attributes or characteristics of a particular geography or space on the surface of the earth.

Geographic Information Systems are increasingly popular and fast growing nowadays, which combines graphic and tabular data regularly is very important and should be taken into account. According to the United States Geological Survey (USGS) defines GIS is a computer-based system for mapping and functional equipment to analyze the phenomena of the room and not the room that occur on the surface of the earth. Therefore, GIS is a combination of two parts, namely the graphics (maps), and databases (Table). Estes and Star (1990) define GIS as "an information system designed to handle data related to spatial and geographical coordinates. GIS also is a database system that controls the ability of spatial data as a set of reference data handling operations. GIS is "a special case of information systems, ie

databases containing observations about the properties (features), activities and events (events) scattered by space, and defined in space as point, line, or area. In other words, geographic information systems are able to process point, line and area for the purpose of inquiry and ad hoc analysis".

According to Benoit and Clarke (1997) has proposed a common definition for GIS data is a unique space that can be linked to a geographic map as a database, information or both combined to define databases and information. For Maguire (1991), however, defines GIS as an institution that reflects the organizational structure that integrates technology into a single database, expertise and financial support over time. Burrough (1986), defines a set of GIS is a powerful tool to collect, store, retrieve at will, transform and load data real-world space. According Cats-Baril et al (1987) defines GIS as a set of automated functions provide extended capabilities for storing, retrieving performance, processing, and display of geographic data have laying to the professionals.

Others Approach

Several approaches can be used to describe the Geographic Information System (GIS) as described below.

GIS as Toolbox

Geographic Information System (GIS) is seen as a very important tool in many fields of study. Burrough (1986) defines GIS as "a set of powerful tools to collect, store, retrieve data, convert, and display spatial data from the real world". Therefore, GIS is emphasized as a means designed or created to solve specific problems in a phenomenon that exists.

According to Benoit and Clarke (1997), the GIS are a computer-assisted system that serves to collect, store, retrieve, analyze and display spatial data. Based on the function described by two researchers showed that GIS is a high-tech tool (toolbox) are widely used in the planning, development and decision-making especially in solving problems that arise. GIS software such as ArcGIS 9.3, ArcInfo, and other software related to the device in the form of maps and analyze spatial and non-spatial data.

GIS as Information System

Geographical information is increasingly important nowadays in all kinds of planning and decision making whether in the public or private sector. It is important to understand and influence the process of technological, socio-economic, spatial and environmental actively with a rational and systematic manner. The importance of this can be seen clearly when the world began to move the information age as a result of development of human civilization. In this new era, a lot of data requirements, accurate, complete and updated in various aspects and supply is very important and should be taken into account.

The development of information technology era began in the second half of the 1980s, when there is rapid development of computer hardware and software, in particular those used to develop information systems. Memory size and speed of the computer that is designed has enabled many GIS operations can be carried out. Increased networking capabilities of the database architecture and graphic higher have led to the development of a Geographic Information System (GIS) in specific areas.

Estes and Star (1990) define GIS as an "information system designed to handle data related to spatial and geographical coordinates. In other words, GIS is a database system capable of handling space data as a reference data set handling operations ". according Duecker (1979), GIS is" a special case of information systems, ie databases containing observations about the properties (features), activities and events (events) that are scattered in the room, and in the space referred to as points, lines or regions.

GIS in Science Approach

Parallel with the development of technology for land surveying, remote sensing, air photos, global positioning system (GPS), computer and mobile communication flow has made the GIS as a tool to grow rapidly. GIS technology is becoming easier and cheaper, have been widely used in various fields such as forestry, anthropology, and business. These changes have made the GIS as an important tool, as a new approach to science. Goodchild et al (1992) called this scientific approach, the science of geographic information (geographical information science) and has defined it as "an issue in relation to GIS technology, preventing the successful implementation of, or create an understanding of the potential ability".

In this paper, the researchers describe the theory and concepts found in the application of Geographical Information System (GIS), and the theories are related to the theoretical slope. GIS theory and concept covers Geographic Information System definition and the approaches in GIS, the historical development of GIS, key components in GIS, GIS relational databases and models in the database. Being applied GIS into slope studies, the researcher are also include the theories and concepts such as the definition of the slope, type of slope, the definition of slope failure and other types of slope failure. An additional, current study also includes part of previous studies (Literature Review) and conceptual studies that exclude GIS analysis term as well as involvement of of GIS analysis term; while the overall conceptual study was explained.

History Development of Geographic Information System

This section describes the historical development of a Geographic Information System that began with mapping and analysis, map, mapping various themes, and computer-aided mapping.

Mapping and Analysis Map (Early 1980s)

Historical development of GIS can be said to have occurred for decades and have been around much earlier than the introduction of computers, especially the use of geographic data such as maps have been used for centuries. For example, members of geography, sailors, land surveying and military experts have used the map as a guide to indicate the location and nature of the spatial distribution of geographical features (Rainis and Shariff, 1998).

Surveying and mapping is an important activity in the government before the fall of the Roman Empire, later developed in Europe in the 18th century. Developments in the evaluation study and understanding of natural resources such as geology, geomorphology, soils, ecology and plant dates back to the 19th century has provided new materials to be mapped. Distributions of natural resources is shown in the form of thematic maps, i.e. maps only contain specific information based on its use or refer to only one subject or theme (Rainis and Shariff, 1998).

Development in Mapping Usage for Various Purposes (1960-1970s)

The development of geographic data in mapping and needs in various sets were first discovered. This requirement stems from the rise of environmental awareness, when the environmental situation is deteriorating in developed countries. In order to achieve the environmental goals was emphasized. Thus, the environmental impact assessment of the various data sets have been created such as land use, soils, vegetation, hydrology, topography, and administrative boundaries began to be integrated for a more effective analysis and detailed (Rainis and Shariff, 1998).

Through manually overlap technique of maps, for the purpose of integrating data was introduced and has been popularized by an architect in the United States named Ian McHarg in the 1960s in his book *Design with Nature*. This stacking process is done through different map layers overlap theme or transparent information on the table light and the procedure is useful but requires a lot of energy and time (Rainis and Shariff, 1998). However, at this stage of development of GIS at the moment, has

already begun using computer systems since the 1960s for the purpose of mapping and analysis, but its use is not widespread as a whole due to the need for expertise is to be taken into account.

Mapping based Computer (1980s-present)

The development of information technology led to the introduction of the new era of computing systems in control systems, data processing and information services. The technological revolution has given new impetus and simplifies the various parties in goal planning, development and decision-making since the 1960s.

In line with this, Moellring (1980) has classified a new representative of maps in the use of computers as a "virtual map" more flexibility than previous maps, known as "real map" and shown on a computer screen in digital form. The introduction of computers in the field of mapping has led to the involvement of a number of professional geographers and cartographers in an attempt to draw maps using a computer (Rhind, 1977). Making processes of the computer can be known by various names such as computerized mapping, mapping the help of a computer or computer-assisted cartography.

GIS Components

Geographic Information System is not just a computer software and hardware to produce a map, but a system of control and analysis of geographic data that includes three fundamental components that operate in the context of an institution (Hua and Ping, 2018; Hua, 2018).

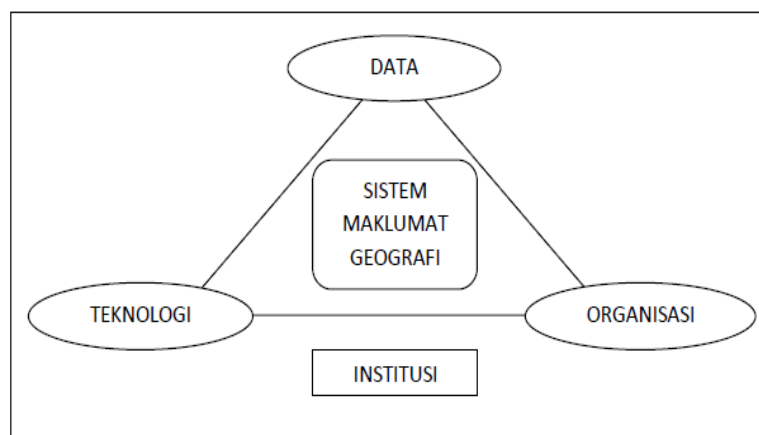


Figure 1: GIS Components
Source: Rainis and Shariff (1998)

Data

Data is the most important component in a Geographic Information System, as data processing is fundamental to effective information. Data also, is at the heart of information systems without data information system is not useful or not useful. Based on worldwide experience to date proves the data is a component that requires a "paramount consideration" in the implementation of geographic information system (Rainis and Shariff, 1998).

It is, as the information system is used to manage, integrate and process data in either room or not a lot of room, from various sources in a given time period. Reliability data, term limits of known data, and the primary consideration of the quality and integrity of the data base is very important in providing more effective and appropriate. Data in GIS database must also be updated, clean and accurate because any mistake will result in inaccurate information and the impact in terms of making decisions (Rainis and Shariff, 1998).

Data can be divided into two parts, spatial data and non-spatial data. Spatial data are referred to as data that refers to a geographical area on the surface of the earth. This data is expensive to collect, manage, and process as it involves a lot of space data problems (Hua and Ping, 2018; Hua, 2018). While the data is not too much space refers to the characteristics or attributes that describe a space, such as demographic, social, economic, and so on that are available in the geographical area. However, both types of data are intertwined with each other and interact. For example, people living in a particular area in a separate room to characterize the region. Therefore, both types of data are very important in information systems.

In addition, the data acquisition problem is a common problem faced by users who operate GIS. This is due to the shortage of data and compatibility are important factors that should be given serious consideration. Solutions and decision-making for individual planning and execution of development is influenced by the data. These problems usually occur in many developing countries. Therefore, making the right decision is made difficult due to lack of data.

Technology

Component technology consists of two main elements, namely software and hardware that is very important in information systems. Since its introduction in the 1960s GIS technology is the most important consideration in the implementation of information systems. However, with the rapid development of computer technology in the 1980s has made the technology is no longer an important consideration and an obstacle to implementing GIS. The two main elements of software and hardware costs are lower over time and processing power growing up nowadays (Hua and Ping, 2018; Hua, 2018).

Software

Software is a key technology in the development of geographic information systems. The existence of various design and software capabilities have improved various functions and operations and allow much development data can be implemented. Usually the software can be classified into several subsystems or major functions and input data acquisition, database management, processing and analysis as well as output and display of data.

Acquisition and data input functions to provide procedures for changing the format of the existing data into a form compatible with the GIS. This is because the GIS data is used to control the space and not a lot of room. In a GIS project entry of input data from various sources and formats, such as existing analog format, remote sensor systems, fieldwork, tables and attributes existing digital data is needed in the formation of the database.

Therefore, the inclusion of data input requires procedures to support the ability to input data in GIS, such as data format conversion, data reduction and generalization, editing and error detection, merger eccentric, registration and interpolation. Usually the input data is one of the major problems to be a major obstacle to the development of geographic information systems. It is, as it involves high costs and time that is 70 to 80 per cent of the overall costs and take several months to complete (Rainis and Shariff, 1998).

Database management is a subsystem that serves to provide procedures for storing, managing and retrieving data indoors and not outdoors (Hua and Ping, 2018; Hua, 2018). Therefore, data contained in the database can be used for the processing, analysis and presentation. Normally these procedures are controlled by the database management system. In the management of the database can be divided into two types of databases, namely databases in GIS and database conventional.

However, procedures or functions that are required in the two databases are almost identical, but there are advantages and a higher handling capacity in GIS database system. For example, the methods used in the management and processing of data will affect the level of efficiency of an information system

operates as a whole. According to Rainis and Shariff (1998), the organization and structure of the data is good when the retrieval, processing and data analysis can be done more quickly and easily. In addition, the data is very important that data management involves issues of data security, data integration and standardization of data. Especially for large organizations that have important data and information.

Whereas the processing and analysis functions is to provide operation process and analysis to produce new information in solving the problem of building and decision making. Therefore, to determine the type of information that can be generated by the GIS, the processing and analysis of data involves combining the various categories of data space. Therefore, to carry out operations analytics, statistics, measurement and other operations, processing and analysis of data is important for purposes of data transformation to information corresponding to an application. This transformation will involve data room and not the room either individually or in combination. Typically operations in GIS spatial data analysis includes the reclassification, duplicity maps, measuring distance and proximity, network analysis, and analysis of the neighborhood and the surface (Rainis and Shariff, 1998).

Output and display data about a procedure that is used to perform the analysis or information into a form that is understandable and useful to the organization for decision-making. Usually, the analysis of data or information can be presented in the form of maps, statistical tables, digital data and reports. Therefore, the last subsystem serves to display the analysis or study of phenomena in space.

Tools

Hardware is an element in the component in GIS technology, which also plays an important role, namely the four subsystems discussed above have actually been implemented using a complete set of hardware comprising a computer (Central Processing Unit, CPU), storage devices (disk drives hard, and scanners), and tools for data output (monitors, printers, plotters, and film recorders). Nowadays, there are several tools in implementing GIS platform of the main frame computer that has many processors to multiple users connected to the frame or the main terminal or the main server. The second is a personal computer or mobile which is a small computer system, and are widely used by individual users. Therefore, both types of platforms are an important tool in the development of GIS.

Organization

The organization is one of the most important components in the implementation of a Geographic Information System. This organizational structure can guarantee the success of any GIS implementation. Yet because these components are often not emphasized during the implementation of GIS, it becomes a major factor to the failure of the GIS implementation. Thus, the basic components of the organization are to ensure the effectiveness of the use of a Geographic Information System, as compared with the other two basic components, namely data and technology to the technical.

However, the effective use of a Geographic Information System is subject to the basic components of the other, depending on the development of technology and its relationship with the organization that implements GIS environment. To ensure proper use of a more systematic and effective, GIS must be placed in appropriate organizations. It is, as not just buying cutting-edge hardware and software and trains someone to perform GIS and the introduction of technology, but it can only be effective when the entire process is integrated into the existing work (Rainis and Shariff, 1998).

In addition, there are factors to be considered in the implementation of the Geographical Information System which is man, skilled workers, administrative procedures, and corporate expectations. Human factors refer to individuals who receive direct and indirect impacts of this technology. This is because any changes to the existing procedures will result in a balance of power, ownership and control will change. Skilled workers are referring to those who are skilled, knowledgeable and committed and without the presence of skilled workers, the implementation of a project will not be achieved.

In addition, the continued support of the administration is very important to enable the implementation of information systems, particularly in connection with financial and moral support. Therefore, continued support will ensure the continuation of the implementation of GIS. In addition, implementation of GIS is also influenced by external factors such as legal institutions, environmental, social and government policy. Therefore, to ensure the successful implementation of GIS should be consistent and in accordance with the requirements of the institutions which have been set.

Relationship Between GIS and Database

The database is an important component in GIS, because without a GIS database that does not mean. It is, as a GIS data model that includes two attribute data model and data model space cannot be integrated together without database. As we know, GIS is able to answer two questions, namely about the "what" and "where", i.e. "What" refers to the data attribute (non-motorized) on a geographical space objects stored in the database. While the "Where" refers to the location in the map data attributes referenced. Therefore, attribute data model and data model can be linked with the ID room or a shared database tables (Benoit and Clarke, 1997).

Model-Model in Database

The models in the database can be divided into two parts, the attribute data model or not indoor and outdoor data model. Both models are interlinked with each other.

Attribute Data Model

Attribute data model (non-spatial) is also referred to as a model of conventional or classic model, this model has been around since the introduction of computer technology. Generally, non-space data management such as administrative, military, banking, and business, using computer technology, has developed much earlier than in comparison with geographical or spatial data management. Now, the management of the data is not this room, which has developed in line with technological developments, the attribute data model has begun to be managed through a system known as a Database Management System. In this model, there are four ways or models for data management attributes of a table model, the hierarchical data model, network model and relational model.

Table Model

Model schedule are also known as flat files. This model is a model that has the simplest concept, that is not a column or attribute data will be incorporated into files that shaped columns with large tables. In this model, data is scrambled and hard attributes typically separated into several different levels of data collection or to the types of different entities. According to Rainis and Shariff (1998), this model is not the kind of flexibility and little danger to include tables there for fear of the same data item in the table. In addition, the data in this model have had a very significant, especially in terms of ability to answer questions that require various forms of relationship or communication between one or more variables.

Hierarchy Data Model

This model is a model that compiles the data in the form of a hierarchy or structure of the branch, namely data elements in this model are related to each other exist, each other a great deal. This model, generally easy to understand, updated, and can provide accomplished faster data set because this is accomplished faster data generated by encoding data connection directly to the database. This model will have the parent and the child, for example like census data that compiled by state, in a state by area, in the district according to the district, the county according to the census. In addition, this model is appropriate if the hierarchical structure can be optimized for searches to be carried out.

Although this model has some benefits, but it still has a major drawback, namely the structure of the branches that form the basis of this model is inflexible, because the ties between the data can only be defined vertically and not horizontally or horizontally. Thus, the relationship between the data is difficult to be modified and the question is limited to the existing hierarchical structure. Database management model based on hierarchical data, usually used to store data space; however, this model has not been successful as the basis for geographic analysis. In addition, this model has the disadvantage that it does not allow the parent who has a lot of elements.

Network Model

This model is a model that uses the concept of linkage in the form of "many-to-many". That is something the parent entity and also has many more children without the need for root. Therefore, the records can be searched without bypass an entire hierarchy above a certain record. This model also has differences with other models in terms of construction and also redefines the existing relationship. However, there are limitations to relate the records of the same type. In addition, the model data storage is less than the recurrence of a hierarchical data model. However, more extensive affiliation information must be stored, so this will add to the size and complexity of the data files. For large databases and complex relationship with information, it will take a long time to update the ties, in case of any changes.

Relations Data Model

This model is the simplest way to represent the real world. This model does not have the key indicators for each field and hierarchy data can be used as a guide. In this model, data is stored in tables and each table will relate to a single entity or a separate theme and data will be stored in a convenient form of record called tuples. In addition, the relational data model has several key advantages when compared to the series model and hierarchy. This is because the values of significant data in table form relationships and do not limit the type of processing that can be done. This model is also able to answer questions that can be formed using the rules of Boolean logic and mathematical operations (Hua, 2017). Therefore the types of different data can be searched, listed and compared.

In addition, the process of adding and deleting data is as simple as it only involves the addition or deletion of a tuple. This model is easy to understand and is a great way to present the idea of the database. However, the model also has the disadvantage that difficult to implement and have low achievement, which in this model, most of the search file or data is sequentially to meet the desired relationship because this model does not use a direct physical connection between the table with another table. Overall, the relational database system is slower when compared with hierarchical database systems and networks.

Spatial Data Model

Spatial model used to present data or to delegate the perception of space and its features in the surface of the earth. For example, the map is a model for describing the data space and the real world today. It is, as the shape of the room a phenomenon might be better understood through the picture as compared to the description of words to describe a space above the Earth's surface.

Performing computer database information based numbering (numerical), and the organization of data in a table or other forms typically vary with the presentation using a map. In this case, we use the model data refers to the organization mechanistic data corresponding to the logical organization an organization that has a fundamental meaning. Generally, GIS has two basic approaches to the data model to represent or arrange for a digital data room, which is the model vector and raster model, also known as tessellation model.

Vector Data Model

Vector model is the model represented by points, lines and areas (polygons) to define the border is of real-world phenomena. Its presentation vector model is very similar to the map drawn. This approach is also known as object-oriented representation. Placement of each entity or object will be defined by its position in space maps drawn up by the reference coordinate system, the position of each entity or a map will have the unique coordinates (Cartesian coordinates, XY). In the vector model, the position of the space and its borders will be represented as accurately as possible to the real world through the representation of points or lines. This is because, in a vector model coordinate space is considered as a continuous space, which allows all positions and other geometrical characteristics, such as length and width will be defined with precision.

In Geographic Information System, this position is commonly referred to as the coordinate system or map projection, which standardized the longitude and latitude, Universal Mercator, Cassini Soldner, or right oblique fulfilled (Rectified Skew Orthomorphic-Malayan RSO). In the vector model, there is an approach to organizing spatial data such as coordinates and topology data in computers and in general this approach can be divided into model without topology and topology model.

Raster Data Model

This model is one way to implement a common data model based distribution (teselasi) space to discrete units. Raster model can actually be broken down into three divisions, namely teselasi uniform, teselasi nesting and teselasi uneven. In the distribution model, the space is broken down into units of polygonal columns (cells) are arranged in a matrix form and is also known as a network, lattice or structure. Normally these units have a size, shape or orientation uniform like squares, triangles or hexagons, unlike vector-based model that focuses on the contents of these areas, and not to the boundary between the entities. In this context, refers to a set of raster cells or units (usually rectangular) which is structured in the form of scan lines of a line followed by another line, just like the set of parallel lines representing the television picture. Generally, the rectangular are known as pixels.

In a raster model, geographic placement of an object defined by the row and column of the cell covered thereby. As defined by the placement of the numbers of rows and columns, the laying of a geographical nature only be recorded to the nearest cell. Values recorded in each cell will indicate the type of objects or phenomena that exist in that location. Therefore, raster approach in space will be filled cells scattered widely and regularly and have a different record. The cell is the smallest unit of space and each cell is an area in the facility. The value given in cell covers the entire cell, and therefore the units in raster model is not consistent with the entities they represent real-world space.

Cartography Model

Cartography model is a method that can describe the current state of the real world using GIS software. This model can be used to solve complex space data, namely modeling to process and analyze multiple layers of data in making decisions to solve the problems faced. For example, in the study of the sensitivity of the hill slope failure and can be processed and analyzed using cartographic modeling. Using this model, the location and the potential occurrence of slope failures can be identified. Overlapping layers of other data such as land use, vegetation areas and so can be carried out for the purpose of processing and analysis, planning and action that can be taken to resolve the issue.

Terrain Mapping Model

Model of terrain mapping is part of the modeling in GIS. This modeling technique used for analysis of the earth's surface. In this model, there are various forms of analytical techniques such as contouring, hill shading, perspective hypsometric tinting and 3D view of the earth's surface for analysis. In the model there are two types of terrain mapping data used by the Digital Elevation Models (DEM) and

data based on triangulated Irregular Networks (TIN). Both types of data that are complementary to each other, although the DEM raster and vector data TIN cannot be combined in a single operation the same analysis.

DEM Model

Model of DEM data is represented by rows of dots altitude (Elevation) (Chang, 2008). Typically GIS users use the format DEM United States Geological Survey (USGS), but users also use alternative sources of DEM data from satellite, radar data, and LiDAR (Light detection and ranging) (Chang, 2008). Using data DEM surface analysis can be carried out using GIS software. All types of data, DEM data can be formed, stored and displayed again in three dimensions using GIS software, the direct analysis of the Earth's surface can be carried out more easily and clearly.

However before this DEM data can be used in the analysis of the earth's surface, the points-based DEM data it needs to be changed to a specific raster data to enable analysis can be carried out. For example, a point which may be obtained from the height of the benchmark on an area must be placed in the middle of a cell in a raster elevation data that can be used to format conversion process. However with the latest ArcGIS 9.3 can analyze DEM data directly without changing data to raster data format (<http://webhelp.esri.com/arcgisdesktop/9.3>).

TIN (Triangulated Irregular Networks) Model

TIN model is estimated on the earth's surface with a series of adjacent triangles (Chang, 2008). In TIN data model z value will be placed in the center of the coordinates x, y to make it as a triangle. TIN data often uneven compared with DEM data representing the coordinates of a regular line. But the line coordinate points are not actually be used to help TIN data format conversion process. The surface model generation can be carried out using a TIN data structure shaped as a triangle next to its ability to store and topological relations between the boundaries in terms of all three. According Harun (2006) TIN data is actually using a merger between two geometry and topology. The analysis results can be calculated and stored in the form of the gradient and the sides of the triangle, the triangle and the area of surface and gradient.

Triangular network that exists in the actual data has helped the formation of three-dimensional surface information (3-D), which is actually a series contains several features that are important in helping the process of producing a 3-D display. For example, each set of data points must have a height or a set of lines containing a pair of points x, y are connected by straight lines on the triangle. Triangle is actually something that contains three coordinates of x, y and z and each triangle must also have a mentoring relationship between the sides of a triangle that has been interpolated z value rooms. In addition, each of the sides of the triangle must have certain nodes to allow the calculation process for the other side of the triangle can be carried out.

Spageti Model Data

This model is a model which is more easily understood and represented by coordinate's Cartesian. In this model, the base map used to be translated or converted to a line-by-line into the XY coordinates. Each point will be encoded as a single coordinate pair, while line is also online XY coordinate pair. In this model, the polygon will be used to represent each region and it is located in a closed loop. The border-to-border area will be defined by XY coordinates, while the data files that have been designed a line between the coordinates and no structure in it (Harun, 2006).

Slope Concept and Theory

Concepts and theories slope will discuss the definition and other types of slopes. It aims to enable a greater understanding of the concepts and theories to understand how the slope of slope failure can occur. In addition, an understanding of the slope of the analysis of the survey can be carried out more accurately, once researchers understand the concepts and theories of the slope.

Slope Definitions

The natural slope of the hill contains a set of attributes such as plants, soil and rock. Each attribute can be counted as a separate system that can affect the overall functioning of the system unit (Salleh, 1992). The term slope, usually used to indicate any form of uneven surface of the Earth between the top of the hill up to the surface level of the river (Salleh, 1992).

The slope of the hill has several definitions based on a specific field angle, according to the Dictionary of Geological Term Issues Anchor noted that, a surface that is tilted at hills, mountains, plateaus, plains or any part of the earth's surface is the slope of the hill. From an ecological point defines the slope of the hill is regarded as an ecosystem that contains components like living organisms, organic debris, water, gas and mineral nutrients, which interact with each other to maintain and develop the slope of a hill, in terms of the flow of energy, water and nutrients (Rhind, 1977).

In other words, the slope of the hill is an element of the earth's surface, including land and ocean surface arising lithosphere meeting with either the hydrosphere or atmosphere (Strahler, 1968). Strahler (1968) defines the angle of slope of the geomorphology of the terrain that is 3-dimensional, resulting from denudation processes such as mass removal and washing the slopes. In reality, the slope represents the dynamic relationship between the ridges (hill) with parallel valley (river).

Slope is a complex phenomenon resulting from the interaction of the lithosphere relationship with the atmosphere (Strahler, 1968), which is inclined from the top to the valley and on bounded by natural boundaries. As the surface of the earth, rivers, peaks and bedrock (Duecker, 1979): A system that is open to the inclusion of energy and matter, such as solar energy, water, gas, organic and parent material (Schell and Lockwood, 1997).

Types of Slopes

The slope can be divided into several types, namely natural slopes, man-made slopes, cut slopes, embankment slopes and slopes of earth dams. Every slope has processes or factors that affect the slope of the slope failure.

Concepts and Theories of Slope Failure

Understanding the concepts and theories of failure is an important matter and needs to know before doing an analysis of the study in the study area. For example, by understanding the definition of slope failure and slope type will be directly briefed early in the failure of the slope is noteworthy and important analysis of the slope should be emphasized.

Definitions of Slope Failure

Slope failure is a very important aspect and should be taken seriously, especially in areas with buildings or areas inhabited by humans. The actual slope failure, also known as landslides and mudslides have defined a movement of soil or rock slope in a large volume. The slope failure usually occurs in areas with steep slopes and form cracks or breaks or slope areas that have high shear.

Types of Slope Failure

There are various mechanisms of slope movements occur; the mechanism is via two main criteria to determine the types of slope movement or slope failure to identify the causes and forms of ground movement in force. Among the types of slope movement, can be divided into several movements of the ruins (falls), slip (slides), a spreadsheet, a wedge, erosion, and the flow (flow). Failure slope form rubble (falls / topping) is a form of slope movement mechanism which normally applies in a very steep slope. This slope movement known as the debris, because the movement on the ground will continue and fall. This type of slope failure, involves round rock layers, when the movement of the slope form rubble separation process begins with the soil that is whether this process happens quickly or in a long time. This separation process, actually happens when there is heavy pressure force block and the height difference between the hills and valleys. In addition, the separation of rocks usually happens in the long run is usually associated with environmental processes such as freezing.

Failure Category		Material Types			
		The Bedrock		Soil Engineering	
				Coarse Particle	Soft Particle
Ruins		Rock Ruins		Debris Ruins	Land Ruins
Serial Ruins (Topples)	Land	Rock		Debris	Land Drops
Slippage	Rotation	Rock Drops		Debris Drops	
	Translational	Slip Rock Block or Stone		Slip Block	Debris Block
Spreadsheet Side		Rock		Debris	Land
Flow		Rock		Debris	Rock
Complex		Involve two mergers or more failure			

Source: Varnes, 1978

For this type of movement sliding slope (slides) Furthermore, a slope failure involving the land movement in the plane of failure experienced high shear. This movement is also, actually occurred as a result of the presence of cracks on the corners of the original surface slope, and land collapses then moves on to more than downslope and accumulated at the foot of the slope of the hill. In addition, the movement of the slope sliding type can be further subdivided into several sub-types of sliding rotation sliding, sliding straight or transition, and slip compounds.

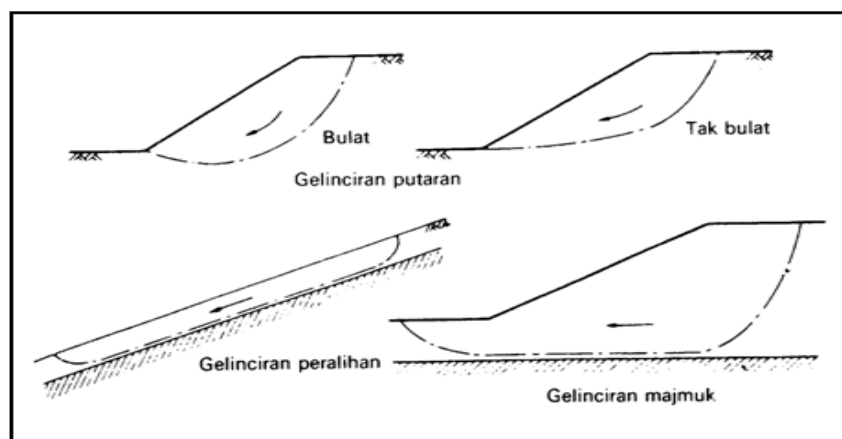


Figure 2: Type of Slope Failure-Slippag

Source: Craig, 1986

Movement slope movement of the wedge (wedge) is the slope failure occurs when there is a cross between the two planar surface discontinuities and creating blocks of rock that was "daylight" on the surface of the slope. Wedge-shaped stone blocks that will have the potential to derail the lines of

intersection between the two planes of discontinuities. In addition, there are two planes failure to consider the failure plane by gravity in a dry state, and the failure of the plane by gravity in the presence of surface water conditions.

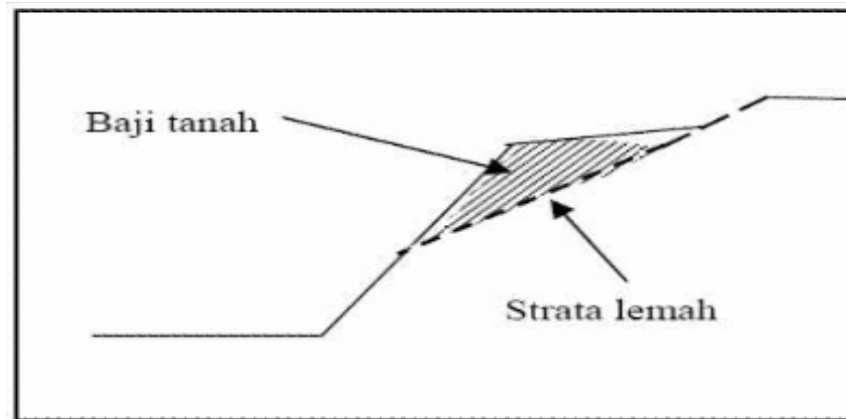


Figure 3: The movement of Wedge

Source: Craig, 1986

Slope movement was kind of erosion, is one type of slope movement that involves two basic processes, namely the process of liberalization of the soil particles are usually due to the impact of raindrops and the transport of soil particles. The type of erosion can be divided into two groups, geological erosion accelerated (accelerated erosion). Geological erosion is a process of production land and this process occurs in a state of equilibrium, while erosion is accelerated erosion is usually caused by action or human activity. The type of erosion due to slope movements outside the mechanism can also be divided into several types of the erosion of the rain impact erosion, corrosion layer, erosion gully and ravine erosion.

For the movement of slope failure types of flow (flow), the flow is common in Malaysia, namely the failure to take the form of a mud flow or flow associated with the flow of water containing a ground (earthflow). This movement occurs when solving process and move material without focusing on the boundary shear displacement. The slope failure usually occurs in conditions of moisture above the water when the water content of liquid limit, however this slope failures can still occur even if moisture does not exceed the limit liquids.

Literature Review

Past research (literature review) is one very important part in the training of scientific research. Past studies have used the first two meanings of the search information from any source of writing, such as books, web sites, journals, and others. While the second is part of the thesis or research proposal containing relevant studies. Past research also represents a combination of the results of research and theoretical studies to serve as a reference and comparison studies of other researchers.

Comparative Study between Researchers Prior to the Research Study

Based on studies conducted by Thanapakiam Periasamy and Professor Dr. Khairulmaini Salleh Osman (2007), entitled "A study of urban spatial slope failure in Hulu Klang," which saw Malaysia as a space undergoing the process of weathering and erosion are very active. Researchers argue tropical climate and population growth in Hulu Klang seen as a factor causing factor to the occurrence of slope failure. They also felt that due to the increase in population has increased the demand of the population for the construction sector. This is directly attributable to development activities mainly in the foothills of Hulu Klang. Researchers also noted that not only the human factors that cause slope failure in Hulu Klang, but also due to the natural factors that increase the rate of weathering and erosion on hillsides.

While in this study, the researchers did not look at the overall population and a tropical climate but looking at the overall steepness, development and plant cover, consisting of natural vegetation and agricultural activities. In addition, this study not only see the steepness, development and vegetation cover per se, but in this study the researchers also use GIS applications to determine the location of potential slope failure. However, these studies also serve as a reference and guide in conducting the study.

The study, titled "hillslope processes, impacts and mitigation measures undertaken by the hill slope failure Rahman et al (2007), U11 and U12 in Shah Alam, Selangor. He said the processes that occur in the slope of the hill include the erosion, and chemical weathering mass movements is a key process in the hilly terrain and the cause of the slope failure in the study area. Through the observations made by him as an image capture area of study, he found that factor to slope failure not only because of the processes that exist but also due to the characteristics of the soil, the steepness of the slope, vegetation cover and land use in the study area, is a causative factor to the occurrence of slope failure at U11 and U12 Shah Alam. In this study the researchers also have proposed control measures such as the construction of slope failure fortress wall, planting grass, the use of waterproof plastic, cutting the hills following the contour lines and so on. Based on this study suggests a study conducted by researchers is the same as in this study. But during this study were researchers in this study attempted to examine the scope of a wider study area and using GIS applications as a tool in the analysis of the study. Whereas a survey conducted by Mohd Ramli Zahurin more on the method of observation in the field and not using Geographic Information System as a medium of study.

The study conducted by Hamzah (2001), which refers to a hazard analysis of slope failure processes of slum communities. In this study, researchers tried to highlight the processes that occur on slopes that cause slope failure and danger to the community of squatters. Through research, he said there are several factors that influence the slope failure occurring plant cover, soil properties, soil erosion rate, topography and climate that includes rain and temperature. Researchers found the slums are often built on hillsides caused minded people faced the threat of danger and risk of slope failure. The researchers also noted that the slope failure would pose a threat to property and lives, thus the researchers suggest the local authorities (LAs) to take appropriate action to mitigate this problem. According to a study conducted showed the researchers focused on slum communities and the factors that influence the slope failure. Similarly, in this scientific training, also focus on the factors that cause slope failure, but that differentiate these two studies are not the focus of this scientific training to the community of squatters and using GIS applications as a major medium in the study analysis. However, this research is very important as a source of reference and guidance on the factors contributing to the failure of the slope.

According to the journal written by Rahman et al (2007), tried to make an initial review of potential slope instability and the characteristics of the physical and chemical soil in Cameron Highlang, Pahang. The researchers are trying to look at aspects of geology as a guide to the potential instability of slopes in Cameron Highland. In this study, researchers found that the content of soil has granite batholiths that smash into the older sedimentary rocks. Intrusive which occur is referred to as the body of igneous intrusive acidity causing formation of sedimentary rocks and metamorphic rocks other. Through observations in the field, researchers found that most cut slopes as the road across the rock mass.

The results of the observations made, based on the kind of features it appears that the physical and chemical nature unstable slopes and easy to collapse is the type of soil which has loose soil friability, poor vegetation cover, large particle size distribution, water content and pH value (soil acidity) Low plays an important role in influencing the instability of the slope. Researchers found the Cameron Highland have a low pH (acidic properties) on all slopes have reduced the iron oxide content in the soil which acts as the cement ground, this, cause easily eroded slopes and weathered conditioning. Based on observations by the geometric properties, the researchers found that high slopes and steep terrain angle is unstable area. Analysis conducted by Zulfahmi Rahman et al (2007) in determining the location of risk areas is the analysis of the internal characteristics of rocks and very different from the methods of analysis using GIS application more room to analyze the map. For example, in this study the researchers to analyze the earth's surface compared to the analysis of rocks.

The study conducted by Qiu et al (2006) entitled "A 3D GIS Development For Evaluating Slope Stability" in Japan. This study is an analysis using a 3D model to evaluate and determine the landslides in the regions in Japan. About 70% of Japan's mountainous areas face the threat of slope failure and this has become an important issue. Researchers are trying to find alternative solutions in order to identify zones of potential slope failure slope. Generally researchers categorize two types of methods such as statistical methods and modeling methodology to determine. Statistical method is a method that is based on the calculation of the quantity or number and is suitable for the analysis of the slope, while modeling methods are more suitable and relevant for the analysis of a large space or regionalism, although this analysis is an analysis of the difficult and involves the processing of large sets of data space, in identifying high-risk areas of slope failure. Therefore, the researchers used this method to solve the issues faced, the analysis of 3D modeling in GIS. With the advantages of GIS, which has two major functions for exposure analysis map (Geostatistical) and databases, enabling analysis of the slope is more pronounced in the process of identifying landslide zones, for regions in Japan. In this study, researchers used a Digital Elevation Model (DEM) to identify the slope. According to a study conducted by Japanese researchers, showed researchers in this study also used the same method of analysis methods of slope surface through 3D modeling and GIS applications makes steepness factor as an indicator of the risk of slope failure.

The study conducted by Ahmad (2005), entitled "Use of Geographic Information System" to predict the collapse of the slope in Penang. Researchers see GIS as a tool to predict the landslide, as the researchers noted that the advantages of GIS to control large amounts of data, analyze the results display, store, manipulate data, and so on. In this study, he tried to predict the landslide area through mapping analysis, and specific analyzes in GIS and landslides resulting model. Researchers also noted that the ability of GIS in data presentation and analysis of results in the form of maps have been able to predict the critical areas landslides. Therefore, in this study the researchers also use GIS applications to predict areas at risk based on the level of sensitivity, but during this study with ongoing study is to predict the researchers not only risky but potentially determine the location area by area in the state of Selangor and map risk areas in 3D.

The study conducted by Aaron (2006), entitled "Review of determining risk areas using Geographic Information System" is an analytical study that makes GIS as a tool to determine the areas at risk in the area of evidence Ampang Jaya Municipal Council (the council). Through this research, he tried to present the results of analysis by the expression of the sensitivity map of the study area using GIS to assist urban planners or developers. Researchers are also trying to use GIS analysis, to ensure that planning and development corresponds to the capacity of the ecosystem without affecting the physical, biological, social and especially in the hills of the council. In his study, try using GIS analysis in the degree of sensitivity and relevance of the study area for the construction site. A study conducted by researchers in this study using GIS as a determinant of slope failure, but rather the scope of the study area where little research and determination of the suitability of the area for development. Whereas in this scholarly training, not only researcher using a gradient parameter as a determinant of risk areas, but researchers also specify the location of sensitive areas throughout the county in the State through 3D modeling.

For a research study conducted by Zubair (2006) entitled "Change Detection in Land Use and Land Cover Using Remote Sensing and GIS data: Case study Ilorin, Kwara State in Nigeria. This study is an analysis of the data using RS (Remote Sensing) and Geographic Information Systems to identify changes in land use and forest area or area with no development (land cover) as a result of human activities (anthropogenic) in Ilorin. In this study, researchers tried to analyze land use activities carried out in the study, when land use activities carried out by the developers do not see the status change in development since 1967, such as those run by other states in the country Nigeria. Therefore, researchers have used the advantages of RS data and GIS analysis to anticipate changes in land use and natural areas, to enable the development planning and land use for the future. In other words, through the RS data and GIS will be a guide to those responsible for development planning in Ilorin. In this study, researchers used the advantages of GIS and RS, which is like the classification of land use and forest area is displayed through the map. The researchers are also using the advantages of RS and GIS analysis to spot trends, rates, location and magnitude of changes in land use and forest (land cover). In

addition, researchers have established a pattern of land use maps as a guide to the developer in Ilorin, the Kwara, Nigeria. In this study the researchers focused on the analysis of changes in land use and land use planning, while studies in scientific training is more focused on the factors influencing the development of slope failure, namely land use analysis conducted by researchers not specific to land use changes but makes use activities the land as a factor of slope failure. However, the study will also serve as a reference in the study.

Summary of Literature Review

Based on a comparison of previous studies indicates that there are two main parts to the failure analysis and the sensitivity of the hill slope. Generally, there are two main aspects of GIS and non-GIS aspects. Aspects of GIS analysis are not to review not in the room, but more on the factors and processes that occur in slope areas. For example, previous studies conducted non-GIS aspects do not look at the location and distribution of the hilly terrain, compared with studies in GIS aspects that are very concerned with aspects such as location and distribution of space and land-use patterns that exist on the surface of the earth. However, both methods of analysis are very important and interdependent of each other, because that is not used GIS analysis will clarify whether the reason for the occurrence of slope failure.

While the analysis in the GIS would explain the failure of slopes and land use of the room where the terrain slopes facing the threat of failure can be identified. Previous studies, too, can show there are methods or other aspects such as aspects of geology, which emphasizes the type of rock and internal processes that occur in rocks of the slope, which also affects the hill slope failure occurred. Such as rock type and chemical composition will affect the processes in soils. Overall, there are various methods carried out by researchers in identifying and dealing with problems or issues arising in connection with the failure of slopes and sensitivity and land use made by humans.

Conceptual Framework

This conceptual framework is seen areas that are sensitive hill slopes and areas with potential slope failure in the Negeri Selangor. In addition, the researchers want to identify and explain the factors and processes, to cause slope failure in the slope of a hill or high ground. The researchers also wanted to see whether there is development or land use residential development in the area of high risk of slope failure. After that, researchers will recommend measures that can be taken to overcome the problems that arise as a result of the analysis carried out. Here is a model that can explain the conceptual framework of the study to be conducted by the researcher.

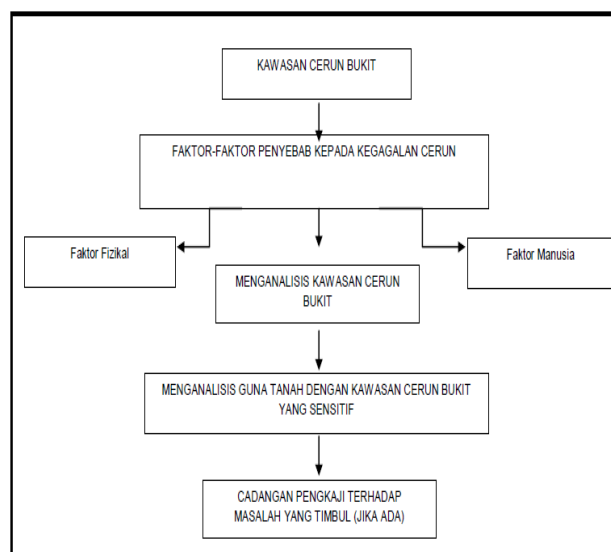


Figure 4: Conceptual Framework

Conclusion

According to the overall theory and concepts, showing the description of the concepts related to the study are researchers run. Sign of the theories and concepts that involve definitions, previous studies and so also assist researchers in conducting studies related to the slope of the hill. In this respect, the researchers will also be a guide in the process of database development in Geographic Information Systems. Based on previous studies that describe the various forms and methods of the study, researchers gave a clearer understanding of ongoing study and research purposes.

Through the theories and concepts of this chapter too, will give an explanation and a more detailed understanding of the application of Geographical Information System. In addition, with a detailed understanding of this, the researchers gave the idea to understand and know the functions or concepts in the application of Geographic Information Systems GIS applications and how they function and play an important role in the processes of research, especially in studies related to the phenomena that occur on the surface of a space. Therefore, this is a very important thing to be a guide for researchers to continue their research.

References

- Aaron, N.E. (2006). Review of determining risk areas using Geographic Information System.
- Ahmad, F.S. (2005). *Penggunaan Sistem Maklumat Geografi (GIS) untuk meramal keruntuhan cerun di Pulau Pinang*. Universiti Teknologi Malaysia, Skudai Johor.
- Benoit, D., & Clarke, G. P. (1997). Assessing GIS for retail location planning. *Journal of retailing and consumer services*, 4(4), 239-258.
- Burrough (1986). *P.A. Principles of Geogrphic Information System for land resources Assesment* : Clarendon Press.
- Cats-Baril, W. L., & Huber, G. P. (1987). Decision support systems for ill-structured problems: An empirical study. *Decision Sciences*, 18(3), 350-372.
- Chang, K.T. (2008). *Introduction to Geographic Information System (4th ed)*. New York, Mc Graw Hill.
- Duecker, K.J. (1979). 'Land resource information systems: a review of fifteen years experience', *Geo-Processing*. 1(2), 105-128.
- Estes, J. and Star, J. (1990). *Geographic Information System : An introduction*. Perintice Hall.
- Goodchild, M., Haining, R., & Wise, S. (1992). Integrating GIS and spatial data analysis: problems and possibilities. *International journal of geographical information systems*, 6(5), 407-423.
- Hamzah, T.A.A.T. (2001). *Satu analisis ancaman bahaya proses-proses cerun terhadap masyarakat setinggan*. Universiti Malaya Kuala Lumpur.
- Harun, N.E.(2006). *Kajian penentuan kawasan berisiko menggunakan Sistem Maklumat Geografi (GIS)*. Universiti Teknologi Malaysia, Skudai Johor.
- Hua, A. K., & Ping, O. W. (2018). The influence of land-use/land-cover changes on land surface temperature: a case study of Kuala Lumpur metropolitan city. *European Journal of Remote Sensing*, 51(1), 1049-1069.
- Hua, A. K. (2018). Spatial-Temporal Analysis Of Pattern Changes And Prediction In Penang Island, Malaysia Using Lulc And Ca-Markov Model. *Applied Ecology And Environmental Research*, 16(4), 4619-4635.
- Hua, A. K. (2017). Land use land cover changes in detection of water quality: a study based on remote sensing and multivariate statistics. *Journal of environmental and public health*, 2017.
- Maguire, D. J. (1991). An overview and definition of GIS. *Geographical information systems: Principles and applications*, 1, 9-20.
- Moellring, H. (1080). Strategies of real-time cartography. *Cartography journal*, 17(1), 12-15.
- Qiu, C., Esaki, T., Xie, M., Mitani, Y., & Wang, C. (2006). A GIS system development for evaluating 3D slope stability. *ESRI. Retrieved, 1*.
- Rahman, Z.A., Rahim, S.A., Yaakob, J., dan Idris, W.M.R. (2007). *Tinjauan awal ketidakstabilan cerun dan cirian fizik-kimia tanah di Cameron Highland, Pahang*. *Journal Sains Malaysia*, Kuala Lumpur

- Rainis, R. and Shariff, N.M. (1998). *Sistem Maklumat Geografi*. Kuala Lumpur. Dewan Bahasa dan Pustaka.
- Rhind, D. W. 1977. Computer-aided cartography. Transactions of the Institute of British Geographers New Series 2: 71–97
- Salleh, K.O.(1992). *Process-response relationships under secondary vegetational systems : some observations of infiltration rates and soil production and their controlling factors under *Dellinea suffruticosa** : Paper presented At Malaysia Ecology Conference A Universiti Pertanian Malaysia, Serdang.
- Schell, S.P. & Lockwood, J.A. (1997). Spatial analysis of ecological factors related to rangeland grasshopper (Orthoptera: Acrididae) outbreaks in Wyoming. Environmental Entomology. 26, 1343-53.
- Strahler, A.N. (1968). *Physical Geography* : John Willey and sons, New York.
- Varnes, D.J. (1978). Slope movements, types and processes, in Schuster, R.L. and Krizek, R.J. (Eds.), *Landslide Analysis and Control*, Transportation Research Board, Nat. Ac. Sci., Washington, D.C. Special Report 176, 11-33.
- Zubair, A.O. (2006). *Change Detection In Land Use And Land Coverusing Remote Sensing Data And Gis : A Case Study Of Ilorin And Its Environs In Kwara State*. Unpublished Master's Thesis. University Of Ibadan, Ibadan.