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THE INTEGRATION OF GLOBAL POSITIONING SYSTEM (GPS) AND SURVEYING PACKAGES FOR NEAR REAL TIME FLOOD MONITORING SYSTEM

(INTEGRASI SISTEM PENENTUDUKAN SEJAGAT (GPS) DAN PAKEJ PENGUKURAN BAGI SISTEM PEMANTAUAN BANJIR HAMPIR MASA HAKIKI)

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TAJUK PROJEK : **THE INTEGRATION OF GLOBAL POSITIONING SYSTEM (GPS) AND SURVEYING PACKAGES FOR NEAR REAL TIME FLOOD MONITORING SYSTEM**

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ABSTRACT

(keywords: Global positioning System (GPS), floods monitoring, surveying)

Traditionally, maps are being used to provide information for planning, implementation and development. However, with the introduction of computerized techniques in map-making and space technology in surveying and mapping, the utility of map data can be coordinated in near real-time situation. Flooding is the common of all natural hazards and the magnitude of flooding can be only a few inches of water or it may cover a house to the roof top. Information about flooding is important for the public preparation and relief operation when floods occurred. Global Positioning System plays a significant role in providing data in area of floods since data can be achieved in a relatively short period and over long lines irrespective of terrain, intervisibility and weather. GPS couple with surveying packages that include geographical information system technology can result into effective, economic and efficient tool for storing, manipulating, and presenting spatial and non spatial information. This research have demonstrated the feasibility of using GPS in near real-time mapping for flood monitoring system especially in providing positions and heights of water level in floods area for updating data that give better understanding, monitoring and managing the disaster. The display of digital map on largest possible scale can enhance the integrated positioning systems made available with visualizing spatial data using a three dimensional in providing water volume on specific flood area and obtaining the analysis on the river. Digital elevation model (DEM) for the entire area using available surveying packages and a complete TIN-DEM modeling for flood monitoring system can be developed. From this technique, water volume on specific flood area and analysis of the river can be obtained.

ABSTRAK

(Kata kunci: Sistem Penentududukan Sejagat (GPS), pemantauan banjir, pengukuran)

Secara tradisi, peta digunakan untuk penyediaan maklumat bagi tujuan perancangan, perlaksanaan dan pembangunan. Walau bagaimanapun, pengenalan teknik komputer dalam pembuatan peta serta teknologi angkasa dalam bidang ukur dan pemetaan telah memungkinkan persembahan data peta dilakukan secara hampir masa hakiki.

Banjir adalah bencana alam di mana magnitudnya adalah daripada beberapa inci ketinggian air sehinggalah mencecah bumbung rumah. Apabila berlaku banjir, maklumat mengenai banjir tersebut adalah penting bagi tujuan keselamatan dan persediaan orang ramai serta operasi menyelamat. Teknik Sistem Penentududukan Sejagat (GPS) memainkan peranan penting dalam penyediaan data banjir bagi kawasan yang terbabit kerana ia membolehkan data diperolehi dalam jangka masa singkat tanpa gangguan daripada segi jarak, rupa bumi, saling nampak dan cuaca. Gabungan teknik GPS serta pakej pengukuran yang mengandungi teknologi sistem maklumat geografi boleh menghasilkan satu peranti penstoran, pengolahan dan persembahan maklumat spatial dan bukan spatial.

Penyelidikan ini telah membuktikan kesesuaian penggunaan GPS secara hampir masa hakiki bagi tujuan sistem pemantauan banjir terutamanya daripada segi penyediaan kedudukan dan ketinggian aras air kawasan yang terbabit dengan banjir. Pengemaskinian data secara hampir masa hakiki ini penting bagi memastikan keberkesanan dalam pemantauan dan pengurusan bencana. Selain daripada itu, pemaparan peta berdigit pada skala terbesar mampu meningkatkan sistem integrasi ini. Justeru, data dapat dilihat secara tiga dimensi. Malah sistem ini juga menyediakan maklumat isipadu air bagi kawasan banjir tertentu yang membolehkan analisis terhadap sungai yang terbabit dapat dilakukan secara terperinci. Analisis ini dapat dilakukan dengan menjana model DEM bagi keseluruhan kawasan yang terbabit. Keberkesanan daripada pembangunan sistem pemantauan banjir telah diuji dengan menggunakan pakej pengukuran yang sedia ada dan model TIN-DEM yang lengkap boleh di hasilkan. Dari teknik ini juga isipadu air kawasan banjir dapat di hitung dan analisis sungai boleh di dapati.

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CHAPTER 1

INTRODUCTION

1.0 Overview

In Malaysia, floods are caused by a combination of natural and human factors. The basic cause of flooding in Malaysia is the incidence of heavy monsoon rainfall and the resultant of large concentration of runoff, which overwhelms river systems. Rapid urbanization within river catchments in recent years has also served to compound the problem. Higher runoff and lessening river capacity have resulted in increased frequency and magnitude of floods.

Monsoon rains have a profound influence on many aspects of the lives of the people particularly in the east coast of Peninsular Malaysia. While the rains are needed for agriculture, particularly wet rice cultivation, they are also largely responsible for bringing seasonal floods. The seasonal floods in the east coast are

therefore a natural consequence of these heavy rains occurring over a short period of time. Furthermore, when the prevailing easterly winds cross the central mountain ranges of the peninsular, they occasionally cause a “spill-over” effect bringing heavy rains and subsequent flooding to the West Coast as well. Thus, rains and floods are often perceived as hazards as well as resources. Nevertheless, while some parts of the peninsular Malaysia are mostly affected by the extensive and severe localized floods due to the onset of the monsoon seasons, other parts may be affected by flash floods.

A flash flood can be defined as a fastest moving flood that cause severe destructive along the pathway. Heavy downpour that is collected in a stream or gully turns the scene from calm to instant rushing force. This is the main cause of lost of lives and damage in properties as the flood will catch the people off guard. Flash flood is becoming very common in Malaysia as more development and urbanization are taking place in a great velocity. Most floods or flash flood occurs during the monsoon season from November till January. The worst flood situation in Malaysia happen 1926 and followed by 1931, 1947, 1954, 1957, 1967, 1971 and 1992. It was estimated that almost 9% of the location in Malaysia (26,000 kilometer square) are flood prone during monsoon season (Flood Commission, 2006). Malaysia is one of the country in Asia that having flood problems.

1.1 Floods

Nowadays, floods has becomes a major hazard to life and property when people live or work on the floodplain (Burton et. al., 1993; O’Keefe et. al., 1976). In terms of hydrology, a flood is simply an overflow of water beyond its normal confines, especially over normally dry land whereas a floodplain is an area of low-lying land adjacent to a river subject to inundation on a regular basis (Lewin, 1988). A major cause of flooding is intense or prolonged rainfall, which in large catchments may occur several hundred kilometers from the flood affected area.

Most river floods result directly or indirectly from climatologically events such as excessively heavy and/or excessively prolonged rainfall. Major landslides, such as 'La Josefina' in the Paute valley near Cuenca, Equador, in 1993, may causes flooding in two ways. First, pounding occurs behind the debris dam across the valley causing upstream flooding; then, as the debris dam is overtopped, erosion or collapse delivers massive flows downstream. River floods may also result when landslides fall directly into upstream lakes or reservoirs causing a sudden rise in water level, which overspills the outlet or dam.

There several types of flood related to rivers such as;

- Floods in river valley occur mostly on floodplains or wash lands as a result of flow exceeding the capacity of the stream channels and *over spilling* the natural banks or artificial embankment.
- Sometimes inundation of the floodplain, or of other flat areas, occurs in wet conditions when an already shallow water-table rises above the level of the ground surface. This type of water table flooding is often an immediate precursor of overspill flooding from the stream channels.
- In very dry conditions, when the ground surface is baked hard or becomes crusted, extensive flat areas may be flooded by heavy rainfall ending on the surface. This rainwater flooding is typical of arid and semi-arid environments but is also experienced much more widely.
- Also typical of arid and semi-arid areas is the situation where there are no clearly defined channels and where sheet wash flooding occurs by the unimpeded lateral spread of water moving down a previously dry or near-dry valley bottom or alluvial fan.
- In urban areas flooding often results from over spilling or surface ponding, as described above, but may also occur when urban storm water drains become surcharged and overflow. This is a growing problem in Britain where ageing and inadequate combined sewage and storm water systems give rise to frequent foul water flooding from combined sewer overflows in urban areas (Parker and Penning Rowsell 1983b; Murray, 1995)

1.2 Problem Statement

The annual costs incurred by the Malaysian Government in flood disaster preparedness, rescue and relief operations, and post-flood rehabilitation of victims and public utilities are substantial. While loss of life due to flooding in the peninsular is not as severe as in Bangladesh or elsewhere in the world, it is nevertheless significant. Flood damages are based on crudely estimated damage to crops and livestock, public structures and properties, and interrupted activities and rescue and relief. The damage figures shown are substantial and would be much higher if damage to private properties were included. The potential flood damage in large urban centre such as Kuala Lumpur can be high. As a result, the Government of Malaysia has designated the government department notably the Department of Irrigation and Drainage as well as agencies to execute strategic decisions to reduce the impact and negative effect of floods.

One of the remedial measures that have been carried out is the development of the flood warning system that can detect the rise of the river level during heavy thunderstorm. The system was designed by the Department of Irrigation and Drainage (Jabatan Parit dan Saliran; JPS) to monitor all the rivers throughout the country. The main focus in this system was given to the design for rivers surrounding Klang Valley. The information system plays the major role to get the information from all the stations situated along the river bank, process the information and channel the information to the appropriate authority for further immediate response. Although the system is very reliable in transmitting flood information, but have generally little effect in reducing the problem. However, it is now understood that it is neither possible nor desirable to control floods completely. Spatial information technology is thus being increasingly recognized as the most effective approach to flood disaster management. It is for this reason that, the research on flood warning system utilizing spatial data has been executed.

Spatial information technologies, in the form of geographic information systems (GIS) and Global Positioning System (GPS), have made major advances in both theory and application for studies of flood management. These technologies have become key components of interdisciplinary research into flood resources management. Because it is not possible to avoid natural flood disasters completely, spatial information technology tools are applied in the collection and processing of data and the development of applications that monitor and create a proper awareness of likely flood disasters and their impact. The changing trends and advancement of spatial technologies have enabled their application in a large number of scientific and technological resources and skills development to reduce flood disasters. These developments include their real-time applications in suitable early warning systems, preparedness and overall flood disaster management. The system emphasizes the estimation of flood plain as an aspect of flood disaster management, which was generally neglected in previous management plans in Malaysia. Expected flood inundation maps are then produced to form the basis of advance warnings of impending floods well before they actually occur.

1.3 Research Objectives

The main overall objective of the research is to demonstrate the feasibility of using Global Positioning System (GPS) and surveying packages in a near real-time mapping for flood monitoring system. The specific objectives can be summarized as follows:-

- To demonstrate the feasibility of using Global Positioning System (GPS) in near real-time mapping for flood monitoring system
- To investigate the available surveying packages that can be used for mapping flood monitoring system of low lying areas prone to flooding.

- To test the integration of GPS and the surveying packages in and around the area of interest.

1.4 Research Methodology

The integration of GPS and Surveying Packages for near real-time Flood Monitoring System is about combining the application of GPS and surveying software to produce flood modeling of area of interest. It is required to collect data using surveying method using GPS and test several surveying packages available to visualize the increasing water level and produce some information that can help in planning. Data will be process using the best suitable surveying packages to make it near to real-time system monitoring. The rainfall and water level data will be collected on web (http://infobanjir.moa.my) supplied by JPS in every time-scale based on place (state and river).

The methodology for the project research involves several parts of investigations to develop near real time mapping system from Global Positioning System (GPS) and surveying packages for low lying areas in Malaysia. The research is divided into five phases which are:

Phase 1. Feasibility studies

The investigation and studies on the existing techniques is carried out in order to provide additional information. This phase consists of the identification of the factors to be considered and the derivation of the parameters used in the development of the algorithm.

Phase 2. Mathematical formalization and Real time data acquisition

Extensive testing with various surfaces modeling simulated data will be carried out. Data will be collected from GPS permanent stations in Malaysia maintained by Department of Survey and Mapping Malaysia

(JUPEM). The data collected at these stations are identified, evaluated and transferred for further processing. Information from JPS and local authorities from several sites will be identified and collected.

Phase 3. Data analysis and processing

The GPS and surveying data from low water level mark are processed at UTM.

Phase 4. Model Development

The modeling and testing of the model are carried out to determine the capabilities of the model developed for near real time and monitoring.

Phase 5. Verification of Model

Field verification is required and are carried out using GPS receivers at several selected sites. Most of the facilities that are needed in this phase are available in UTM.

1.5 Contribution

As mentioned earlier, the information to determine the feasibility of integrating GPS and Surveying package is required. The contribution of this study is to make some suggestions so that it can brings benefits to government agencies, planners and even public who are interested in current information of areas that are prone to flooding. The use of modern technology coupled with surveying packages can improve and enhancement of information can be obtained in identifying the area in near real time.

With correct selection of surveying package and proper usage as well as with suitable data collected, it gives information to the extend of water level if further flooding occurs. Potential mapping system of any low lying areas can be

obtained and the results can show the water level height as indicators for the planning and rescue purposes.

1.6 Global Positioning System (GPS)

As mentioned in section 1.4, the geographical position of points on the ground can be derived from GPS. What is GPS? To answer the question, this section introduces the system. It is not the aim of this study to discuss deeply into the measuring operation, processing techniques and error sources in GPS since the three dimensional position coordinates part of the final product in this system will be considered. Therefore only the general overview is highlighted to provide an insight into the system.

GPS is an acronym for Global Positioning System, sometimes called NAVSTAR (**NAV**star **S**ystem with **T**iming **A**nd **R**anging), a United States Department of Defence (DoD) satellite-based navigation system. It is a commercially and militarily successful system. GPS can be used for variety of applications in many military and civilian disciplines where highly accurate three dimensional coordinate differences between stations are required. Results can be achieved in a relatively short period and over long lines irrespective of terrain, intervisibility and weather. The system can also be used to determine time, absolute and relative three dimensional positions and velocities in a global coordinate system, all virtually instantaneously. It is cost effective for routine geodetic activities because the instruments are portable and relatively inexpensive to purchase and to operate.

The main function of GPS is to provide a set of coordinates which represent the location of the GPS unit with respect to it's latitude, longitude and elevation on planet Earth. It also provides time, which is as accurate as that given by an atomic clock. The actual application of the GPS technology is what leads to such things as navigation systems, GPS tracking devices, GPS surveying and GPS

mapping. GPS in itself does not provide any functionality beyond being able to receive satellite signals and calculate position information. There are about 26 GPS Satellite in the constellation at the height about 22,000 km that continuously transmitting satellite signals to the receivers. The actual principal of GPS is very easy to appreciate, since it produces similar results to traditional "triangulation" although GPS does not use angles. The GPS locator has the same coordinated time as the satellites, which have atomic clocks on board. Behind the scenes, there are also many complex calculations taking place which enable the system to compensate for atmospheric distortion of the signals, and so forth, but the principle remains the same.

The GPS observations are independent of the local gravity field at the observation point. The GPS techniques are used in many applications such as levelling projects for monitoring dams, road constructions, drainage design in irrigation schemes, oil pipelines, subsidence studies due to water or natural gas removal and monitoring of vertical Earth crust movement. In some of these applications, conventional levelling using spirit level instruments is being replaced by heights determined from GPS. GPS is capable of very high precision positioning but height determination is usually of a poorer quality than the horizontal positioning due many error sources that affect all three dimensional parameters. For further reading there are several published texts about this system such as Hofmann, Lictenegger and Collins (1992), Ackroyd and Lorimer (1990), Leick (2003) and Seeber (1993).

Another application of the Global Positioning System (GPS) has led to a new and potentially significantly new technique in mapping and monitoring of flood water in low lying areas. It is essential to know the water level as well as position where the areas prone to flooding can be detected. Warning activities can be activated thus saving the life and properties before the worst tragedy struck. GPS, has grown from a supporting technologies for positioning to a developed,

acceptable technology that can fulfill many requirements and it cost is within reach of consumer budgets.

1.7 Outline Treatment

The integration of GPS and surveying packages for flood monitoring system in this research shows the needs to combine the latest technology with the available surveying packages in contributing towards important decision making. In this chapter the objectives and the methodology of the research as well as the GPS technology is introduced. Chapter 2 has been written to describe the data collected using GPS are integrated with the surveying package. The development of the TIN DEM techniques are shown in the chapter.

In chapter 3, the contribution of Global Positioning System (GPS) technology in flood monitoring system is shown. The surveying package such as Arc view and Surfer are used. Chapter 4 described the integration of GPS and surveying packages in flood monitoring studies. In this chapter, model are developed to indicate the are covered by flood water when the level increased in height. The results of the research obtained in chapter 2, 3 and 4 are presented at International Symposium and Exhibition on Geoinformation in 2004 and 2005. Through this event many opportunities to expand the networking towards the betterment of the research carried out have been achieved.

CHAPTER 2

DEVELOPMENT OF TIN-DEM DATA STRUCTURE USING SURVEYING PACKAGES FOR FLOOD MONITORING SYSTEMS: A CASE STUDY OF SUNGAI SKUDAI AT KAMPUNG SEDENAK, JOHOR

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Abstract

(Key Words**:** Digital Elevation Model (DEM), Triangulated Irregular Networks (TIN), surveying packages, modeling, flood monitoring)

Floods at Sungai Skudai occur mostly on floodplains as a result of flow exceeding the capacity of Sungai Johor Basin. This complex system demands accurate elevation modeling to support flood level estimation and to mitigate flood system. In such a small system, details survey as a data capture techniques conducted along the river is important. Digital elevation model (DEM) for the entire area using available surveying packages and a complete TIN-DEM modeling for flood monitoring system was developed. Some innovative techniques for analyzing the terrain model are carried out where 2D and 3D models of TIN-DEM provided from modeled flood levels can be improved. The result from the model based on GIS environment was analyzed.

Key researcher

Assoc. Prof. Dr. Md. Nor Kamaruddin

Mohd. Zukhairi Abd. Latef

2.0 Introduction

It is important to have accurate terrain representation in many hydrologic studies. Such terrain representation can range from defining a river channel with cross-sections to build a digital elevation model (DEM) of entire catchments. For flood modeling studies, elevation data is essential for defining the channels in which water flows regularly and the low-lying areas over which water floods. Such studies usually focus on small or simple domains, with conventional surveying being the major source of elevation data. As the study domain becomes larger and more complex, conventional surveying methods become unfeasible and alternate forms of terrain data must be utilized.

A DEM provides and interface on which various data sources can be integrated and analyzed. For large coastal lagoons, terrain representation for flood modeling must encompass many different types of data, including contour lines, spot heights, cross sections, break lines and streamlines. The DEM provides a digital description of the terrain surface, giving continuous elevation values over the entire study domain. Such a tool enables for confined areas and the display of computed flood extents.

A Triangulated irregular Networks (TIN) is actually a set of triangles that represents the terrain surface. Consider a set of survey coordinates marked on a map. These coordinates are “triangulated”: a set of triangles is specified such that their vertices are these spatial points, no triangle contains coordinates other than its vertices, and the triangles cover the area of interest exactly and without overlapping each other. Any such set of triangles defines a TIN. The maximum area a TIN can cover is the “convex hull” of all coordinates. The convex hull is the polygon which contains all coordinates, whose vertices are the coordinates, and which is convex; that is, any straight line segment connecting two points in the interior of the polygon is entirely contained by the polygon. The convex hull

of all coordinates is also the convex polygon of smallest area containing all coordinates.

A TIN may fail to cover its maximum area while covering all available coordinates; some triangles along the boundary may be missing. This paper presents the development of a TIN-DEM for low-lying areas around Sungai Skudai at Kampung Sedenak, using methods to improve terrain representation in areas with sparse data coverage by detail survey.

2.1 Study Area

Sungai Skudai at Kampung Sedenak located at northwest from Johor Bharu and mostly the area covered the palm oil plantation and urban area. It is connected by Ladang Sedenak Reservoir and Ladang Gunung Pulai Basin. This river comprise with a major bodies of water that are connected by complex channels of Sungai Johor. The study area covered 500 x 1000 m2 and detail survey has been conducted 1 km along the river (Figure 2.1).

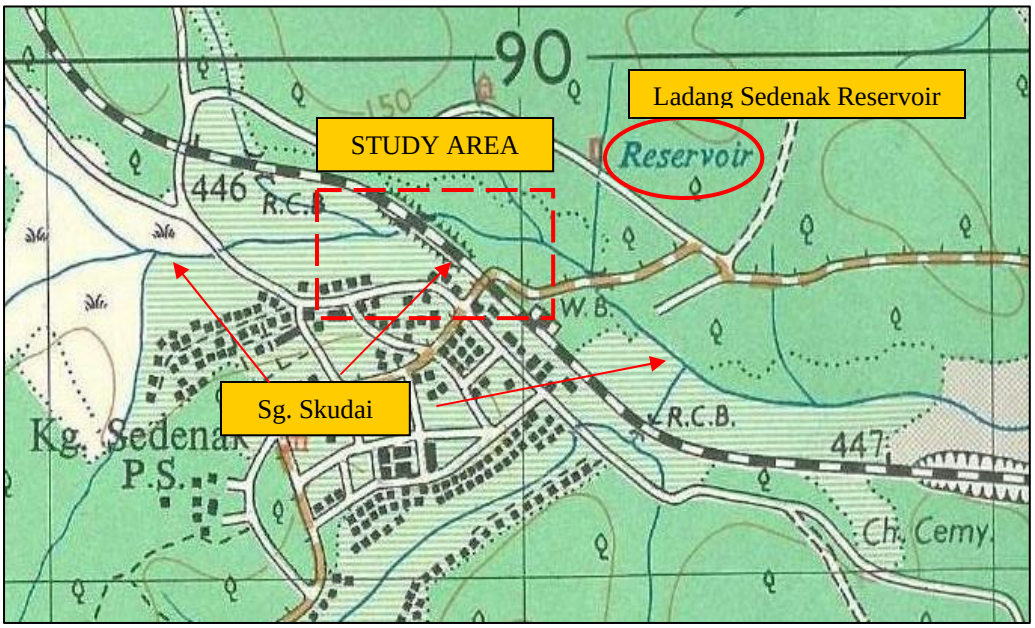


Figure 2.1: Topographical Map of Sungai Skudai

2.2 Data Integration With Surveying Packages

As with many other countries for flood mitigation project, there exists a long history of data collection from various engineering project. In this study of the river, geospatial data (x, y, z) originally gathered by detail survey along the river and by digitizing topographical map of Kampung Sedenak. Detail surveys are conducted on February 2004 based on some control points the positions of which (horizontal coordinates and height) are known using GPS handheld for certain area of Sungai Skudai.

From a control point horizontal angles, distances and vertical angles to the details close to the control are measured, and then the coordinates of these details are calculated automatically by Topcon SET 3F total station and its reflectors. Nowadays, surveying equipment such as the total stations become common used in detail surveys because both the distance and the angles or bearing can be measured with the coordinates of points computed. The output or reading can be displayed automatically by pressing a button on the control panel of the instrument. Each total station can store up to 5000 or more coordinated points inside its internal memory, and as a built-in COGO (Coordinate Geometry) program to facilitate computations, setting-out, and other surveying operations in the field. Field observation data can be downloaded on Civil Design Survey software and then imported to a CAD and integrated with GIS for further analysis for modeling.

In this research, ArcView GIS 3.2 is used for flood modeling and flood monitoring purposes. Figure2.2 shows the flow chart of the process from detail survey to the geodata base and finally to the flood monitoring system.

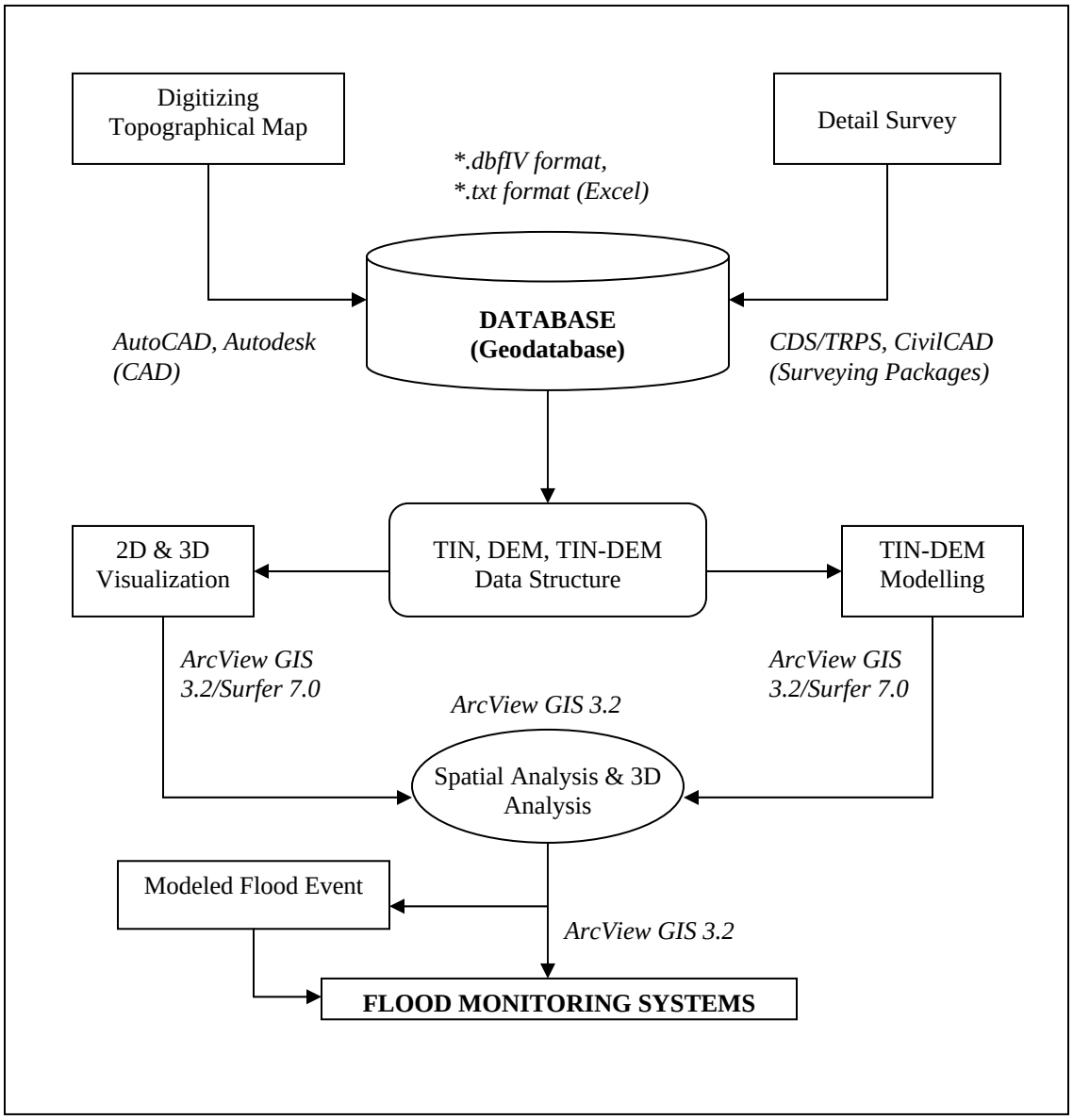


Figure 2.2: Data Acquisition and Database System for Flood Monitoring

2.3 DEM Generation Techniques

It is widely recognized that both TIN and GRID approaches to elevation modeling have relative benefits and weaknesses. Where dense collections of spot heights are combined with a detailed survey of an area to pick up changes of gradient, a TIN is best suited to representing the surface and honoring the ground measurements. Where large areas with sparser terrain data occur, a GRID approach based on an intelligent interpolation algorithm can be far more effective. Both figure below shows the same sparse source data represented using two approaches. The TIN representation results in flat surfaces for areas where only contour data is used. The GRID approach results in 'smarter' estimates.

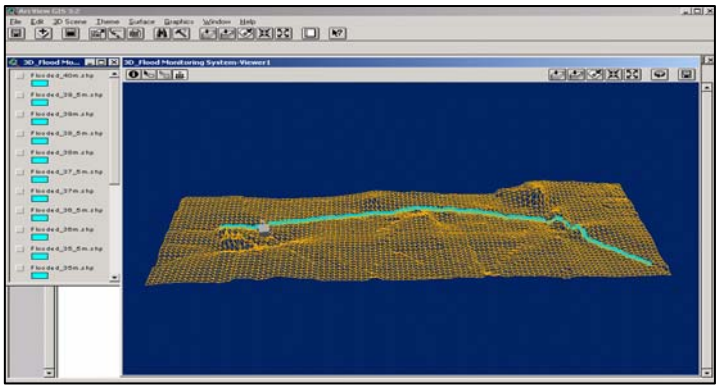


Figure 2.3a: TIN Approaches

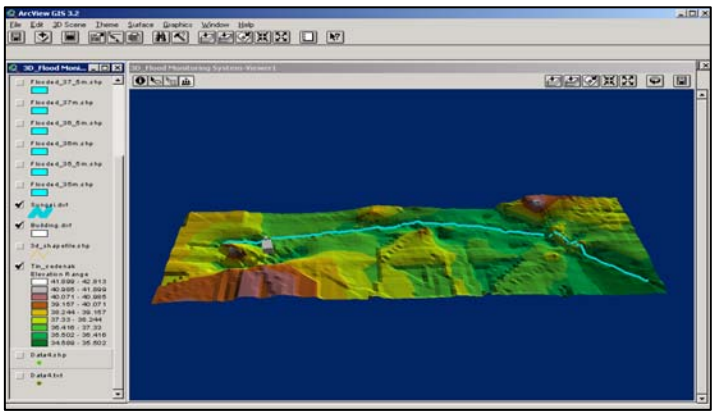


Figure 2.3b: TIN-DEM Approaches

The choice of representation depends on the type of source data. Where contours are the major source of data, an algorithm that utilizes the contour shape is far superior to one that simply treats the contour lines as a series of points with the same elevation. TIN algorithms rely on user defined breaklines to properly represent stream and ridgelines. It is difficult to obtain these features as source data in many cases, especially over a large area. The resulting digital elevation model is dependent on the source of data, the interpolation technique used and the target application. For example, a DEM built from 20m height interval contours for catchment modeling will be vastly different from one built from dense 0.1m accuracy spot heights and break lines for urban flood modeling. The terrain model being built here is a combination both, including a large area covered by high resolution contours and sparse spot heights, with a need to represent topographic features correctly.

2.4 TIN-DEMS Data Structure

In the TIN-DEM generating system for representing a natural topography of a basin, three datasets are produced: (1) a triangle network dataset, (2) a vertex data set, and (3) a channel network data set. Each of the triangles, squares, and vertices is indexed by a number which is given to specify it. The vertex data set contains the x, y and z values of the vertices. The triangle network data set contains the properties by triangles. Each triangles is described by an index of the square in which the triangle is contained; indices of its three vertices; indices of three triangles which are adjacent to the triangle; three ‘side-attribute-indices’ which specify whether water flows into the side, along the side, or out of the side; three ‘side-component-indices’ which specify whether the side forms a part of valley, channel, slope, ridge, or boundary of a study area; and a unit normal vectors of a triangular facet. The indices of vertices, the side-attribute-indices, and the side-component-indices are ordered in a counterclockwise direction.

In this research, the vertex data set has been used to develop the TIN-DEM model. Each triangle in the model contents the geospatial values (x, y, z). So, the flood modeling and flood monitoring systems is depending on the slope and valley which provided by the geospatial data on TIN-DEM model. A sample vertex data set is illustrated in Figure 2.4

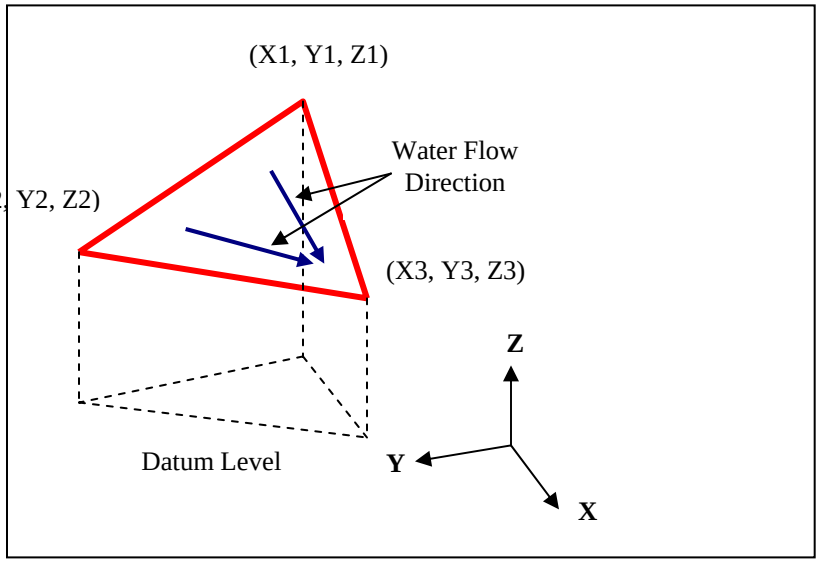


Figure 2.4: TIN-DEM Data Structure

The relation between geospatial data and water flow direction is depending on the value of z-component. For a logical representation of a TIN-DEM network in a computer, a water flow direction is represented by a set of TIN-DEM for determining the direction of water flow when flood occur. Figure 5 shows vector map in 3D visualization of water flow according to the TIN-DEM data structure.

2.5 Result and Analysis

The result carried out by analyzing the modeled flood level and TIN-DEM model using Arc View GIS 3.2. This analysis shows the flood area and volume of flood water. It includes the 3D model of TIN-DEM with data of modeled flood

level simulation using ArcView 3D-Analyst. Using ArcView 3D-Analyst, it is able to develop the interactive packages for flood monitoring system. The result of TIN-DEM is shown below:

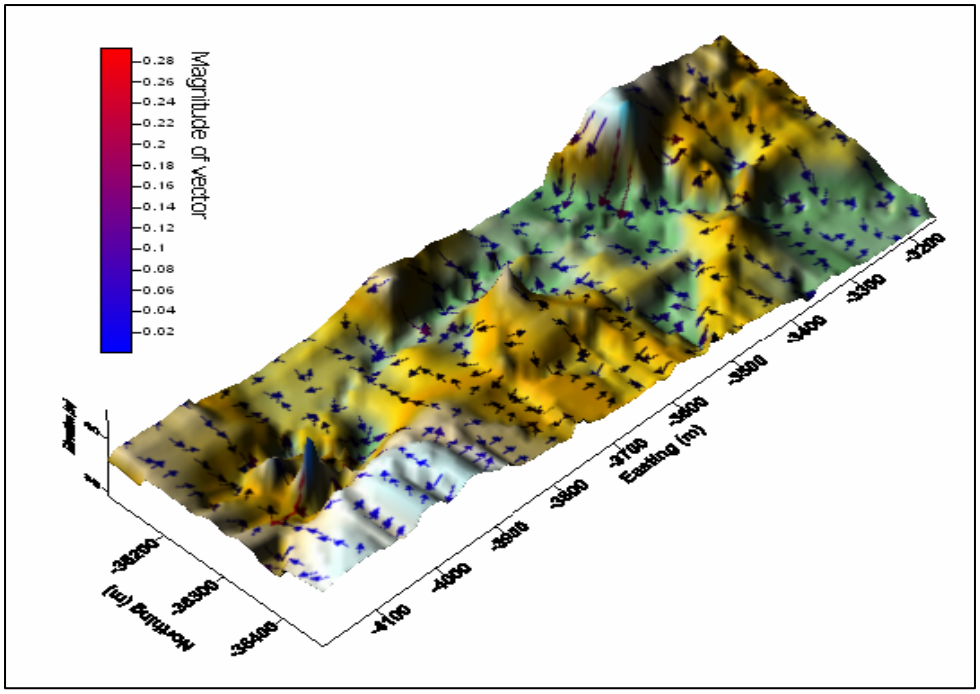


Figure 2.5: 3D Vector Map of Water Flow Direction

2.6 TIN-DEM Data Point Structure:

In this study, TIN-DEM data structure was developed using 3500 data points generated from the interpolation of detail survey raw data. Table 2.1 shows the minimum and maximum of geospatial data on this test area.

Table 2.1: Maximum and minimum of geospatial data

	X	Y	Z
Minimum	-4187.88	-36467.6	34.5887
Maximum	-3154.13	-36107.2	42.8125

2.6.1 Area When Flood Event:

Table 2.2 shows the area of land above water level (not flooded)for different water level. In this research the datum level is taken is 30.0 m. The area is computed using a simple calculation with the formula below and the test area at datum level of 30.0 meter before any flood event is 373012.676 m^2 (terrain surface). Further computation was made to obtain, the volume of water from test area from datum level of 30.0 meter and the value is 2720598.463 m^3.

Table 2.2: Computed value of Surface Area

Flood event at level	Surface Area (Not Flooded)
35.0 m	372535.587
35.5 m	353575.338
36.0 m	320737.417
36.5 m	272502.487
37.0 m	203759.583
37.5 m	142780.046
38.0 m	94366.073
38.5 m	59095.802
39.0 m	40348.353
39.5 m	30118.691
40.0 m	14296.555

**Area in m^2*

2.6.2 Volume of Water When Flood Event:

In Table 2.3, the volume of water was calculated from the volume of terrain of test area and the volume of modeled flood event at particular level. The datum level is at 30.0 meter. From the above result, the volume of water at datum level is 2720598.463 m^3 . The volume of water at different level can be calculated

and the residual surface area when at flood event can also be computed. Finally the volume of water when flood event was calculated using formula below:

$$V_W = V_{WL} - (V_D - V_R)$$

Where;

V_W = Volume of water when flood event *(A x h)*

V_{WL} = Volume of water at flood level *(A x h)*

V_D = Volume of study area from datum level *(A x h)*

V_R = Volume of residual surface area when flood event *(A x h)*

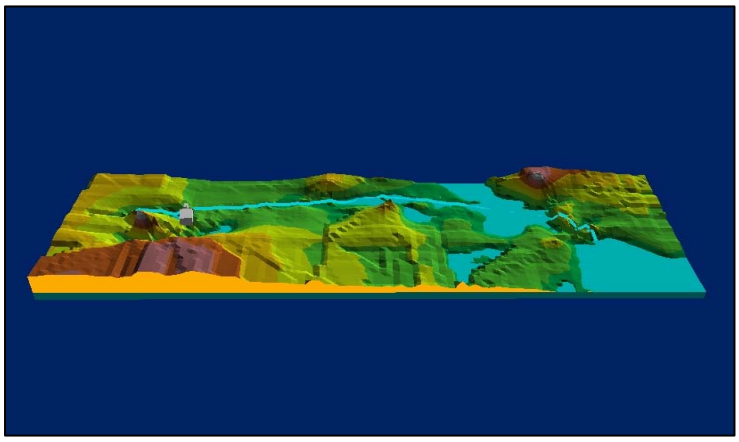
Table 2.3: Computed Volume from datum level:

Flood Event	Volume of Water when Flood Event (V_{WL}), m^3	Volume of Flood plains from Datum Level 30.0 m (V_D), m^3	Volume of Residuals area when flood event (V_R), m^3	Volume of Water when flood event (V_W), m^3
35.0 m	1862817.50	2720598.463	857647.911	133.052
35.5 m	2049099.25		675667.774	4168.561
36.0 m	2235281.00		506883.947	21566.484
36.5 m	2421662.75		358671.740	59736.027
37.0 m	2607944.50		240968.159	128314.196
37.5 m	2794226.25		155445.706	229073.493
38.0 m	2980508.00		97041.749	356951.286
38.5 m	3166789.75		58323.777	504515.064
39.0 m	3353071.50		34365.353	666838.390
39.5 m	3539353.25		16603.258	835358.045
40.0 m	3725635.00		5724.257	1010760.794

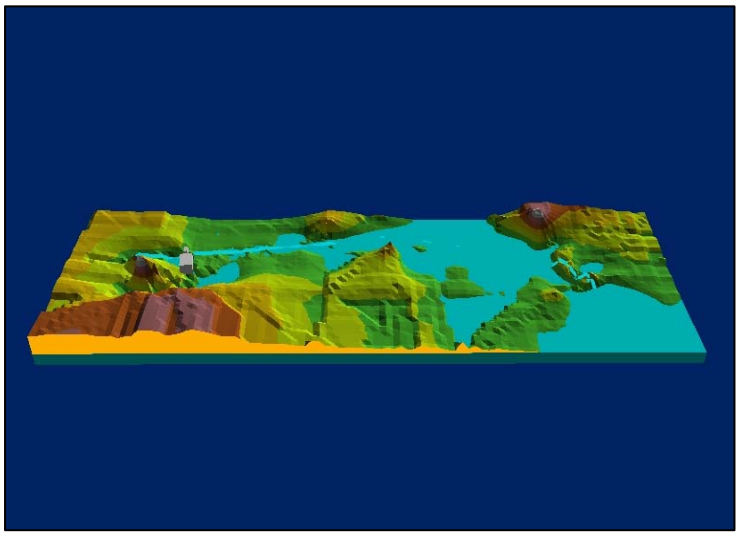
From Table 3, it can beseen that as the water increases the volume increases while the area above the water decreases .

2.6.3 Visualization of Flood Event:

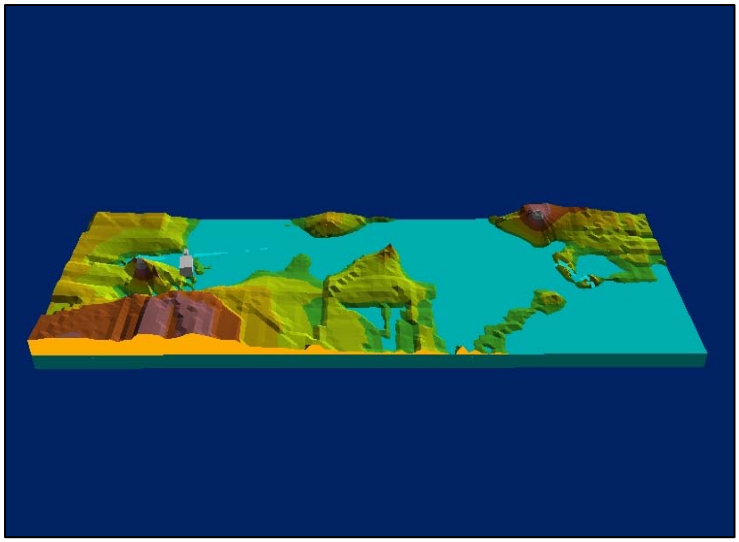
From the tabulated results (table 3), the water level can be visualized shown at different stages in Figure 2.6a to 2.6h. The water level starts at the 35.0 meter level and increased to the highest level in the area of 40 meter at an increment of every 0.5 meter. This can be seen from the diagram below and the area covered by water when the water level increased.



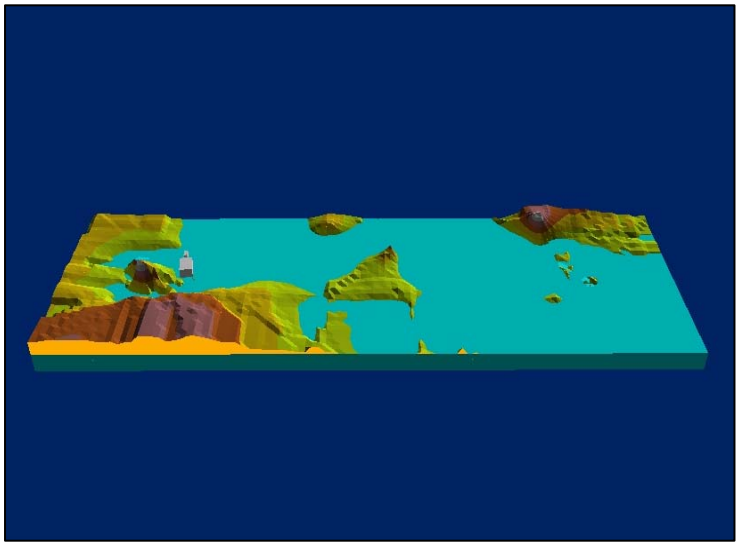
(a): Flood event at 36.0



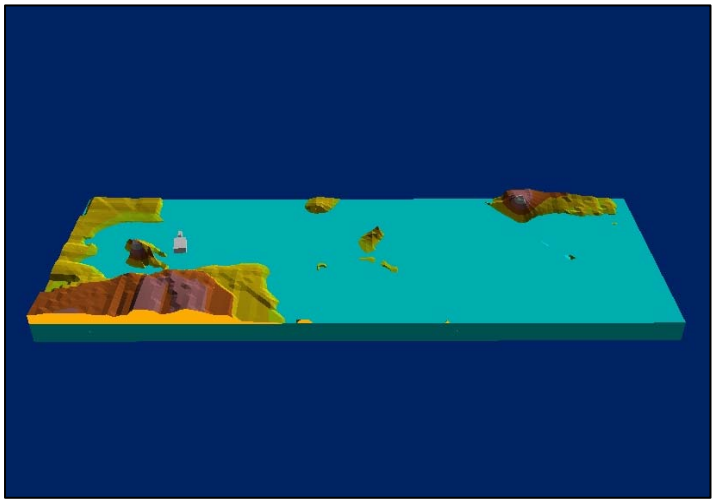
(b): Flood event at 36.5



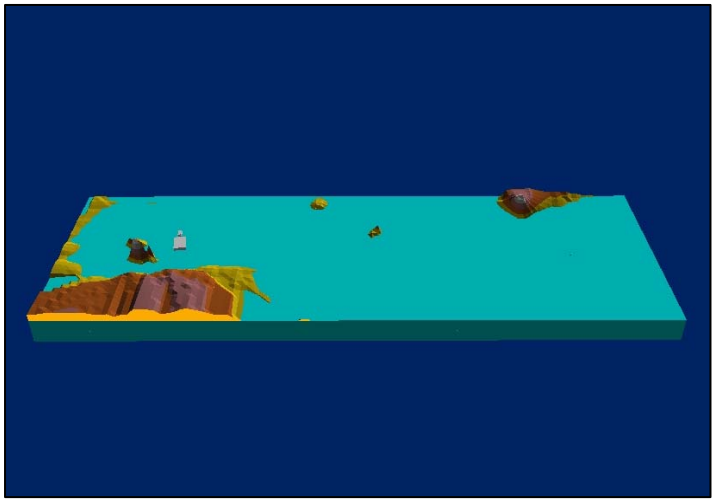
(c): Flood event at 37.0



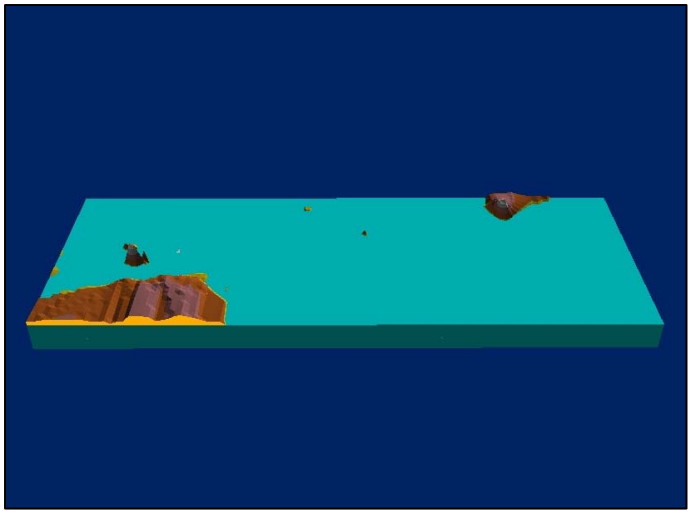
(d): Flood event at 37.5



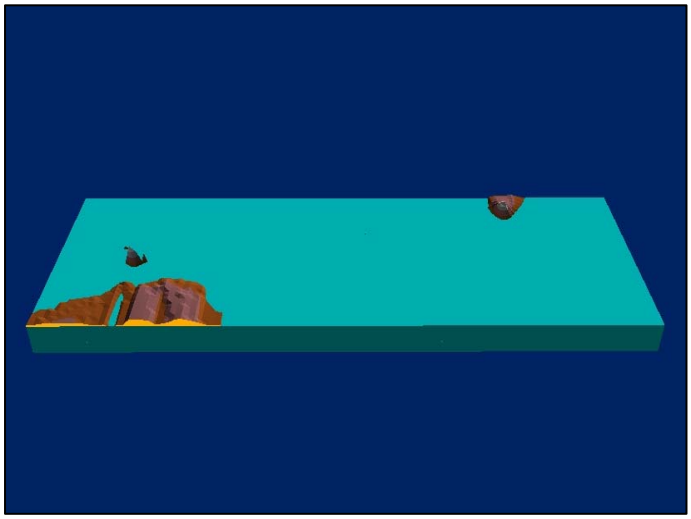
(e): Flood event at 38.0 m



(f): Flood event at 38.5 m



(g): Flood event at 39.0



(h): Flood event at 39.5

Figures2.6a to 2.6h: The area covered as the water level increases.

2.7 Conclusions

In this study, Geographic Information System (GIS) has been integrated with surveying packages for development of TIN-DEM data structure in flood monitoring system. From geospatial data conducted by detail survey along the Sungai Skudai, the TIN-DEM model of study area was developed to identify floodplains area. The modeled of flood was developed for monitoring of flood event along the Sungai Skudai and the volume of water at flood event level for particularly flood model has been listed. This TIN-DEM based on topographic model incorporates the advantages of grid-based methods with their ease of computational implementation, efficiency, and availability of topographic databases. It also gives the advantages of contour-based methods such as subdivision of a basin considering the direction of water flow.

2.8 References

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CHAPTER 3

FLOOD MONITORING SYSTEM USING GPS TECHNOLOGY

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FLOOD MONITORING SYSTEM USING GPS TECHNOLOGY

Abstract

(Keywords: Flood, surveying packages, GIS, GPS and spatial information)

Flood monitoring is becoming increasingly significant to environmentally concerned parties around the globe. Flood is among the most common and widespread natural hazard phenomenon causing billions of dollars in damage each year. Changes in land use pattern especially development from the rural area to the urban area have become one of the major cause. A major step forward would be achieved by a system that could be used to observe water level at any point in the world in order to produce good flood monitoring system.

This paper aims in the preliminary description of the integration GPS technology and several surveying packages to develop near real-time flood monitoring system. This technique will be use to produce river flood modeling. GPS data will be process using the best and suitable surveying package with GIS extract the spatial information of the flooded areas based on the spatial database created for the study area. From this technique, water volume on specific flood area and analysis of the river can be obtained.

Key researcher:-

Md. Nor Kamarudin.
Zulkarnaini Mat Amin,
Azrinda Hassan Mohamad

3.0 Introduction

In year 1971, the major flood incidence occurred in Malaysia. Following the disastrous flood, the government has speed up effort to design flood alert and monitoring system through Department of Irrigation and Drainage Malaysia. Recently, with the increase of flood occurrence due to population growth and land development activities, the flood monitoring system has significantly expanded over the years.

The effectiveness of these means mainly depends on the timeliness of rescue operations set up during emergency situations, and therefore also on the capability to foresee the events. Surveyors have long been involved in development work and of it is flood defense work. The need to construct defenses to any particular protected area to a consistent level was recognized and it is an important to employ surveyors, effectively to carry out assets surveys. The proposed guidance on flood proof construction is described and reviewed, and a role for surveyor is identified. In order to be able to sufficiently monitor severe rainfalls, this research has been carried out to develop flood monitoring system using GPS technology integrating with several surveying packages. With information from GIS extraction, some types of information can be classify which are otherwise difficult to access by traditional methods, particularly for flood monitoring.

3.1 GPS Technology

The global positioning system (GPS) is a space-based worldwide radio navigation system. With appropriate number receiving GPS receivers, the users can obtain an accurate three-dimensional position fix anywhere in the world 24 hours a day.

Some characteristics of GPS as a surveying tool are:

1. GPS is a three-dimensional positioning system; a precise GPS fix that yields latitude, longitude and ellipsoid height.

2. The highest precision of GPS positions that can be obtained is around the 1 mm level horizontally relative to a global datum. To achieve this requires networks of permanently installed GPS receivers. Typical field GPS survey gives accuracies of a few centimeters relative to a global datum. Vertical position quality is generally about 2.5 times worse than horizontal.

3. GPS is a purely geometric positioning tool; that is, GPS coordinates do not give any information in relation to level surfaces, only in relation to the geometric elements of coordinate system axes and ellipsoid. For this reason GPS does not give orthometric height information directly.

4. GPS does not require intervisibility between ground reference points; neither is the geometric arrangement of the ground network crucial to the results as it is required in theodolite triangulation survey.

5. With care, GPS can be used very accurately for terrestrial survey over any distance - even between points on opposite sides of the world. For this reason, global datums are used for GPS positioning. This feature makes GPS vastly more powerful than traditional survey techniques.

GPS using Real Time Kinematic (RTK) technique has been applied in many research purposes. This is a new technique in GPS surveying because of by using this techniques, the coordinates will be establish with centimeter level of accuracy compared the conventional static GPS survey. During RTK technique survey, reference station and receiver unit roving with each other through radio signal link. Reference station will receive the satellite signal during surveying, where by GPS data and reference station coordinate transmitted through radio modem.

By that, any roving receiver unit will be received GPS signals from the satellite. At the same time, they will also received GPS data transmitted by reference station via radio link. This technique offer higher accuracy survey in real time. The mechanism of radio link between two GPS receiver is shown in Figure 3.1.

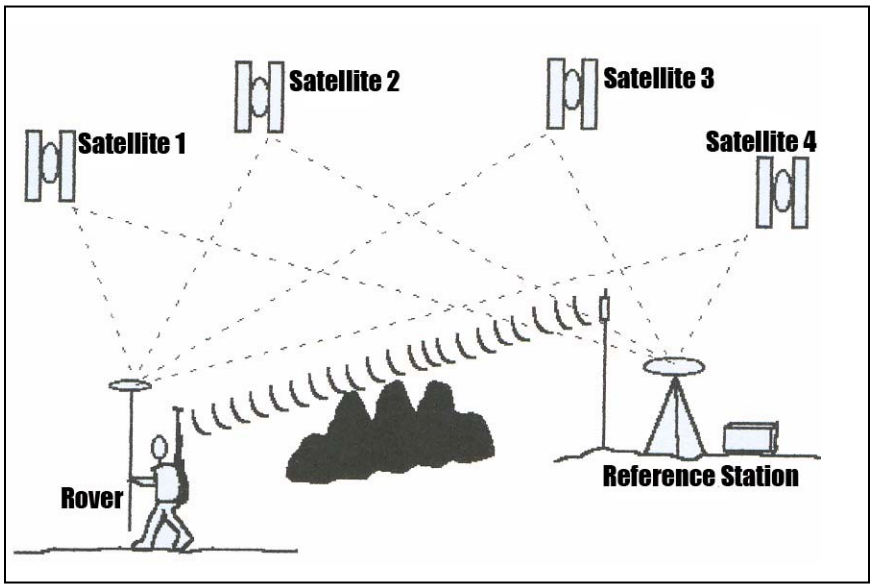

Figure 3.1: Radio link between two GPS receiver

3.2 Study Area

At the moment of planning the flood monitoring system, it was decided to choose a river which concerns about instance flood increment characteristics with the presence of flood-prone towns in the area. The Skudai River was chosen: a river whose headwaters are in the Gunung Pulai. The location of the Skudai River is shown in Figure 3.2. The study area is at Sedenak and the area is 500 meter x 1000 meter. The survey area mainly comprised the lowlands of the Skudai River flood plain. Situated along the river are road, railway, settlement,

contour/landhill, building/monument and pipeline gas reserved about 50 metre along the river.

Figure 3.2: Skudai River in Sedenak and location of the study area

Observation data is obtained from GPS using RTK technique. There are three tide poles established along the studied river for recording water level to use as sampling data in flood modeling simulation. The rainfall and water level data was obtained from the Department of Irrigation and Drainage Malaysia.

3.3 Integration GPS and several surveying packages

As the first phase of the research, determining and analyzing the suitable surveying software become the main focus. Several surveying software packages are used to fulfill the purpose. Four surveying packages are being studied and analyzed for this research and these include Civil Design and Survey (CDS), AutoCAD Map, Surfer 8.0 and ArcView GIS 3.2.

By conducting Triangulated Irregular Networks (TIN) approach, the surface terrain is produced in the initial phase of the research. From the TIN approach the Digital Elevation Model (DEM) can be developed to provide a digital description of the terrain surface giving continuous elevation values over the flood prone area. Figure 3 shows the flow of the research methodology consisting of two distinct sets of work.

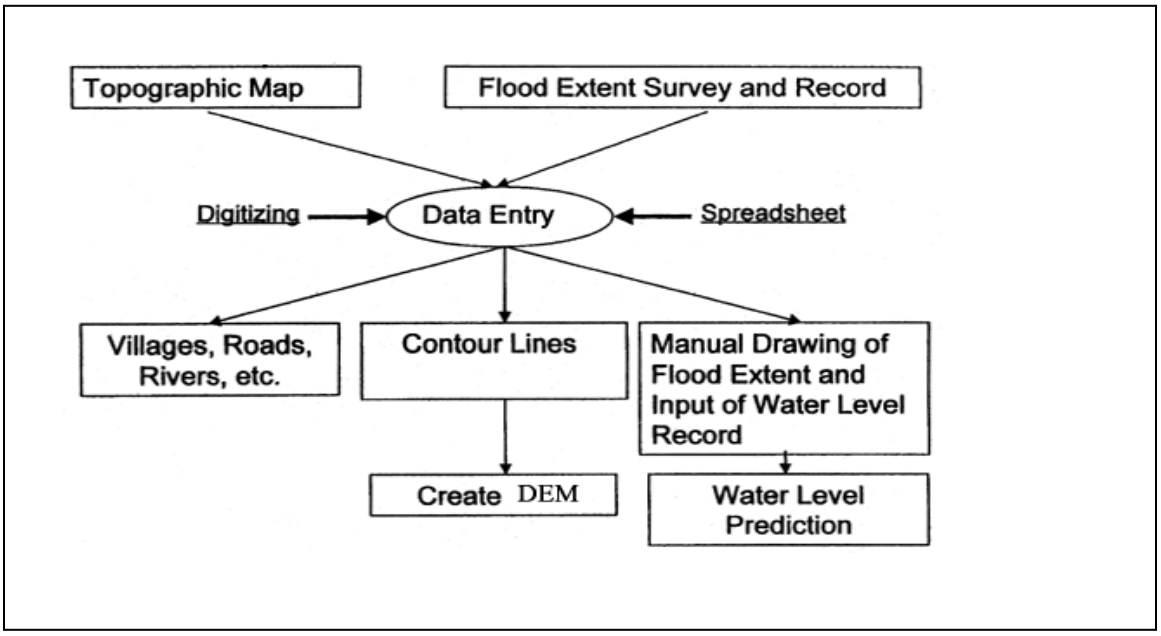

Figure 3.3 : Research Methodology

Based on the observation and research carried out, most of surveying packages in market are available in generating 3D model that are used and produce mapping information in CAD environment. To make the correct choice of the right and ideal surveying software packages for integration with GPS in developing near real-time flood monitoring system is an important task. Two surveying software has been chosen for the analysis platform in the subject research and are discussed in detail in the following section.

3.4 Surveying Packages

In this section, two surveying softwares are chosen to carry out the objective of this research.that is Surfer 8.0 and ArcView GIS 3.2

3.4.1 Surfer 8.0 Surveying Package

Analysis by using Surfer 8.0 shows that this surveying software able to create contour and 3D surface mapping program. It can easily convert data into outstanding contour, surface, wire frame, vector, image, shaded relief and post maps. Using Surfer, it can be completely controlled by any automation-capable programming language including Visual Basic, C++ or Perl. Surfer includes GS Scripter; a Visual Basic-compatible programming environment that enable to write, edit, debug and run scripts. In this way, it can automate repetitive tasks, create front ends for running Surfer, or carry out any task that Surfer can do.

By using the package, the Surfer 8.0 allows to create a multitude of map types to visualize obtained data from observations. Figure 3.4 shows the Gridding surface map of Sedenak and Figure 3.4.1 shows DEM map of Sedenak.

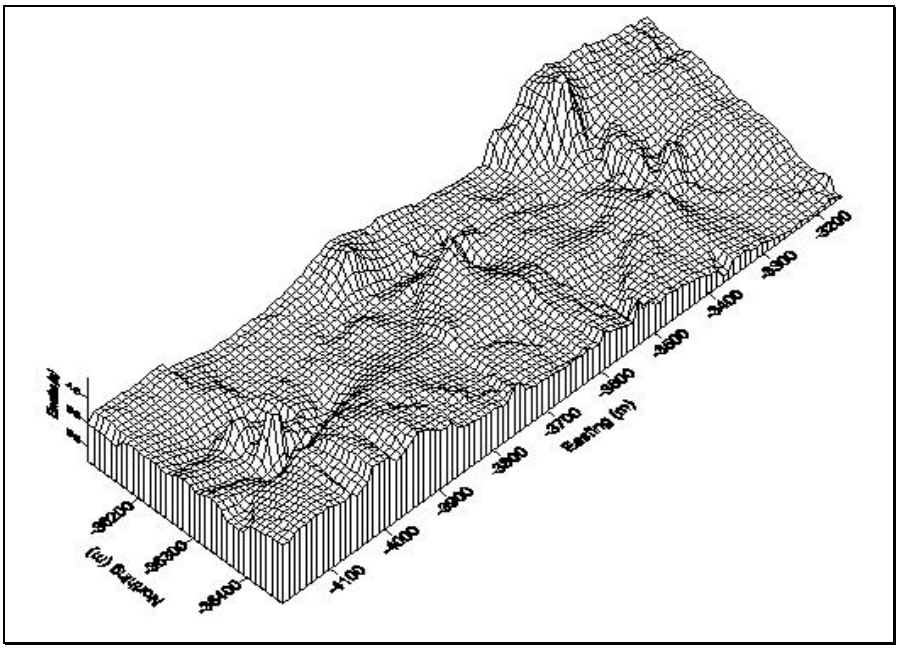

Figure 3.4: Gridding surface map of Sedenak Using Surfer 8.0

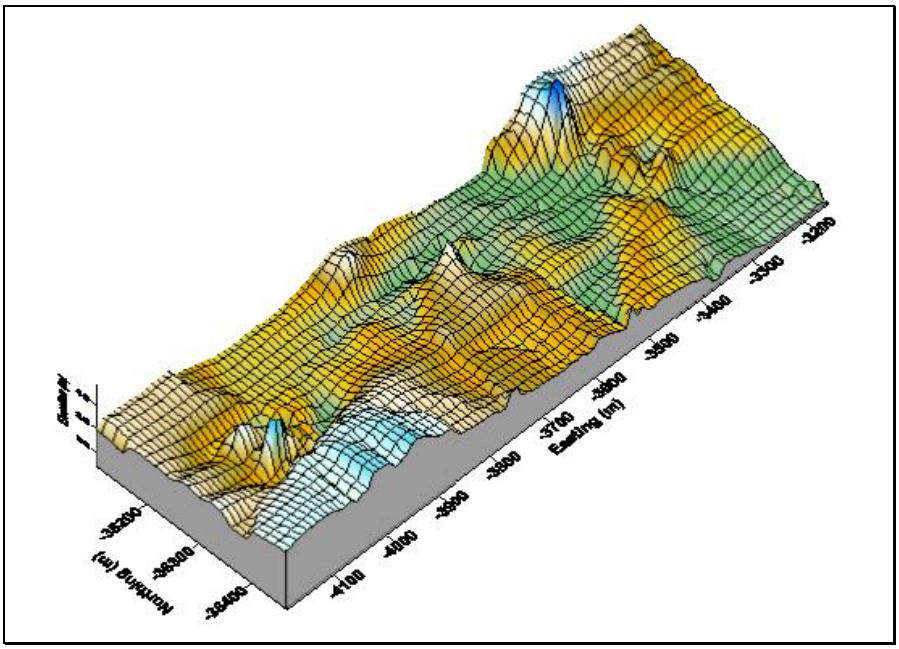

Figure 3.4.1 : DEM map of Sedenak Using Surfer 8.0

3.4.2 ArcView GIS 3.2

In this research, we view the development of the flood management database from a spatial perspective. Using a spatial perspective means that the quantitative and qualitative data, referred to as attribute data in a GIS, is collected and stored together with the associated geographic coordinates.

This will provide the information about:

1. Location of a feature, event, or activity.
2. Relationship of features, events, and activities as they are distributed over the earth's surface.

A GIS is designed to link attribute data, for example village name or a specific crop, with spatial data - location or extent as per a geographic coordinate system. The coordinate system can be based on latitude and longitude or a specialized map projection.

A GIS is implemented using specialized software that provides a standard or customized Graphical User Interface (GUI), i.e., the buttons and menus on a Windows. The GIS GUI enables the user to view a map on a computer monitor, and by moving the cursor and clicking on any map location or feature, the user can call up and view any stored information related to the location or feature.

During the research analyzing process, decision has been made to concentrate on ArcView GIS 3.2 to produce flood monitoring and generating 3D river model. With the advent of Geographic Information System (GIS), the capability of GIS in storing large and diverse spatial data allows the complex analysis of many sites to be carried out quickly, efficiently and with a high degree of repeatability. Initially, all field data, including location data, were stored in a spreadsheet. The data collected from DID's online website was supplemented with data collected by researcher in a field surveys within the flood prone areas. All collected data was entered into the AutoCad Map by digitizing. This is the process by which an electronic cursor traces and transmits to a computer a digital representation of the map feature.

In addition to infrastructure data, the following map features were digitized:

1. Contours, 0.5 meter interval
2. Hydrologic features, i.e., rivers
3. Building

The digitizing was done using AutoCad Map software. After processing the data, the spatial information will be forwarded to ArcView GIS 3.2 software. The spreadsheet data format and the digital data were combined in this software. Each type of data, for example all road data or all river data, were saved as individual themes - data layers - in ArcView. The digitized contour data was processed integrated with the ArcView Spatial Analyst module to create the DEM. A theme was created of the extent of each historic flood. The associated water level in the rivers also was entered. Initially this data was used to check the

predication of different flood scenarios. The flooded area predicted by the model can be seen in 3D views. Figure 3.5 shows the Sedenak area represented using TIN-DEM approach. It clearly shows the flows of the Skudai River and the contour of the map.

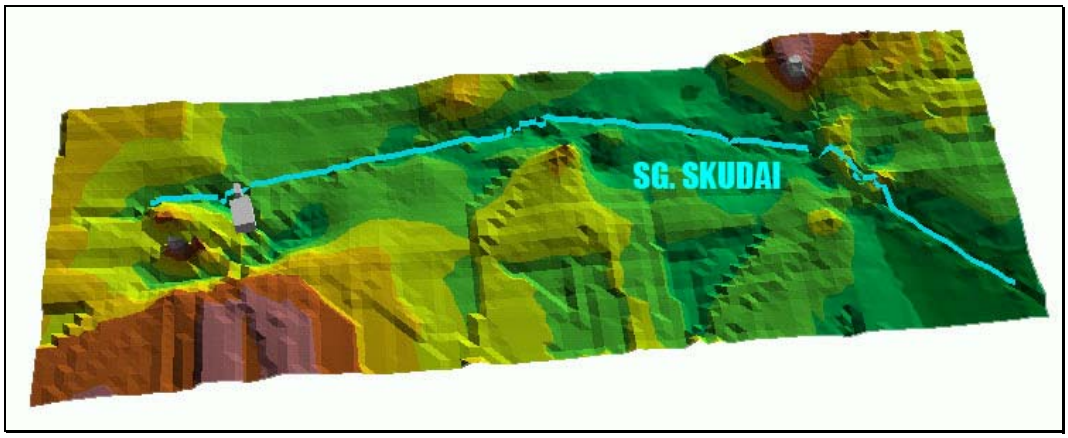

Figure 3.5 : 3D view of Skudai River Using ArcView 3.2

As for the visualization of water level in Skudai River, a first phase model has been developed using ArcView GIS 3.2. By applying TIN-DEM approach, the flood monitoring model initially can be viewed by determined water level. Figure 3.6.1 and 3.6.2 below show the visualization of water level according to the determined water level. By clicking the required water level in the model, it will show the water increment graphically according the selected water level. This is the first phase achievement of this research as it will be undergo several enhancements through out the research time.

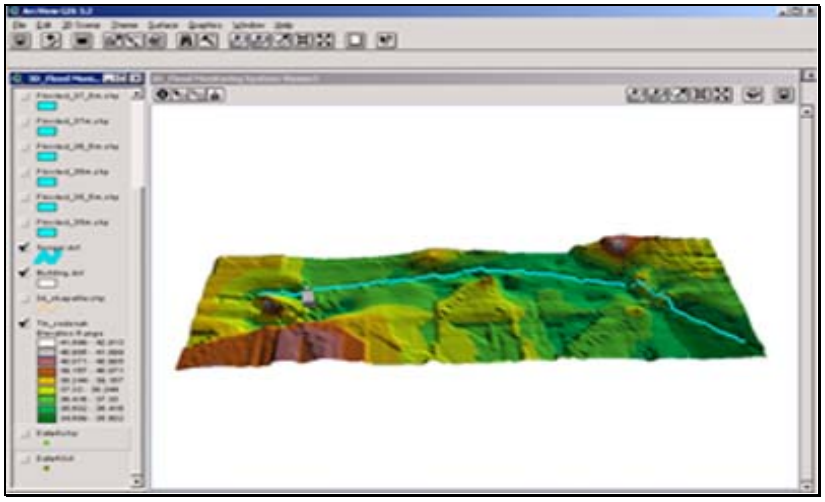

Figure 3.6.1 : Skudai River map using TIN-DEM approach (Using ArcView 3.2)

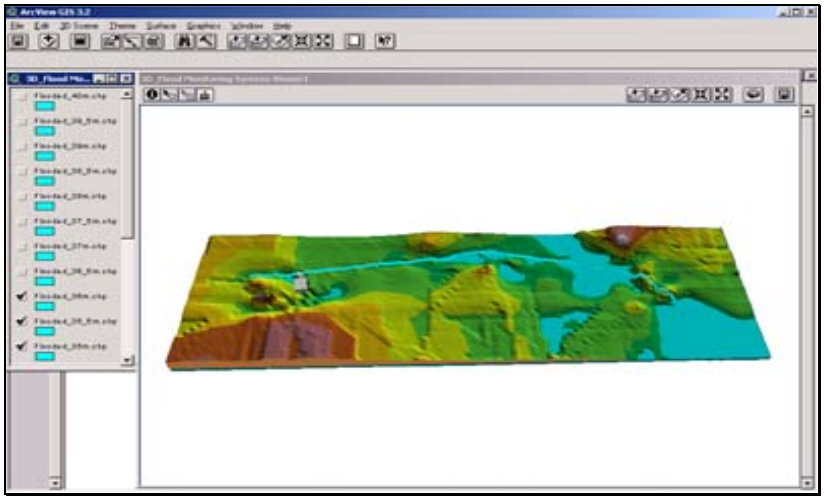

Figure 3.6.2 : Flood extent for water level of 36 meters (Using ArcView 3.2)

3.5 Conclusion

The final products of this study consisted of maps that represented the flood area, water volume on specific area and analysis of the particular river. The

role of GPS in this research is vital to achieve the objective of the research. By applying GPS survey using RTK technique, it provides high accuracy data, fast and able to update data in a short period of time. Integration of GPS and several surveying packages such as ArcView or ArcGIS is essential to produce efficient flood monitoring near-real time system.

Combination GPS and GIS is well suited to analysis complex data sets. Although the GIS can perform many of the tasks necessary to determine water volume and flood area, a final step remains in order to fully understand the temporal aspects of the flooding events. This visualization step involves the use of various computer software packages, coloring and animation procedures and output types.

3.6 Future Work

Some ongoing projects are expected to be carried out in remaining research time. A prototype of a flood monitoring near-real time system is projected to be produce in the end of the project. This system provides daily information on potential floods in Skudai River and few other rivers. This flood monitoring system can be used as a pre-analyzing to water authorities or other concerning parties. The prototype is projected to be an application includes graphically information regarding on flood area, water volume and analysis of the river. The GPS is used for increasing and densifying data purpose.

This prototype is expected to be customized in order to make it user friendly and interactive. The future plan will be enhancing the visualization model using ArcView GIS 3.2 into ArcGIS. By using ArcGIS, the prototype customization using Visual Basic can be developed without DDE communication. On top of that, ArcGIS provides data visualization, query, analysis and integration capabilities along with the ability to create and edit geographic data. With

ArcGIS, users can perform many customization need with little development effort. ArcGIS is designed with an intuitive Windows user interface, and customization is performed using the built-in Microsoft VBA scripting capabilities or a COM-compliant programming language such as Visual Basic or Visual C++.

3.7 Acknowledgments

We would like to thank Department of Irrigation and Drainage Malaysia and Research Management Centre (RMC) UTM Skudai. This project (Vote 74150) was funded by RMC.

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CHAPTER 4

FLOOD PLAIN SIMULATION MODEL BY INTEGRATION OF SURVEYING PACKAGES AND GIS.

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FLOOD PLAIN SIMULATION MODEL BY INTEGRATION OF SURVEYING PACKAGES AND GIS.

Abstract

(Keywords: GIS, GPS, spatial data, Triangulated Irregular Networks (TIN) and profiles.)

Geographic Information Systems (GIS) are tools for managing, analyzing and displaying geographic data and data which can be related to geographic objects. The collaborating element of present day GIS and computers can benefit organizations using a GIS (combined with other data base systems) as the foundation of all its data operations. To produce an effective flood monitoring systems it is therefore highly beneficial to utilize both flood modeling and GIS technologies.

This paper is focusing on development flood plain simulation model. An evaluation of this approach has been using the practical application of surveying packages and GIS software. The model includes GPS data of the flooded areas based on the spatial database created for the study area. In order to identify the potential flood risk zones, respective hydrographs have been drawn to show the occurrence for the particular area. For instance, it has been implemented for the river basin of the Gombak River in Kuala Lumpur. ArcView Software is chosen to implement the model for the reason that it's highly relevant towards the model development. The final section of this paper, we will concentrate on visualizing spatial data using a three dimensional in providing water volume on specific flood area and obtaining the analysis on the river. Triangulated Irregular Networks (TIN) is the methodology that was used in producing the flood plain model. TIN was our working map because it provided us with elevation, which is very important when looking at water levels and cross sectional river profiles.

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4.0 Introduction

The competence of very high performance GIS software packages such as ArcView and surveying packages such as AutoCad and Surfer offers new prospects for engineers to perform flood monitoring analysis with interactive visualization. Data processed by surveying packages is transported to produce a digital elevation model (DEM). When a DEM is available, a GIS system can be used to draw geometrical data for the surface of the area, the river branches and spills/overflows from the DEM. It can also be used to distinguish the potential flooding areas (areas to be modeled in two-dimensional) and to visualize the spatial extent of the modeled floods. In this way, the GIS system is applied both as pre-processing tool and a post-processing tool. The communication between the surveying packages and the GIS system acts in two directions. Development of this flood plain simulation model is projected to visualize flood prone area within the study area.

Hence, an evaluation of this approach of river flood plain simulation model has been made by the practical application of the surveying packages; AutoDesk Map 6 and Surfer 8.0 in combination with ArcView 3.2. It has been implemented for the Klang-Gombak River basin in Kuala Lumpur. The river network for this basin is shown in Figure 1.

4.1 The Study Area

The study area of the research covers Gombak River and Klang River at Kuala Lumpur near Jalan Raja and Klang River near Jalan Melaka towards where the two rivers meet until Klang River close to Market Square. This covered river area crammed with commercial and historical buildings, compounds and structures. For instance, Klang and Gombak Rivers Confluence is located 0.1 km from Masjid Jamek, 0.1 km from Market Square and it is also located 0.1 km

from Bangunan Sultan Abdul Samad. Estimation area covered is about 600m² x 800 meter square.

Klang and Gombak Rivers Confluence and its adjacent rivers have a history of frequent flooding problems. Previously, Kuala Lumpur suffered serious damages during the flash flood in April 2001. Flash floods following over two hours of heavy rain caused thousands of vehicles and several main roads in the city to be submerged and lives lost. According to "The Klang River Basin Environmental Improvement and Flood Mitigation Project" study commissioned by the Government and funded by the Asian Development Bank in July 2003 clearly indicates that the confluence of Klang River, Gombak River and the Ampang River could not carry storm water during the heavy rains. This river was selected for this study because of availability of river survey data and concurrently, due to its flood prone area.

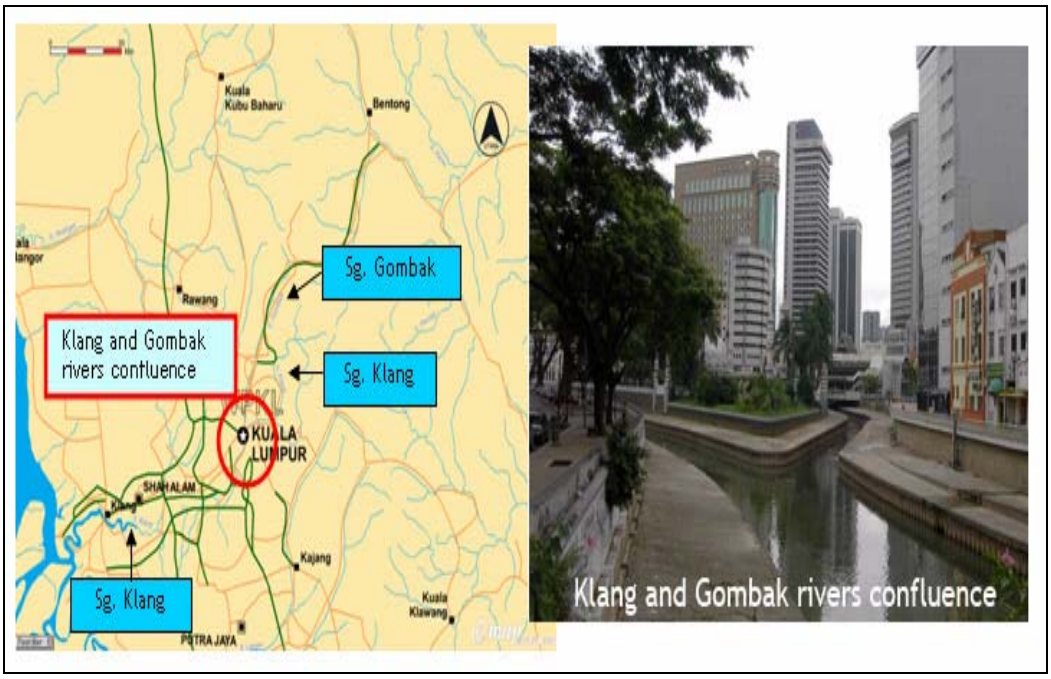


Figure 4.1: Klang and Gombak rivers confluence; flood prone area in Kuala Lumpur.

4.2 Objective of the study

The main purpose of the study is to develop flood plain simulation model by integrating surveying packages and GIS system.

The study will concentrate on visualizing spatial data using a third dimension in providing water volume on specific flood area and obtaining the analysis on the river. Triangulated Irregular Networks (TIN) is the methodology that been using in producing the flood plain model. TIN was our working map because it provided us with elevation, which is very important when looking at water levels and cross sectional river profiles.

4.3 Use of a surveying Packages

Essentially, the use of surveying packages is integrated module packages that comprehensively resolve in every surveying operation, engineering and its design. Surveying packages capable in receiving data input from electronic data collector, digitization and memory card. On the other hand, it able to process details observation data from a fieldwork. Surveying packages used in this study are Civil Design and Survey (CDS), Surfer 8.0 and AutoDesk Map 6.0. CDS used for processing surveyed data for producing a plan. It competent in doing engineering analysis and CDS open for high capability with recent needs.

4.3.1 Data : Downloading, processing and editing

Data collected and downloaded from total station and is carried out information regarding water level and rainfall is obtained from Department of Irrigation and Drainage's (DID) official website. With CDS, data is processed and calculated automatically in obtaining the height value, coordinates and its adjustment for every detail. After downloading, data exported into Autodesk Map

for editing process before integrate it with ArcView software for modeling and analysis. The contour, lines, Triangulated Irregular Network (TIN) and Digital Terrain Model (DTM) are generated from previous calculations. These are the steps that required in producing the model. Data processed is forwarded to editing stage by Autodesk Map. A plan on study area is produced using Autodesk Map software shown in Figure 4.2.

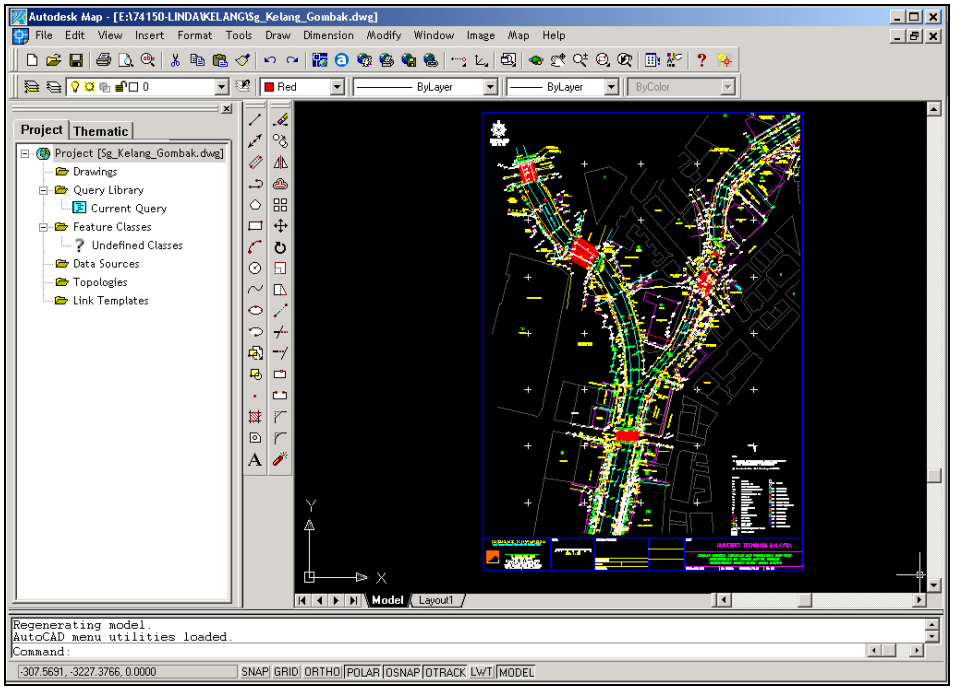


Figure 4.2: A plan on study area is produced using Autodesk Map software

4.4 Use of a Geographical Information System

The growth of GIS technology recently has brought the GIS software into various analyses, not only on spatial information in fact on its attributes information too. ArcView is chosen for completing the study in modeling the flood plain simulation of area covered around 600m² x 800m² and the base height of the model is depends on z value (elevation) obtained from the generate contour taken at 22m. The water level is simulated by few times that each is represented for different height of water level. The normal water level height at Gombak River is at 26m and it simulated at increment of 1m water level until the maximum height of the water level is at 32m. When water level reach maximum level at 32m, flood will occur and drench homes and business surrounding.

4.4.1 Visualization of Flood Plain

In Figure 4.3, the area of interest is shown at two instances that is on the left column the visual shows the area before flooding while on the right column show the area was flooded at different stages. The water level shown in the visualizations with the increment of water level from 26m until 32m.

The river flow with the normal height about 26.0 meter. From the figure, it is clearly shown that the area is risky to flood since the height values on the top bank of the river is at 30m. With different depth value, both the 3D and 2D display are created from ArcView software. The interpolation from raw data and detail survey using ArcView are able to illustrate and compute the water volume is shown in Table 4.1.

Figure 4.3: Visualizations of increment water level from normal height; 26m until the maximum height of 32m

Table 4.1 shows the computation of the volume of water at different level of water. Here the volume is computed and the percentage of the flooded area is given. The results are shown graphically in Figure 4 where the increase in volume with respect to the increase of height.

Table 4.1: Flood area and its volume.

Water Level (m)	Water Volume (m^3)	Flood Area (m^2)	Percentage of Flood Area (%)	Area flood unaffected (m^2)
26	2171570.617	16438.445	3.674	431028.835
27	2593125.289	22834.777	5.103	424632.503
28	3008650.328	30230.484	6.756	417236.706
29	3416976.451	49992.149	11.172	397475.131
30	3793798.225	146730.442	32.791	300736.796
31	4105644.776	255949.238	57.299	191518.042
32	4266926.467	285282.902	63.755	162184.378

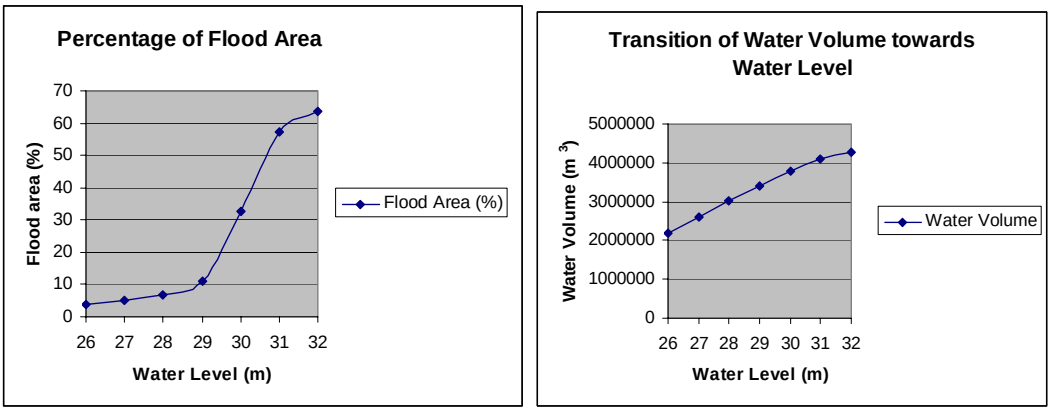


Figure 4.4: Percentage of Flood Area and the Water Volume Towards Each Water Level

From the Figure 4.4, it can be seen that at 26 meter which is the normal water level in the river. The increment of 1meter water level will increase risk of the flood prone area. For instance, at 28 meter the increment of water volume is about 3008650.328 m3. And at 32m it will increase to 4266926.467m3. This will cause the water spills from the river bank and cause overflow to the area involve since the height of the bank of the river is at 30.0 meter.

4.4.2 Analysis on cross-sections graphs

From Figure 4.4 it can be clearly seen that the water level will caused the water to over flow it bank. The cross sections A-A' graph of Gombak River in Figure 4.5 shows that the maximum water level is at 32m. From the cross sections line between point A and point A' is about 400m. For clear analysis on each increment of water level, Figure 6 shows clearly the relation between cross sections and water depth for each water level. The water level is taken at 26 meter, 28 , meter , 29 meter and 30 meter.

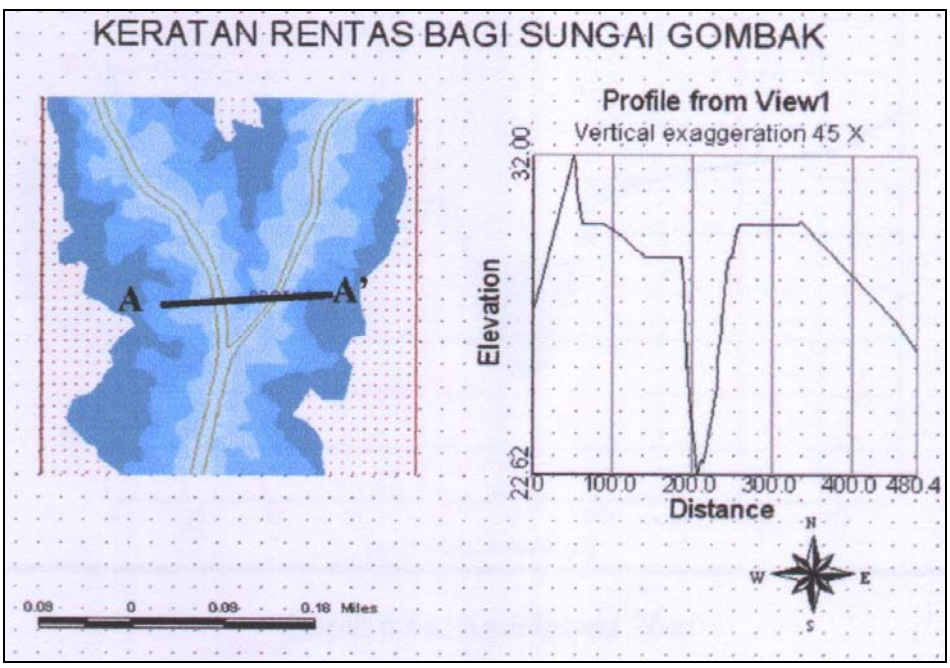
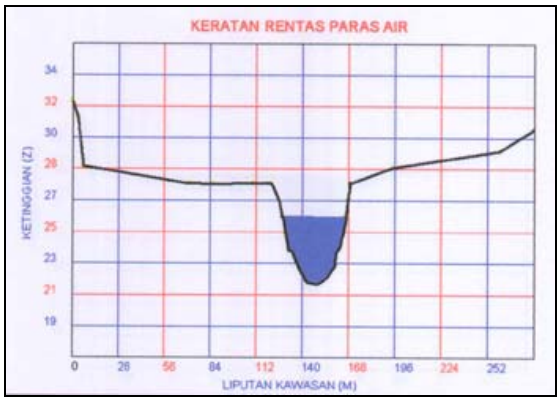
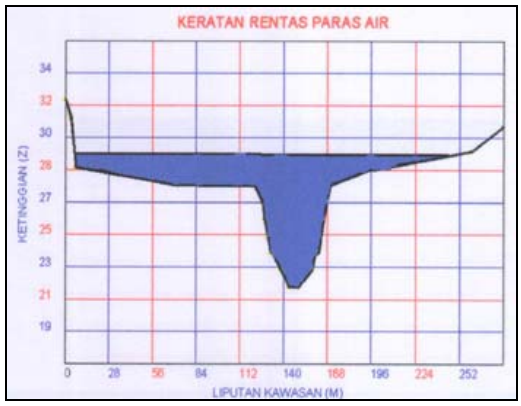


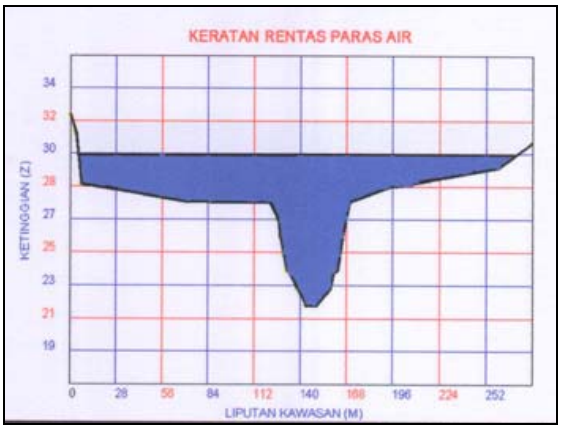
Figure 4.5: Cross Sections Graphs



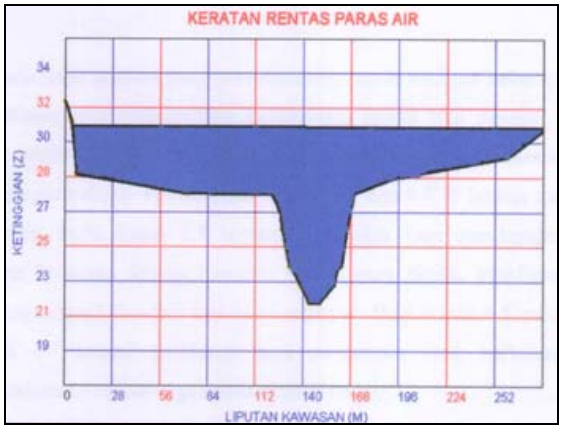
Water Level 26m



Water Level 28m



Water Level 29m



Water Level 31m

Figure 4.6: Relation between cross sections and water depth for each water level.

4.5 Conclusion

Flood plain simulation model can be created and further studies from it can be carried out.. The integration between survey interpolated data and ArcView give a result as has expected. Creating flood plain simulation using ArcView and few other surveying packages managed to generate desire flood plain model that can provide information regarding the extend of area covered

under water at different water level. It can gives information for flood management work and can give rescue work time for planning if flooding occurred.. In fact, using ArcView the application is made easy especially for updating of data and the flood plain simulation can produced in interactive visual aid to the user.

4.6 Acknowledgement

Our gratitude goes to Department of Irrigation and Drainage (DID) for providing the required rainfall data on Gombak River. This research was made possible by support from Ministry of Science, Technology and Industry (MOSTI) that has granted Intensified Research in Prioritized Area Grant (IRPA).

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CHAPTER 5

SUMMARY AND CONCLUSIONS

5.1 Summary

Flooding is the common of all natural hazards. It happens during heavy rains, when rivers overflow, when dams or levees break or when ocean waves come onshore. The magnitude of flooding can be only a few inches of water or it may cover a house to the roof top. Information about flooding is important to the public. Flood warning can be informed through radio or television when it occurs or about to happen so that the public can evacuate to higher or safer ground if required to do so.

The integration of GPS and surveying packages for near real-time flood monitoring system is about combining the application of GPS and surveying software to produce flood modeling of an area of interest. Preparation and planning for search and rescue operation need to be launched with the help of updated information of the area involved. Data need to be processed with the best suitable surveying packages to make it near to real-time system. It is useful if the data provided have the element to show in a 3D model and can established the coordinates as well as height of the point in the area. The points that are required include the height of riverside, height along the riverbank, the position and the river depth (invert level) of the river. Besides that, the information of supplied rainfall quantity in the area and river water level as near real time is important. It is also important to know the direction of water flow and the volume of water, the cross-section and longitudinal section of the river in the specific area.

There are four surveying packages which are tested in the process and then generated in 3D model of the river for flood monitoring system. A brief description of the package are discussed a below. They are

i. CDS TRPS
ii. AutoCAD Map 6
iii. ArcView GIS
iv. Surfer

5.1.1 CDS TRPS

This software is developed by Foresight Software. The objectives of the software is to assist Civil Engineers and Surveyor to improve their efficiency in the calculation and design process on a Personnel Computer based platform. The data process can be view using TRPS in the form of various attributes such as points, point numbers, height, codes, description, layer, road number, offset, and design. TRPS will display a value that is saved from what they have been imported. The job process can be query and edited at any stage.

5.1.2 Autodesk Map 6

Autodesk Map 6 is the premier solution for creating, maintaining, analyzing, and producing mapping information in a CAD environment. Autodesk Map 6 contains the object-oriented capabilities of AutoCAD software as well as its own unique spatial data management and multiple drawing access strengths. It can digitize, maintain, analyze, and plot maps and map sets, and create thematic maps and legends. It also can work with multiple drawings and use information from external data sources for all mapping tasks. Autodesk Map provides a powerful toolset for developing and managing complex design projects. Autodesk Map increases project team efficiency by creating a comprehensive cost-effective project database. Autodesk Map integrates multiple drawings into one seamless environment providing access, editing, and reporting of drawing, attribute, and related database information within a single Autodesk Map session.

5.1.3 ArcView GIS

This software manufactured by Environment System Research Institute, Inc under Arcsoft Software Series. It is specially created for desktop GIS and mapping; present and analyze geographic information. It can w orking spatially with easy to load tabular data, such as dBASE files and data from database servers, into Arc View and can display, query, summarize, and organize those data geographically.

With this software, the display can show and view geographic data in interactive maps and show every view features in Arc View's unique geographic 'Table of Contents'. It can also tabulate in highlight records in table and show attributes in view. The summary of the statistics, sorting and querying can be done. As for charting, the work can be simultaneously be carried out and show the drawing business graphics and data visualization capability that is integrated into Arc View's geographic environment.

5.1.4 Surfer 8.0

The next surveying package tested is the Surfer 8.0. The analysis using Surfer 8.0 shows that this surveying software able to create contour and 3D surface mapping program. It can easily convert data into outstanding contour, surface, wire frame, vector, image, shaded relief and post maps. The Surfer can be completely controlled by any automation-capable programming language such as Visual Basic or C++ program languages. The Surfer package includes GS Scripter; a Visual Basic-compatible programming environment that enable to write, edit, debug and run scripts. In this way, it can automate repetitive tasks, create front ends for running Surfer, or carry out any task that Surfer can do. Using this package, the Surfer 8.0 allows creating a multitude of map types to visualize from observation data and some of the results are in Figure 3.4 showing the surface map and Figure 3.4.1 showing the DEM map.

5.2 Conclusions

Global Positioning System plays a significant role in providing data in area of floods and couple with surveying packages that include geographical information system technology can result into effective, economic and efficient tool for storing, manipulating, and presenting spatial and non spatial information. Traditionally, maps are being used to provide information for planning and

execution of relief operations. However, with the introduction of computerized techniques in map-making and space technology in surveying and mapping the utility of map data in this type of operations can be coordinated in near real-time situation. This research have demonstrated the feasibility of using Global Positioning System (GPS) in near real-time mapping for flood monitoring system especially in providing positions and heights of water level in floods area for updating data. The integrated approach to include the GPS technique and available surveying packages give better understanding, monitoring and managing the disaster. It is essential that the coordination of work, easy data exchange at all level must be ensured to facilitate smooth functioning of the entire system. The display of digital map on largest possible scale can enhance the integrated positioning systems made available to the disaster management team, for effectiveness not only in search and rescue operations but also rehabilitation works for other disasters.

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APPENDIX

APPENDIX A

Figure A1: Stream that can cause flooding

Figure A2: River flowing

Figure A3: River flowing

Figure A4: GPS receiver for data collection near river bank

Figure A5: GPS receiver collecting data

Figure A6: Landscaping

Figure A7: Water level rising near river bank.

Figure A8: River that is prone to flooding

Figure A9: Klang River in Kuala Lumpur

Figure A10: Height of water level above Klang River

Figure A11: Klang River in Kuala Lumpur

Figure A12: Klang River in Kuala Lumpur