FLOOD MAPPING AND FLOOD DAMAGE ESTIMATION USING GIS

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CIVIL ENGINEERING
UNIVERSITI TEKNOLOGI PETRONAS
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By

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Dissertation submitted in partial fulfillment of

the requirements of the

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CERTIFICATION OF APPROVAL

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Approved by:

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Assoc. Prof. Dr. Abdul Nasir Bin Matori
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UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

June 2010

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

Mohamad Rezafahmi Bin Mohd Saleh

ABSTRACT

Flood mapping has been used widely in many countries nowadays as a method to encounter this natural hazard phenomenon. In the past few years, studies about the flood analysis and modeling used to take years. But now, with the facilitation of Geographical Information System (GIS) automated process, the studies are faster and even accurate in modeling the flood inundation area. The used of GIS is essential as a planning tool for floods, educating the populations at risk and managing floods as they actually rise. Features in the GIS itself such as the 3-D Visualization and detailed hydrological characteristic help a lot in defining areas which is vulnerable to flood. Generally, flood mapping can identify the effects of flooding and those effects are represented in hazard and risk mapping. The main advantage of using GIS for flood management is that it not only generates a visualization of flooding but also creates potential to further analyze this product to estimate probable damage due to flood. This paper is to demonstrate the use of GIS in constructing the flood map at studies area. The map then are derive into Digital Terrain Model (DTM) to make the identification in flood vulnerable areas easier which provide high detailed representation of the topographical variations in the Earth's surface.

ACKNOWLEDGEMENT

This project has taken about a year of planning and working processes in order to fulfill the requirements of Final Year Project subject. In a year duration, many peoples had being involved either directly or indirectly whose contribute in assorted ways to this project in order to make it a success. Thus, it is a pleasure for me to convey my heartfelt gratitude to them all in this humble acknowledgement.

In the first place, I would like to record my gratitude to Assoc. Prof. Dr. Abdul Nasir Bin Matori. He was not only served as my supervisor but also encouraged and challenged me throughout his constructive comments, critics and valuable suggestions. Besides, his full supports and advices had actually inspired me and develop my skills as a researcher and engineer to be.

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Not to forgot, my parents and family members who have given a never-ending support in the quest to gain valuable knowledge and experience in this university throughout the completion of this project. They deserve a special mention for their inseparable supports and prayers.

Certainly on the list of peoples to be thank of are all friends from all around and also to those people that not be mentioned here. Your names may slip of my mind at this moment, but your actions and helps stay in my mind forever.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Flood is known as one of the natural hazard phenomenon that affects many countries in the world. It is an evitable natural phenomenon where its happen anywhere and anytime in all rivers and natural drainage systems that not only damages the lives, natural resources and environmental but also causes major loss in economy and health.

Malaysian early settlements are historically known grew on the banks of the major rivers in the country like other major populations in the world. Together with natural factors such as heavy monsoon rainfall, intense convection rain storms, poor drainage and other local factors, floods have become a common element in the lives of a significant number of Malaysians.

Huge funds are needed in implementing the flood insulation project and restructured area that has been affected by floods. Many effort and initiative by government and local authorities in identifying the flood causes and vulnerable areas that is risky towards this natural phenomenon. Thus, there is a need to further studies about this topic where an effective plan could be generated at the end of the studies.

Geographical Information Systems (GIS) technology are used widely in many discipline because its multi functional purposes such as analyze spatial information, edit data, maps and present the results of all these operations. By using this GIS tools in flood mapping, an accurate prediction and details about the flood characteristic could be determine. Besides that, a proper plan can be prepared to reduce the risk and casualties during the floods such as identifying areas that need to be focused on when the floods occurs.

1.2 PROBLEM OF STATEMENT

As a consequence of seasonal floods occurring almost annually in one part of the country or another, flood losses in terms of loss of life and damage to properties are substantial. During the flood, low level areas are most vulnerable to flooding. For example, main river basins are the area which is fully congested with human settlement where most agriculture and other economics converge here since ancient times, and these areas are extremely vulnerable to natural disasters due to both geographical and meteorological conditions.

Unfortunately, the developments around these areas are still continued in recent years. Many developers did not realize that the risk and possibilities of flood to occurred in their area. Many houses and commercial areas were constructed to attracted more civilian without taking any identification about the surrounding geographical and meteorological. Then, when this natural hazard phenomenon comes, it will destroy anything that is around its parameter.

The annual cost that government need to spend for flood disaster preparedness, rescue and relief operations, and post-flood rehabilitation of victims and public utilities are substantial. Lack and ineffectiveness of flood evacuation plan also contributed to the increasing numbers of casualties and properties. Therefore, by doing this study a method in identifying floods using GIS mapping could be really helpful to the communities.

1.3 OBJECTIVES

Upon completing the project, a few objectives need to be achieved. The objectives of study are as follows:

1) To identify the areas that are vulnerable to flooding using GIS
2) To roughly estimate the damage in the flooded area

1.4 SIGNIFICANCE OF PROJECTS

At the end of the research, the use of GIS technologies as a method of flood mapping in Malaysia could be implemented widely so that the casualties and losses during the floods phenomenon can be reduced. Besides that, others matter can be achieved such as:

1) Prevent any development in flood high-risk area
2) Prepare better and more effective flood evacuation plan
3) Focus on flood high-risk area by providing more facilities such as evacuation area

1.5 SCOPE OF STUDY

The scope of studies for FYP 1 is to get familiarize with GIS software and gathering all information regarding flood research which has been discovered by the previous people. In FYP 2, the work is more to finding the final results which is the flooded area in selected area.

The author has chosen few places in Malaysia which has flood occurrence history almost every year as the study areas. Each areas geographical and hydrological feature need to identify to ensure the research methodology can be done without any obstruction or constraints. The study area was chose at Kubang Pasu district in Kedah, Kampung Gajah and Sungai Siput, Perak. Then, the flood mapping process will go through those areas to identify the prone areas. As an addition to this study, the author added a rough estimation about the flood damage mainly to the residential and some facilities there.

CHAPTER 2

LITERATURE REVIEW

2.1 NATURAL PHENOMENON

Flooding can occurs along the rivers and when torrents hit an area continuously or in coastal areas of the sea which exposed with big waves during storm. Technically, flooding will most probably occurs in low level area especially at downstream. A lot of factors contribute to this natural phenomenon such as poor drainage system, ineffective water catchment area, dam breakage and tsunami effects. Therefore, it is importance to rectifying this problem and used the technologies that exist to let the human life much more comfort and better.

2.2 FLOOD MAPPING

Flood mapping has been used widely in many countries nowadays as a method to encounter this natural hazard phenomenon. Existing flood maps need to update because, in the nearly 20 years since the original studies were completed, additional information has become available about peak flows and floodplain elevations that would significantly change the flood estimates these maps display. On the other hand, complete re-studies using traditional methods are costly and time-consuming, so it is unlikely that the maps can be restructured quickly enough to meet demand.

Depending on the function, users have very exact demands on content, scale, precision or readability of the map. Flood maps are primarily used for flood risk management strategy (prevention, mitigation), land-use planning, land management, emergency planning, public awareness rising, and private sector, in particular insurance sector [1]. In other aspect, flood maps may be required for other activities that may be less organized in application, localized in demand or necessary as secondary or additional information for decision-making on issues not directly related to flooding, such as environmental planning or soil contamination after flood.

Maps have been used for thousands of years, but it is only within the last few decades that the technology has existed to combine maps with computer graphics and databases to create geographic information systems or GIS [2]. In most technique to create the flood mapping, Geographic Information Systems (GIS) have been recognized as a powerful tool to integrate and analyze data from different sources. GIS links sets of features and their attributes and manages them together in units called themes. A theme contains a set of related features, such as roads, streams, parcels, or wildlife habitat areas, along with the attributes for those features. As with the old Mylar maps, the layers which are underneath remain visible while additional themes are placed above [3].

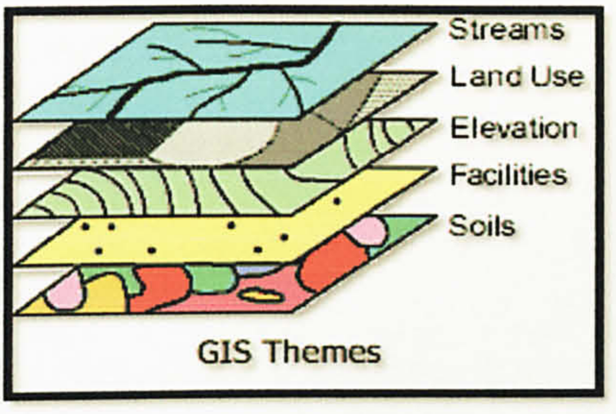


Figure 1: Example of GIS themes
Source: http://www.inforain.org/gis

2.3 UNDERSTANDING GEOGRAPHICAL DATA

Geographical data is the information about the earth surface and the objects on top of it such as rivers, forest, hills and etc. This information comes in three basic forms which is:

- Spatial Data
- Tabular Data
- Image Data

2.3.1 Spatial Data

Spatial data contains the locations and shape of map features and normally known as digital map data where the users need when to identified to make maps and study spatial relationship. For instance, spatial data is the points that represent such things as shopping centers, banks, and physician's offices, and lines that represent such things as street, highway, and rivers.

2.3.2 Tabular Data

Technically, tabular data is the descriptive data that GIS links to map features or in other words, adding the information to geography. It is collect and compile for specific areas like states, census tracks, cities and often comes packaged with the feature data. Some tabular data contains geographical locations, such as addresses, bird nest sites or places where flood have occurred. Then, from the locations, map features can be created, displayed and analyzed along with other spatial data.

2.3.3 Image Data

Image data is important to get an overview about the particular area that need to be investigated where it is include such diverse elements as satellite images, aerial photograph, and scanned data. Image of the earth taken from satellites or airplanes can be displayed as maps along with other spatial data containing map features.

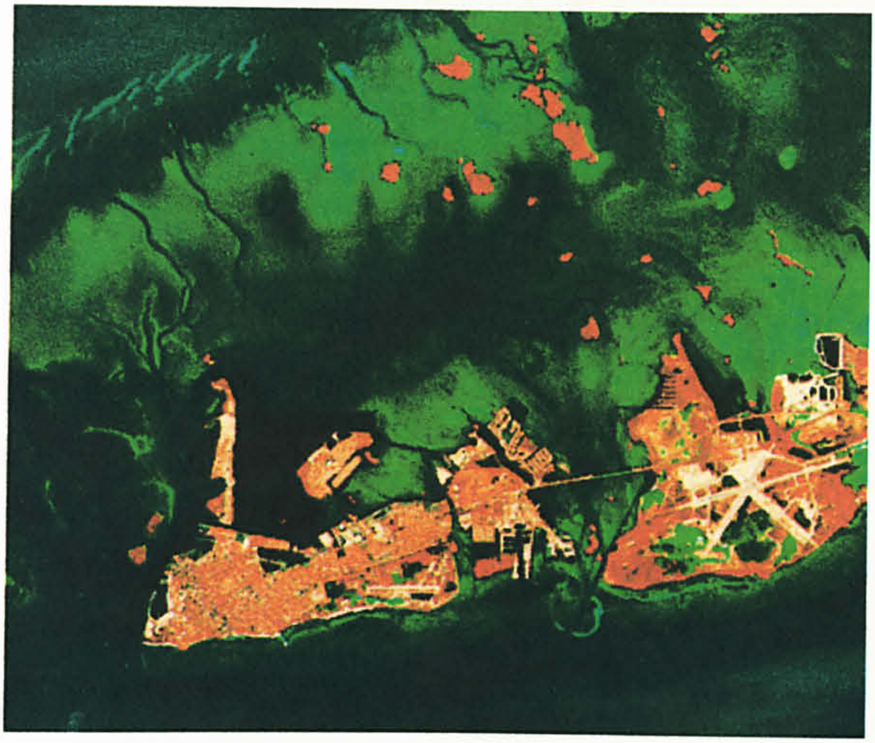


Figure 2: Satellite Image
Source: EOSAT

By using the existing technologies such as Geographical Information System (GIS), it allows users to overlay the additional information such as roads, buildings and critical facilities which allowing quick assessment of the potential impacts for a particular flood level. Then, GIS can used to map areas along the periphery of the inundated area where uncertainty in the flood or land elevations translates into uncertainty about the extent of inundation [4].

Generally, flood mapping can identify the effects of flooding and those effects are represented in hazard and risk mapping. However, for management purposes the cause of flooding are of very high importance. Early warning systems, warn and alarm schemes, clearance of channels etc. are fully based on the cause and development of flood event [1]. It is evident that GIS has a great role to play in natural hazard management because natural hazards are multi dimensional and the spatial component is inherent [5]. The main advantage of using GIS for flood management is that it not only generates a visualization of flooding but also creates potential to further analyze this product to estimate probable damage due to flood [6].

More recently, advances in computer and GIS technology have increased the accessibility and mobility of GIS tools, such that communities can use GIS to manage their local knowledge and community data collections using mobile GIS and Global Positioning System (GPS) technologies [7]. As a consequence, GIS has now become a fundamental component of community-based methodologies [8].

For the studies of flood mapping using GIS, the author will identify the terrain and contour in low level area which is vulnerable to having flood. It is importance to know the area information because there are many factors that contribute to flood. Then, the studies continue with the investigation in what level of water the flood will occur. Besides that, by referring the flood mapping, areas of flood occurred can be determined and predicted when it will happen. During the floods, some of existing flood evacuation plans is not fully comprehensive where only covers areas which had been previously affected by floods. Therefore, after identifying the areas that are highly vulnerable, a proper flood evacuation plans can be constructed without any areas effected left behind.

In order to have a further understanding about the role of GIS in flood management, the author has refers to some of the previous research in journal, books, articles and other relevance references. In Malaysia, there was a research regarding the floods which has changes the Sungai Langat channel. By comparing maps showing the conditions in year 1973 and 1996, they need to identify changes in alignment along the river. Then, by using the GIS, identification of reaches that have undergone changes and their relation to sinuosity indices was made. The results are useful to guide river restoration works and promote multiple benefits of biodiversity enhancement, cleaner water, and reduction of flood risk [9].

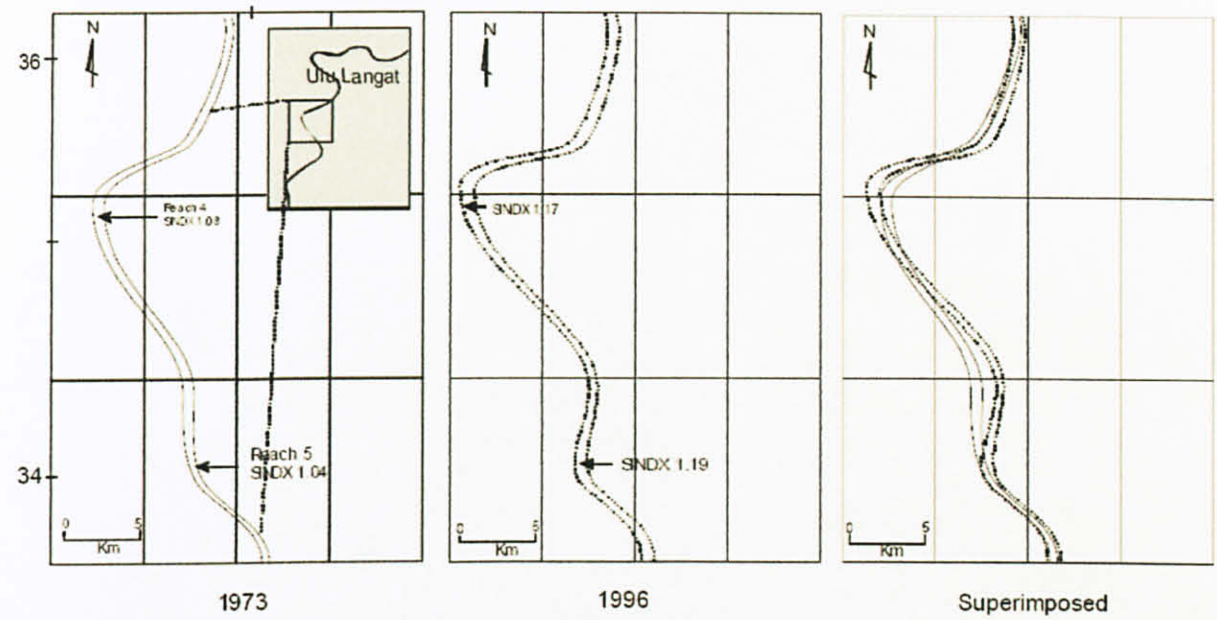


Figure 3: Superimposition technique between 1973 and 1996 topographical maps
Source: Malaysian Journal of Civil Engineering, 2006

GIS extrapolation analysis then were used to identify the changes in sinuosity index (SINDX) in the up-stream, mid-stream and down-stream reaches. Changes in channel plan form were detected by superimposing the maps of year 1973 and 1996 (Figure 2). This technique provides evident on how the channel sinuosity is modified in size and position as the results of lateral erosion and sediments movement [9].

In determining the flood areas, sometimes it is necessary to couple a complex GIS with a simplified one. Good examples of this situation take place from the collaboration between teams with different equipments or from the need to use a more sophisticated system when a simpler one proves to be insufficient [10]. GIS are commonly equipped with tools that are significant to the implementation of hydrologic and hydraulic models, like algorithms for the calculation of watershed contours, slope, Digital Terrain Models (DTM), network functions, and the capability to overlay images.

Studies about coupling GIS with hydrologic and hydraulic models started in 1975, when the Hydrologic Engineering Centre (HEC) worked on the integration of HEC-1 in a GIS using a grid based method [10]. The result of this effort was HECSAM (Spatial Analysis Methodology). In this approach, GIS served simply as a database to feed the hydrologic model.

2.4 DIGITAL TERRAIN MODEL (DTM)

For the most part in generating the flood mapping, it is necessary to derive the Digital Terrain Model (DTM). DTM is basically a digital file providing highly detailed representation of the topographical variations in the Earth's surface and it can be used by combining other digital data such as maps or orthophotograph where a 3D image of land surface can be produced.

The concept of creating digital models of the terrain is relatively recent and the term digital terrain model (DTM) is generally attributed to two American engineers at the Massachusetts Institute of Technology during the late 1950s [13]. The definition they coined then was: "DTM is simply a statistical representation of the continuous surface of the ground by a large number of selected points with known X, Y, Z coordinates in arbitrary coordinate fields" (Miller and LaFlamme, 1958). Specifically, their early work was concerned with the use if cross-sectional data to define the terrain. Since then, several other terms, such as digital elevation model (DEM), digital height model (DHM), digital ground model (DGM), and digital terrain elevation data (DTED) have been combined to describe this and other closely related process. Although in practice these terms are often presumed to be synonymous, in reality they often refer to distinct products (Petrie and Kennie, 1990).

2.4.1 Elements of Digital Terrain Modeling

The production and use of DTMs generally involves five discrete procedures or tasks. These are generation, manipulation, interpretation, visualization, and application as shown in Figure 2.1. Deriving products from a DTM should not be viewed as a one-way process, but rather as the result of various interrelated stages in modeling [15].

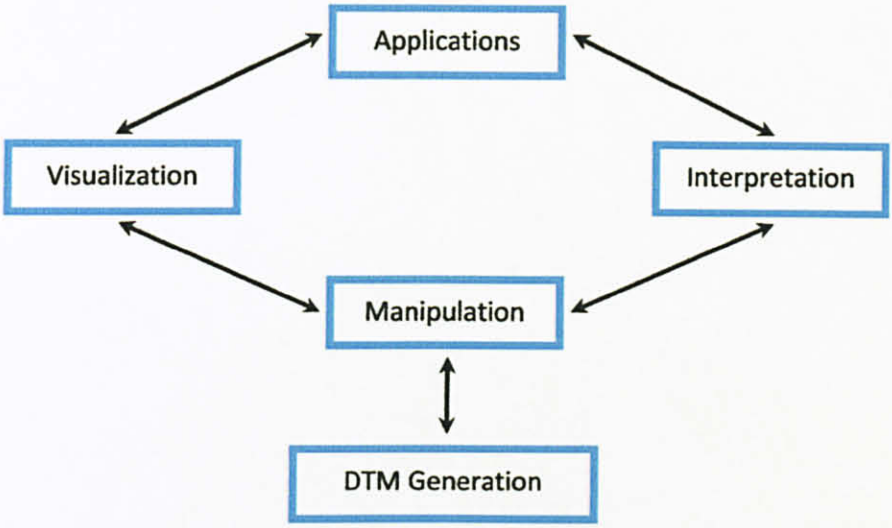


Figure 4: Main tasks of DTM

2.4.2 Data models in DTM

During the process of acquiring terrain data, a relatively unordered set of data elements is captured. In order to construct a comprehensive and usable DTM, it is necessary to establish the topographical relations between the data elements as well as an interpolation model to approximate the surface behavior [13]. It is impossible to record every point, and consequently a sampling method must be used to extract representative points. These discrete points can then be used to build a surface model that approximates the actual surface [14]. There are three methods are commonly used to represent surfaces in digital form which is contour line, grids (lattice or elevation matrix), or triangulated irregular network (TIN) [15].

Contour or isolines of constant elevation at a specified interval are probably the most familiar representation of terrain surfaces. Contour accuracy depends upon whether the isolines have been generated from primary or derived data [13]. The contour lines are needed in GIS to prepare a DTM of an area. In order to get a DTM, contour lines must be digitized and allocated height values in the segment editor. Then, contour interpolation operation is used. A simple method to get a general view of the terrain is to apply the ‘‘Shadow filter’’ on the DTM with the ‘‘Filter operation’’ [11]. From the

DTM that been derived, the flow of the flood can be predicted and inundation area can be identified.

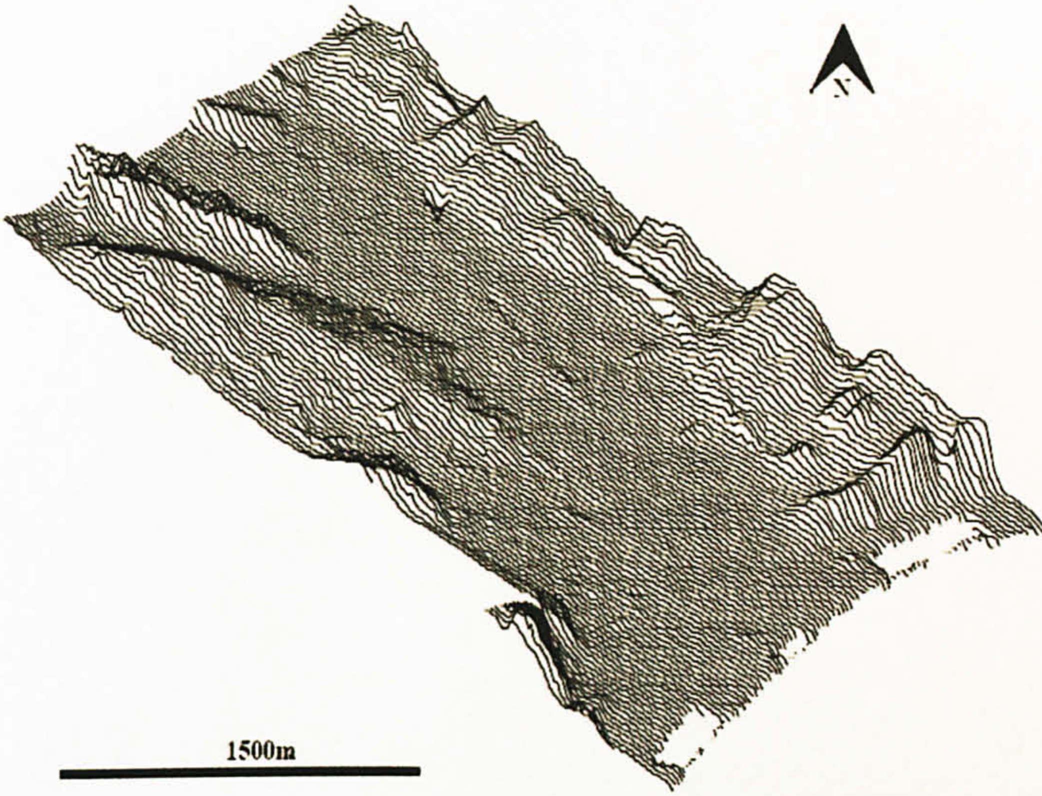


Figure 5: Elevation data in the form of contours used by GIS for computing the DTM
Source: Corriea et al. 2007,

2.5 DRAINAGE MODELING

Water resources engineering is a distinct branch of environmental modeling that deal primarily with water quality and quality management. Because of its importance to society, sustainable water resources engineering has evolved into its own discipline separate from traditional environmental engineering. Whether mitigating floods, assessing reservoir water supplies, or making decisions about wastewater treatment and disposal, water resources engineering is a large-scale activity that is impacted by terrain at all levels [10].

Hydrology is the science of the movement and distribution of the Earth's waters through all spheres of the Earth's system. To characterize and model the distribution of water level (whether in a river or as soil moisture in the ground) in a region is a fundamental requirement of water resources management [15]. Consequently, one of the most basic modeling units within hydrological modeling is the watershed [13]. Alternatively known as the catchment or basin, a watershed is defined as a control volume such that all water entering the control volume drains to one specific point.

2.5.1 Surface Water Drainage and Watersheds

Water poured over a hard perfectly smooth surface will run off or drain by gravity in the direction of steepest descent (when disregarding inertial effects). Routes of steepest descent are called slopelines or flowlines, and these lines are perpendicular to contour lines (which are lines of constant elevation). The runoff process leads to the development of surface drainage networks, which result from the accumulation of flow from merging flowlines [16]. The location and nature of these drainage networks, or river networks, ultimately lead to the definition and delineation of a watershed.

Accurate hydrological modeling requires the accurate representation of a river network. According to El-Sheimy and Valeo (2005), river networks are often idealized as *dendritic* systems that look like trees, where a single branch (or flowline) flows into a larger branch, which flows downstream to yet another larger branch, which flows downstream to yet another larger branch. This is indicated as in the illustration on the left in Figure 6.

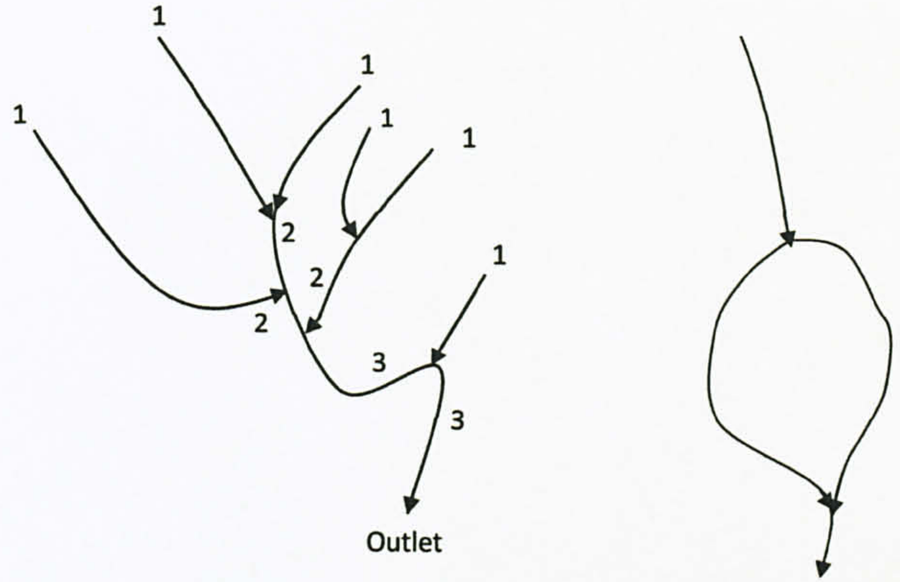


Figure 6: Representation of stream networks as dendritic (left) or anabranching (right)
Source: El-Sheimy and Valeo (2005)

The diagram on the left illustrates the *dendritic* quality where single river channels each meet at a confluence with a larger channel while the illustration on the right in which a river has split off into two channels, which are then rejoined into one channel. It exist in reality and are termed by geomorphologists as *anabranching* rivers. This type of rivers gives a problem when attempting to develop river networks using DTMs because the derivation of river networks by DTMs almost exclusively relies on the assumption of a dendritic network [17].

Horton (1932) and Strahler (1957) are considered pioneers in the quantification of river networks. A stream of lowest stream order 1 is a stream with no other tributaries (small rivers) draining into it. As streams converge at confluence points, streams of higher order are created. The stream order is assigned such that when two streams of the same order converge, then the order of the new stream is the old stream order number plus 1. Similarly, catchments are also assigned orders according to the Horton's law of basins, which implies that the drainage area of a catchment is directly proportional to the stream order of that catchment [16].

CHAPTER 3

METHODOLOGY

In order to achieve the objectives of the project, research and investigation about the flood mapping will be done. The work flow of the studies was divided into two which is Primary Work and Secondary Work. Primary work basically is the flow where the authors concentrate more on researching and studying of the project while Secondary work proceeds when all the data are available to achieve the final objective.

<u>PRIMARY WORK</u>

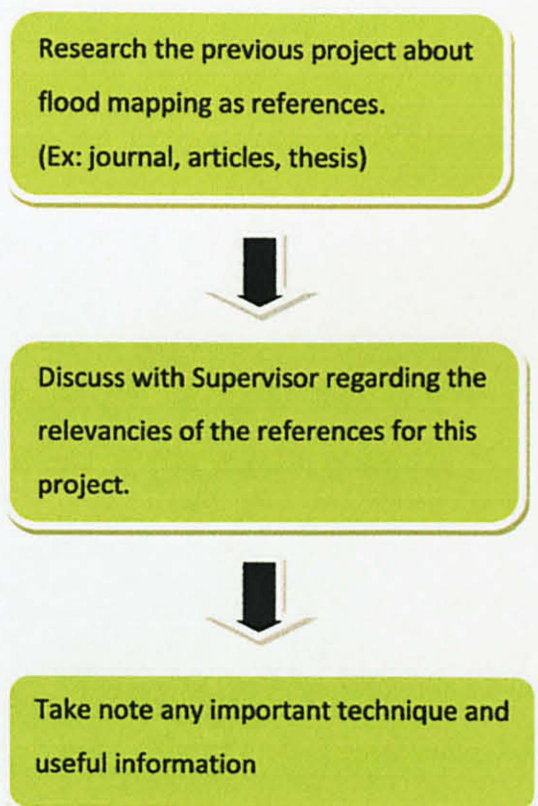


Figure 7: Primary work flow

SECONDARY WORK

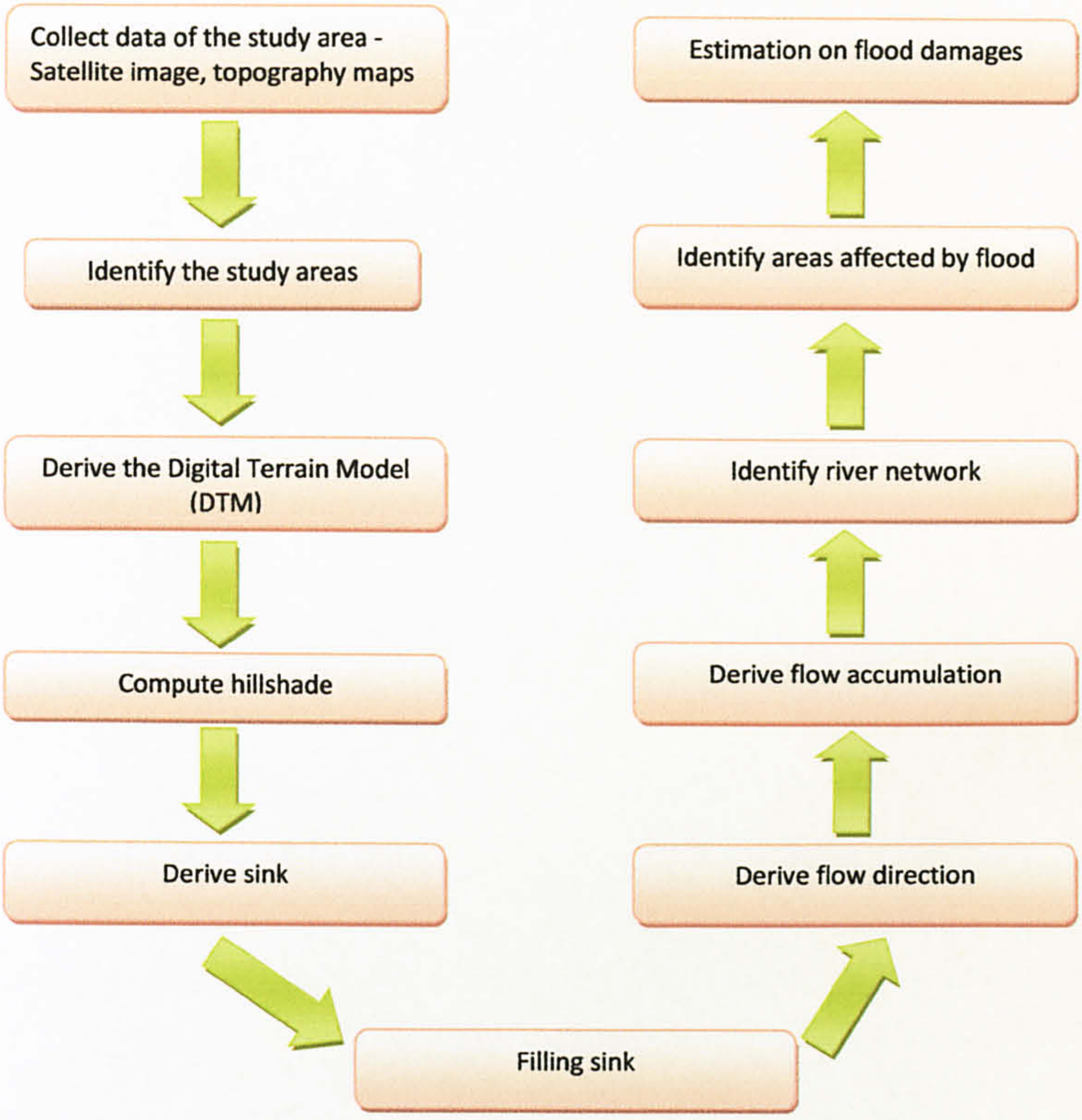


Figure 8: Secondary work flow

3.1 PROJECT RESEARCH

In this stage, it involved the literature research on the topic of the project and the related issues. Various source of information such as from journals, books and magazines need to consider during the research. The good understanding regarding the topic is really important to make sure the project will run smoothly.

3.2 PROJECT TOOLS

The author use ArcView GIS 3.2 as a tool to generate the flood mapping. ArcView is a useful software or desktop GIS and mapping. It is a product of Environmental Systems Research Institute, Inc. (ESRI). ArcView GIS is powerful software that provides for visualizing, querying, exploring, and analyzing data geographically. In other hand, ArcView is a powerful GIS tool that can display information, read spatial and tabular information from a variety of data formats, access external databases, produce thematic maps (use colors and symbols to represent features as well to represent features based on their attributes), perform spatial queries, connect spatial information to database attributes, provide several analytical tools, and allows for a high degree of customization using Avenue [12].

3.3 DATA GATHERING

The elevation data for this research was given in AutoCAD (.dxf) format as 3D contour lines. The author has select Kampung Gajah and Sungai Siput, Perak and Kubang Pasu, Kedah as the study area where the previous flood occurrence record, topography map and satellite image are taken as a part of studies. As additional research for this study, an estimation of flood damages will be included in the result. The values of the properties are divided into 4 parts as table below.

Table 1: Value of Properties

Item	Value of Properties	Remark
1	Cost of Repairing Road	Table 2
2	Houses and Building Properties	Table 3

Table 2: Cost of Repairing Road

Item	Repair Method	Cost (RM/km)		
		Residential Road	Normal Road	Highway
1	Resurface	200,000	300,000	2.0 million
2	Reconstruct	0.75 million	1.5 million	3.5 million

Source: Department of Highway and Transportation, Jurutera Perunding Zaaba Sdn. Bhd.

Table 3: House and Building Properties

Item	Properties	Value / Cost (RM)	
		Kampung House	Single Storey Terrace
1	Cleaning Up	484.00	858.00
2	Related Medical Expenses	115.00	210.00
3	External House Repairs & Replacements	742.00	1,350.00
4	Furniture & Related Items	2,015.00	3,984.00
5	Kitchen & Related Accessories	737.00	1,024.00
6	Electrical Items & Accessories	3,081.00	3,657.00
	Total	**7,174.00**	**11,083.00**

Source: Sg. Damansara Flood Impact Survey, 2007

Table 4: Damage Rate with Flood Depth

Item	Flood Depth (ft)	Average Damage Rate (RM/ft)
1	1.0	7.89
2	3.0	3.72
3	4.0	6.69
4	4.5	12.56
5	5.0	5.25
6	5.5	9.52
7	6.0	11.29

Source: KTA Tenaga Sdn. Bhd. "Flood Assessment of 26 April 2001 Flooding Affecting the Klang Valley and Generalized Procedures and Guide lines for Assessment of Flood Damages"

3.4 BASIC TRAINING WITH ArcView GIS 3.2

In early stages the author has done some basic training in order to get familiarized with GIS software by using ArcView GIS 3.2. As an example in creating the Digital Terrain Model (DTM), an area situated in Gunung Semanggol, Perak was used where elevation are in AutoCAD format (.dxf) as 3D contour lines. The author has used the hydrologic modeling to identify stream network and catchment zone in the practice area which later can be useful to be implemented in the flood mapping.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 RESULTS

The result was based on 3 study areas, which is at Kubang Pasu (Kedah), Sungai Siput (Perak), and Bota (Perak). The raw data was in AutoCAD .dxf format which represents contour lines and elevation. Hydrological modeling technique is implemented to derive the river network. From that, the flood areas can be identified according to the delineation of river network.

4.1.1 Identification of Flood Area

Area 1: Kubang Pasu, Kedah Darul Aman

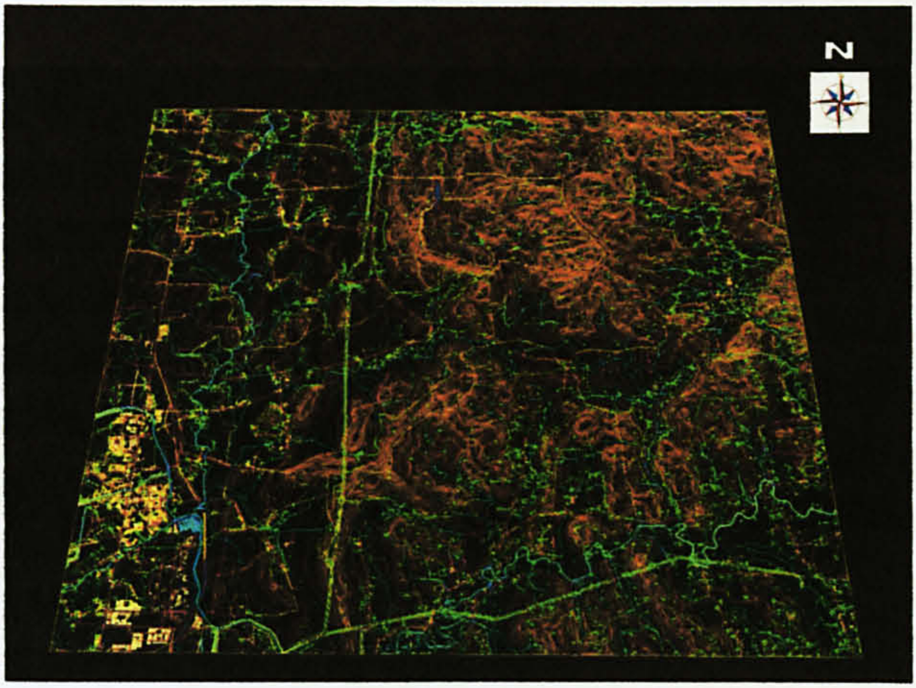


Figure 9: Kubang Pasu map in .dxf format

From the Figure 9, it shows a part of Kubang Pasu district locate at Kedah Darul Aman. The area contains roughly about 41 percent of residential area where most of it concentrate at the south east of the map which in Jitra city. At the north east, most of the area is used for agricultural activities, mainly for palm plantation and paddy field. There are 2 main river that can identified from the map indicated by the blue line, Sungai Bata that across the Jitra city and Sungai Padang Terap at the south west of the map.

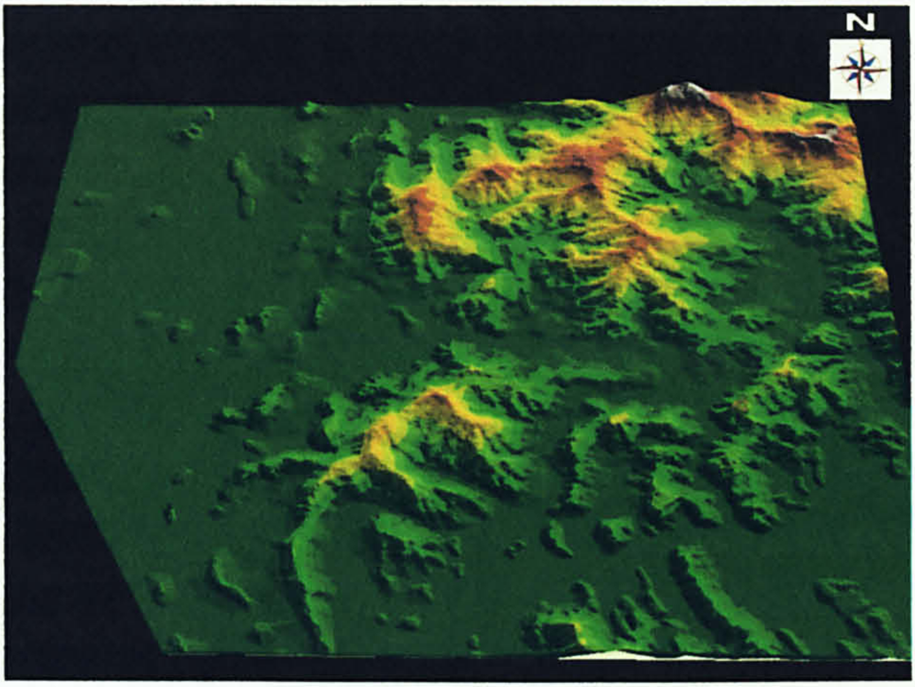


Figure 10: Digital Terrain Modeling of Kubang Pasu

Figure 11: River network overlay with Kubang Pasu map, blue shaded indicate the flood area

(Refer Appendix 6 for K1 – K5)

<u>Area 2: Bota, Perak Darul Ridzuan</u>

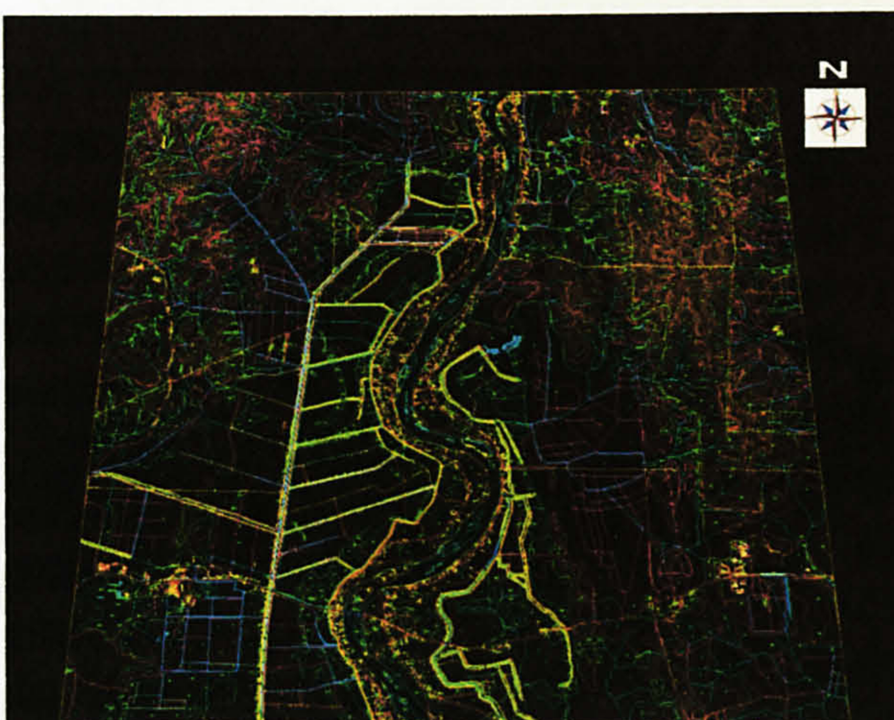


Figure 12: Bota map in .dxf format

From the Figure 12, it shows a part of Bota, Perak Darul Ridzuan. In the middle of the map, there is a river known as Sungai Perak. Roughly, about 36 percent of residential area was identified in this area mostly village type while 26 percent of the area contains agricultural part that concentrated on east of the map.

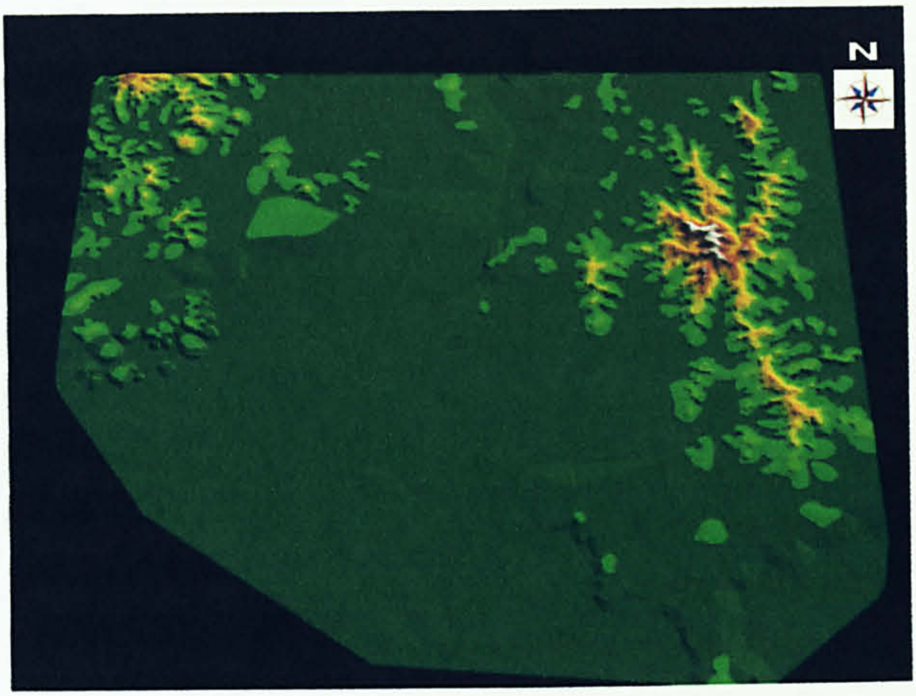


Figure 13: Digital Terrain Modeling of Bota

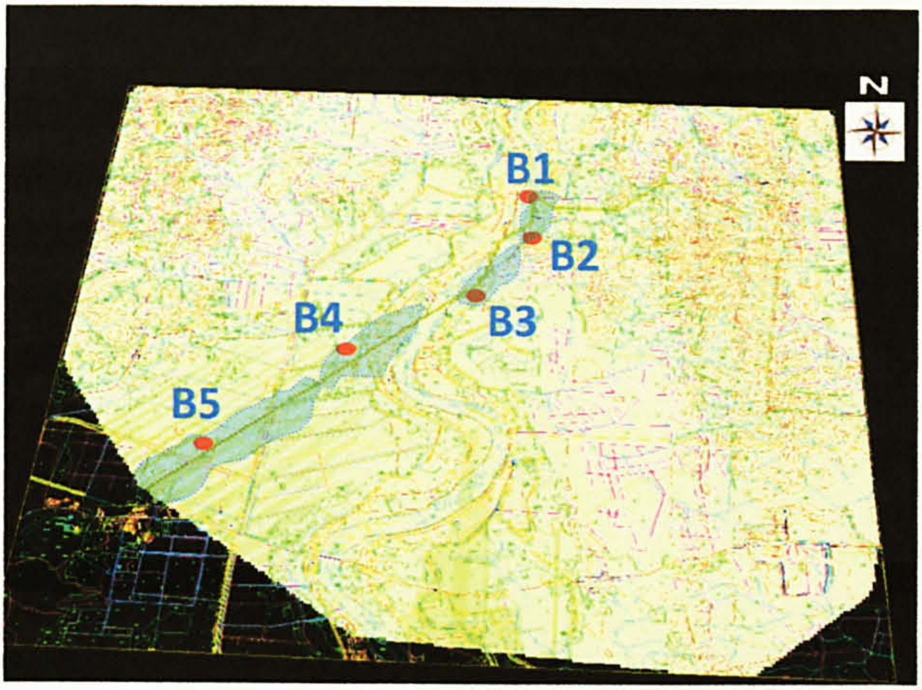


Figure 14: River network overlay with Bota map, blue shaded indicate the flood area

(Refer Appendix 6 for B1- B5)

<u>Area 3: Sungai Siput, Perak Darul Ridzuan</u>

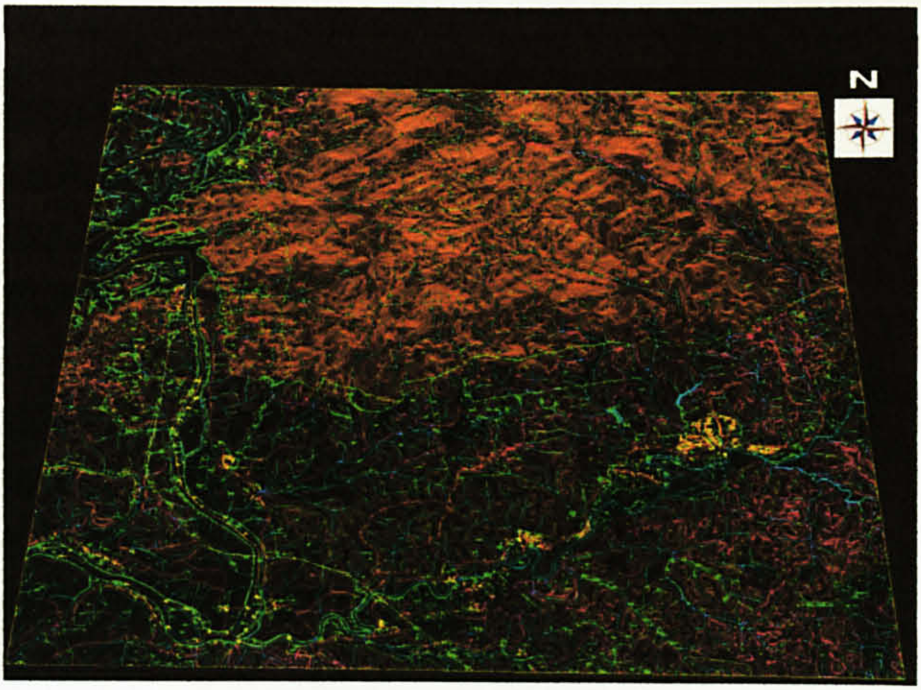


Figure 15: Sungai Siput map in .dxf format

Figure 15 shows Sungai Siput map that located at the north part of Perak Darul Ridzuan. The north side of this map are the hill land with the highest peak >1000 metres. Most of the residential area are concentrated along the Sungai Pelus with most of the house are village type.

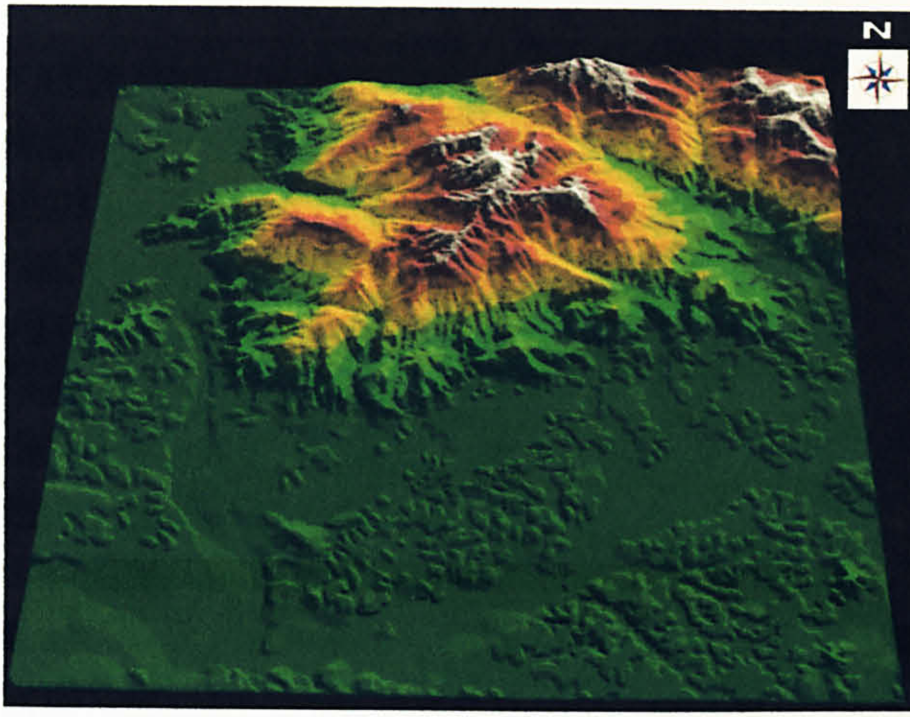


Figure 16: Digital Terrain Modeling of Sungai Siput

Figure 17: River network overlaid with Sungai Siput contour map, blue shaded indicate the flood area

(Refer Appendix 6 for S1- S3)

As shown in the Figure 9, Figure 12, and Figure 15, the selected area data is in the AutoCAD format (.dxf) which then being transformed to Digital Terrain Modeling (DTM). Then, fill function works to derive depression less DTM. In order to derive hydrologic characteristic about a surface, the direction flow from every cell in the raster need to be determine.

According to Figure 11, Figure 14, and Figure 17, the flooded area can be derived by overlaid the delineation of river network with the contour lines. River network color are changing from light to dark which means the light color line is the source of water from hill side and the more darker line is moving to the lower land. The blue shaded indicate the possibilities of flood occurred in that area.

4.1.2 Comparison between Results and Existing Flood Data

Area 1: Kubang Pasu, Kedah Darul Aman

As shown in Figure 9, there are four areas that being identified to have high possibilities for flood to occur. The results of this study are then compared to the actual flood occurrence history in the area to determine area that is exactly flooded. Refer to Figure 9, the blue shaded area that been marked with K, represent villages as state below:

Table 5: Villages marked as shown in Figure 11

Mark	Area Name
K1	Kampung Bukit
K2	Kampung Bendang
K3	Kampung Bata
K4	Kampung Lahar
K5	Kampung Kerkap

From the results, all the villages have successfully proved as flood prone areas. From 2002 until 2009, there was several flood occurrences happen at those areas according to the pictures and newspaper article at ***APPENDIX 1***. During the flood, two of the main river which is Sungai Bata and Sungai Padang Terap has overflow, thus caused flooding to the residential area along the river. In November 15, 2009, Sungai Bata has recorded water level at 9.33 meter (alert level 9.16 meter), which is above the danger level.

Area 2: Bota, Perak Darul Ridzuan

As shown in Figure 14, there are two areas that being identified to have high possibilities for flood to occur. The blue shaded area that been marked by B, represent villages as stated below:

Table 6: Villages marked as shown in Figure 14

Mark	Area Name
B1	Kampung Merua
B2	Kampung Bukit Chupak
B3	Kampung Bendang Bidara
B4	Kampung Parit 6
B5	Kampung Parit 1

Refer to the results, all the villages in the blue shaded have successfully proved as flood prone areas according to the *Peta Banjir Daerah Perak Tengah* from *Drainage and Irrigation Department of Malaysia (JPS) Perak Tengah.* On 2008, about 53 villagers from Kampung Parit 6, Mukim Layang-Layang has been transferred to the nearby relief centres. In the shaded area mark by number 2, most of the areas are used for agricultural activities. Those farmers who cultivate oil palm and fruit orchards have been facing difficulties in carrying out their agricultural activities because there are gardens or orchards, flooded with water. The articles and pictures regarding flood in Bota, Perak are shown in ***APPENDIX 2***.

Area 3: Sungai Siput, Perak Darul Ridzuan

Figure 17 shows two areas that being identified to have high possibilities for flood to occur. The blue shaded area that been marked by S represents of several villages as stated below:

Table 7: Villages marked as shown in Figure 17

Mark	Area Name
S1	Kampung Pulau Kemiri
S2	Kampung Melintang
S3	Kampung Mentimun

Refer to the results, all the villages in the blue shaded are proved as flood prone area. In December 29, 2009, about 30 houses from five villages were almost flooded due to heavy rain which causes Sungai Perlus to overflow. Roughly, about 100 houses along the Sungai Perlus have been affected badly by flood. The flood that has recently occurred in the last 10 years has destroyed some of the oil palm and rubber plantations and interrupts the only road network to Sungai Siput town from their respective village. The photos and articles about flood in Sungai Siput are shown in ***APPENDIX 3***.

4.1.3 Flood Estimation Damage

A rough estimation regarding flood damages have been done to the areas affected. The values of properties are taken from Table 1 that contains of houses and building properties, and cost of repairing road.

4.1.3.1 Road

In certain area, road has been affected badly due to the flood such as erosion on the road pavement, road being taken away by the strong river current and many others minor problems. It will take a huge financial amount in order to resurface and reconstruct the road.

Area 1: Kubang Pasu, Kedah Darul Aman

Table 8: Estimation Cost of Road Resurface in Kubang Pasu

Village Name	Length of Road Affected	Cost of Losses (RM/km)	Losses (RM)
Kampung Bukit	0.45 km	200 000	90 000
Kampung Bendang	0.42 km	200 000	84 000
Kampung Bata	0.22 km	200 000	44 000
Kampung Lahar	0.30 km	200 000	60 000
Kampung Kerkap	0.84 km	200 000	168 000
TOTAL			**446 000**

Area 2: Bota, Perak Darul Ridzuan

Table 9: Estimation Cost of Road Resurface in Bota

Village Name	Length of Road Affected	Cost of Losses (RM/km)	Losses (RM)
Kampung Merua	0.26 km	200 000	52 000
Kampung Bukit Chupak	0.16 km	200 000	32 000
Kampung Bendang Bidara	0.16 km	200 000	32 000
Kampung Parit 6	0.26 km	200 000	52 000
Kampung Parit 1	0.39 km	200 000	78 000
TOTAL			**246 000**

Area 3: Sungai Siput, Perak Darul Ridzuan

Table 10: Estimation Cost of Road Resurface in Sungai Siput

Village Name	Length of Road Affected	Cost of Losses (RM/km)	Losses (RM)
Kampung Pulau Kemiri	0.77 km	200 000	154 000
Kampung Mentimun	0.17 km	200 000	34 000
Kampung Melintang	0.52 km	200 000	104 000
TOTAL			**292 000**

Table 8, 9 and 10 is the analysis of the rough estimation of the flood damage that effected road in all the three areas which is in Kubang Pasu, Bota and Sungai Siput. The author considers that, the flood is not much to make the road to be reconstructed. Value of resurface from Table 2 of this report was taken as the factor value of losses. The highest total loss for road damages is in Kubang Pasu, Kedah. All the length of road affected was roughly calculated using Ruler mode in Google Earth (***See Appendix 5***)

4.1.3.2 Houses

For cost estimation on the number of house damages, the author has made a rough number of houses affected according to satellite photo. It is because since there reference data about the numbers of latest houses in those areas.

Table 11: Estimation Cost of House Affected

Area	Houses Affected	Value of Losses (RM)	Total Losses (RM)
Kubang Pasu	258	7174.00	1,850,892.00
Bota	182	7174.00	1,305,668.00
Sungai Siput	134	7174.00	961,316.00
		TOTAL	**4,117,876.00**

The author was make an assumption that, the value of single storey house will be the same as value of kampong house since there was no reference data of losses of a single storey house. The value above shows that the highest losses and damages are experienced by the most developed area which has more numbers of houses or high population area.

CHAPTER 5

ECONOMIC BENEFITS

Water resources planning and analysis used to take years but now with the facilitation of GIS automated process, it has trimmed down to just a task of few days. The concept of water resources planning has changes from only planning to prediction, effective management and quick response system through effective use of GIS and computer based modeling.

GIS application to hydraulic modeling is universal, effective, economical and less time consuming technique for river system analysis. Inadequate planning of water resources cause loss of life and damage to properties every year and leave tens of thousands homeless. As the people in the developing countries, we can utilize these tools and save money, time and can efficiently and timely model our water resource system at the tips of our finger.

GIS are in widespread use by both public and private organizations. Any more organizations would like to implement the technology, but they must first justify this major purchase. The most commonly used technique to justify any capital investment in is cost benefit analysis. Traditional cost-benefit analysis begins with an organization's identifying, listing, valuing, and summing the tangible costs associated with purchasing and implementing a GIS.

Tangible costs for GIS begin with the hardware needed for the operation, including computers, servers, and extensive data storage capacity to accommodate the vast quantities of both raster and vector data associated with GIS. Furthermore, there may be a need for a dedicated server, and other peripheral devices, such as printers, monitors, global positioning systems (GPS) devices, and perhaps even digital recording devices (such as a camera, for example). Once the organization has determined what hardware it needs, it may work with vendors to agree on prices. GIS software is another key part of the implementation.

Just as important to the analysis are the estimated tangible benefits of implementing GIS. There are three major categories of tangible benefits that a cost benefit analysis for GIS should include: cost reduction, cost avoidance, and increased revenue from sale of data; however, there may be legal limitations on data sales, and any organization that wishes to sell data is advised to seek a legal opinion before proceeding. Like costs, many benefits of GIS implementation are tangible where it is relatively easy to identify their economic value.

Some costs and benefits will be intangible and therefore difficult to assess. Among intangible costs are temporary disruptions of service within the organization caused by the changeover to GIS, uncertainty and hardship caused to staff members by the adoption of new technology, and other potential organizational dislocations created by the implementation of GIS. Intangible benefits may include better decisions which are more readily accepted by stakeholders and client groups, for example. At the very least, it is important to identify any estimated intangible costs and benefits. If these intangibles are organizational disruptions, as described above, it is important both to identify them and to suggest strategies to mitigate their effects.

Engineers dealing with the water in one way or the other must be up to date with the demand of the hour and should step forward to learn and apply new techniques to serve our province best by making use of the GIS application to water resources projects. It is the slogan of the time, demanding engineers in the developing countries to play their vital role in efficient water resources planning, management, and prediction in developing.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

In conclusion, based on data and findings presented in previous chapters, it can be concluded that the used of GIS in identifying area that is vulnerable to flooding has been proved. Besides that, by using GIS, it can reduce time and a numbers of man powers in identifying flood prone area manually. The technique that has been practice can be developing more to gain much more accurate in identifying various types of places. Furthermore, in order to reduce the risk of life and properties losses, the local authorities must ensures there is no development occurred in those that is highlight as flood high risk area. Then, from safety measures that we consider, it should prevent any life losses and money to being waste just like that.

5.2 RECOMMENDATIONS

The use of GIS application in flood mapping especially in Malaysia is still in the early stage. It is because there are not enough people capable in handling such this application which are quite new. GIS give a very wide application not just for flood mapping use, but it is also can be use in various types of analyzing task. The results of this study are mainly dependent on the data of an area and also the accuracy of flood maps that generated by hydraulic and hydrology simulation software. In the future, the use of GIS in flood mapping can be improved by determining the technique to identify which level of water can give a flood impact to area nearby. Besides that, in order to estimate the flood damages, the latest information regarding the area of studies must be collected to achieve high accuracy of results.

REFERENCES

[1] Flood Mapping in Europe Good Practice Handbook, EXCIMAP (2007)

[2] What is GIS, **http://www.inforain.org/about/about_gis.html**

[3] GIS for Beginner, **http://www.mapcruzin.com/what_gis.htm**

[4] Joseph L. Jones, Tana L. Haluska, Alex K. Williamson, and Martha L. Erwin (1998). Updating Flood Inundation Maps Efficiently:Building on Existing Hydraulic Information and Modern Elevation Data with a GIS, *U.S. Geological Survey Open-File Report 98-2003*

[5]Coppock, J.T. (1995). GIS and natural hazards: an overview from a GIS perspective. In: Carrara, A. and Guzzetti, F., Editors, 1995. *Geographical Information Systems in Assessing Natural Hazards vol. 6*, Kluwer Academic, Netherlands, pp. 21–34.

[6] Hausmann and Weber, 1988. P. Hausmann and M. Weber , Possible Contributions of Hydroinformatics to Risk Analysis in Insurance. *Proceedings of the Second International Conference on Hydroinfromatics, Zürich, Switzerland, 9–13 September, Balkema, Rotterdam* (1988), pp. 57–62

[7] Phong Tran, Rajib Shaw, Guillaume Chantry and John Norton (2008) GIS and Local Knowledge in Disaster Management: A Case Study of Flood Risk Mapping in Viet Nam, *Disasters 152-169*

[8] Hatfield (2006) Using Participatory Methodologies, Geographic Information Systems and Earth Observation Data to Map Traditional Ecological Knowledge in Hong Ha Commune, Thua Thien Hue, Viet Nam. *EOSTEM Project Milestone 9 Report*. Hatfield Consultants, West Vancouver.

[9] Mohd Ekhwan Toriman, Zulkifli Yusop, Mazlin Mokhtar, and Hafizan Juahir, 2006,' APPLICATION OF GIS FOR DETECTING CHANGES OF SUNGAI LANGAT CHANNEL', *Malaysian Journal of Civil Engineering* 18(1) : 59-70 (2006)

[10] Francisco Nunes Corriea, Maria de Graca, Flood Plain Management in Urban Developing Areas, GIS Base Flood Analysis and Urban Growth Modelling, *Water Resources Management*, Vol 13. pp 23-37 (1999).

[11] F. Forte, R. O. Strobl, and L. Pennetta, 2005, 'A methodology using GIS, aerial photos and remote sensing for loss estimation and flood vulnerability analysis in the Supersano-Ruffano-Nociglia Graben, Southern Italy', *Environ Geol* (2006) 50: 581–594

[12] Introduction to ArcView GIS, **http://people.morrisville.edu/~shayyaw/ArcView**

[13] Miller, C., and LaFamme, R.A., "The digital terrain modeling-theory and applications," *Photogrammetric Engineering*, 24(3): 433-442, 1958.

[14] Peucker, T., Fowler, R., Little, J., and Mark, D., "The triangulated irregular network," *Proceedings of the Digital Terrain Models Symposium*, St. Louis, MO, 1978

[15] Moore, I.D., Grayson, R.B., and Ladson, A.R., "Digital terrain modeling: a review of hydrological and geomorphological, and ecological applications," *Hydrological Processes* 5:3-30, 1991)

[16] Horton, R.E., "Drainage basin characteristics," *Transactions American Geophysical Union*, 13: 350-361, 1932.

[17] Naser ES, Catrina V., Ayman H., "Digital Terrain Modelling", *Acquisition, Manipulation and Applications*, 2005

APPENDIX 1

ARTICLES AND PHOTO OF FLOOD IN KUBANG PASU, KEDAH

The Star Online, 15th November 2009

Sunday November 15, 2009

More families evacuated as flood situation worsens in Kedah

ALOR SETAR: Kedah continues to move families to temporary relief shelters as floods damage more houses.

Some 200 victims were ordered to move to the Sekolah Kebangsaan Malau centre yesterday, bringing the total number of evacuees to 679.

A spokesman from the state flood operations room said the five centres in Kubang Pasu district housed 516 victims.

In Padang Terap, the number of evacuees at the two centres remained unchanged at 54. The situation in Kota Setar district remained unchanged with 109 victims still staying in the two relief centres.

Meanwhile, the water level at several rivers in the Kubang Pasu and Kota Setar districts were still above the danger mark, such as Sungai Bata recorded at 9.33m (alert level 9.16m); Sungai Kongluang 13.2m (13.2m) and Sungai Pantai Johor at 2.16m (alert level 2m).

In the Padang Terap district, Sungai Kuala Nerang recorded a reading of 16.65m (17.1m) and Sungai Kampung Kubu was at 12.61m (12.8m).

In Kuala Terengganu, folks were advised not to play in floodwaters as a precaution against contracting cholera following 11 confirmed cases since the outbreak a week ago.

State health director Dr Nordiyanah Hassan said most of the 97 people warded at the Sultanah Nur Zahirah Hospital are expected to be discharged from today.

One person was discharged yesterday after testing negative for the disease. Another died of the disease on Tuesday. — Bernama

Kosmo, 23rd October 2006

Kedah, Perlis sambut Aidilfitri dalam banjir

KOSMO 23/10/2006

ALOR STAR - Kemeriahan menyambut Aidilfitri di Kedah dan Perlis terganggu apabila beberapa kawasan di dua buah negeri itu dilanda banjir bermula kelmarin.

Bagaimanapun, sehingga malam tadi tidak ada kemalangan jiwa berlaku akibat banjir tersebut.

Jabatan Perkhidmatan Kaji Cuaca pula meramalkan Pantai Barat terutamanya Kedah, Perlis dan Pulau Pinang akan berhari raya dalam suasana hujan lebat dan berkemungkinan banjir.

Ketua Penolong Pengarah Pusat Ramalan Cuaca, Jabatan Perkhidmatan Kaji Cuaca, Wong Teck Kiong berkata, hujan berterusan dan kadang kala lebat itu mula melanda beberapa negeri di Semenanjung sejak 12 Oktober dan dijangka berlarutan sehingga awal bulan depan.

"Ia merupakan fenomena peralihan monsun barat daya ke monsun timur laut," katanya.

Di Kedah, lebih 1,000 orang penduduk daerah Pendang, Kubang Pasu dan Pokok Sena terjejas teruk akibat kawasan mereka dilanda banjir sejak malam kelmarin.

Di Pendang, kira-kira 15 buah kampung dinaiki air di antara 0.5 dan 1.5 meter yang menyebabkan beberapa penduduk terpaksa dipindahkan ke rumah saudara-mara dan rakan-rakan yang berdekatan.

Ahli Dewan Undangan Negeri (ADUN) kawasan Sungai Tiang, Suraya Yaacob berkata, antara kawasan yang dilanda banjir ialah Pekan Kubur Panjang, Kubang Pisang, Lubuk Batu, Lahar Tunjung dan Bendang Raja.

"Mangsa-mangsa itu dipindahkan ke rumah keluarga mereka yang berdekatan dan tiada pusat pemindahan yang ditubuhkan setakat ini," katanya.

Katanya, beberapa batang jalan kecil turut dinaiki air termasuk Jalan Tobiar-Kubur Panjang berhampiran Kubang Pisang ditutup untuk sebarang kenderaan ringan.

Di Pokok Sena, kira-kira 60 buah rumah dinaiki air dan antara kawasan yang terlibat ialah Kampung Bendang Baru, Kampung Gulau, Lahar Dalam, Permatang Limau, Alor Cina dan Lubuk Keriang.

Beberapa penduduk juga terpaksa dipindahkan ke rumah-rumah jiran berhampiran.

Ketua Pemuda UMNO Bahagian Pokok Sena, Haris Che Mat berkata, beliau dan ahli-ahli bahagian memantau perkembangan banjir di sekitar daerah kecil itu di samping turun menyampaikan sumbangan Hari Raya.

Di Kubang Pasu, mangsa banjir dari 12 buah kampung di daerah itu pindahkan ke dua pusat pemindahan banjir sejak malam kelmarin.

Sebanyak 276 mangsa daripada 68 keluarga dipindahkan di pusat pemindahan Sekolah Kebangsaan Kodiang, manakala 175 mangsa daripada 27 keluarga di dewan orang ramai Kampung Lahar dekat sini.

KENDERAAN terpaksa mengharungi banjir selepas air melimpahi Jalan Pokok Sena di Kedah semalam.

Menteri Besar Kedah, Datuk Seri Mahdzir Khalid yang ditemui semasa melawat mangsa banjir di pusat pemindahan Kampung Lahar dekat sini petang semalam meminta mangsa bencana alam itu supaya banyak bersabar dan tabah menghadapi dugaan, apalagi di saat umat Islam sedang membuat persiapan akhir menyambut ketibaan Aidilfitri.

Bagaimanapun, tinjauan mendapati, paras air di Changlun mulai pulih begitu juga paras air di kawasan Padang Terap mulai surut.

Sementara itu di Kangar, sebanyak 12 mangsa banjir daripada tiga keluarga di Kampung Jelempok dekat sini dipindahkan ke Dewan Orang Ramai Jelempok berikutan banjir yang melanda kawasan itu sejak malam kelmarin.

Penolong Pegawai Operasi Jabatan Pertahanan Awam (JPA3), Sarjan Syed Nazri Syed Hassan berkata, setakat pukul 4.30 petang semalam, air berada pada paras 0.5 meter dan mula mengalir keluar ke kawasan hutan Kandis dan sempadan Kodiang-Jelempok.

"Buat masa ini, kita buat persediaan di dewan orang ramai Jelempok ini dan kemungkinan bilangan keluarga akan bertambah kalau hujan lebat masih berterusan dalam tempoh yang agak panjang," katanya ketika dihubungi di sini.

Hujan lebat yang berlaku di utara Perlis terutama di kawasan ladang tebu Chuping sejak tiga hari lalu dikatakan menjadi punca banjir itu.

Jabatan Kebajikan Masyarakat telah menghantar bekalan yang berupa barangan keperluan seperti kain selimut, tikar dan juga makanan kepada mangsa sehingga banjir pulih semula.

Photos of the Flooded Areas

Paddy field flooded with water in Kampung Bukit

Paddy field flooded with water in Kampung Kerkap

Paddy field flooded with water in Kampung Lahar

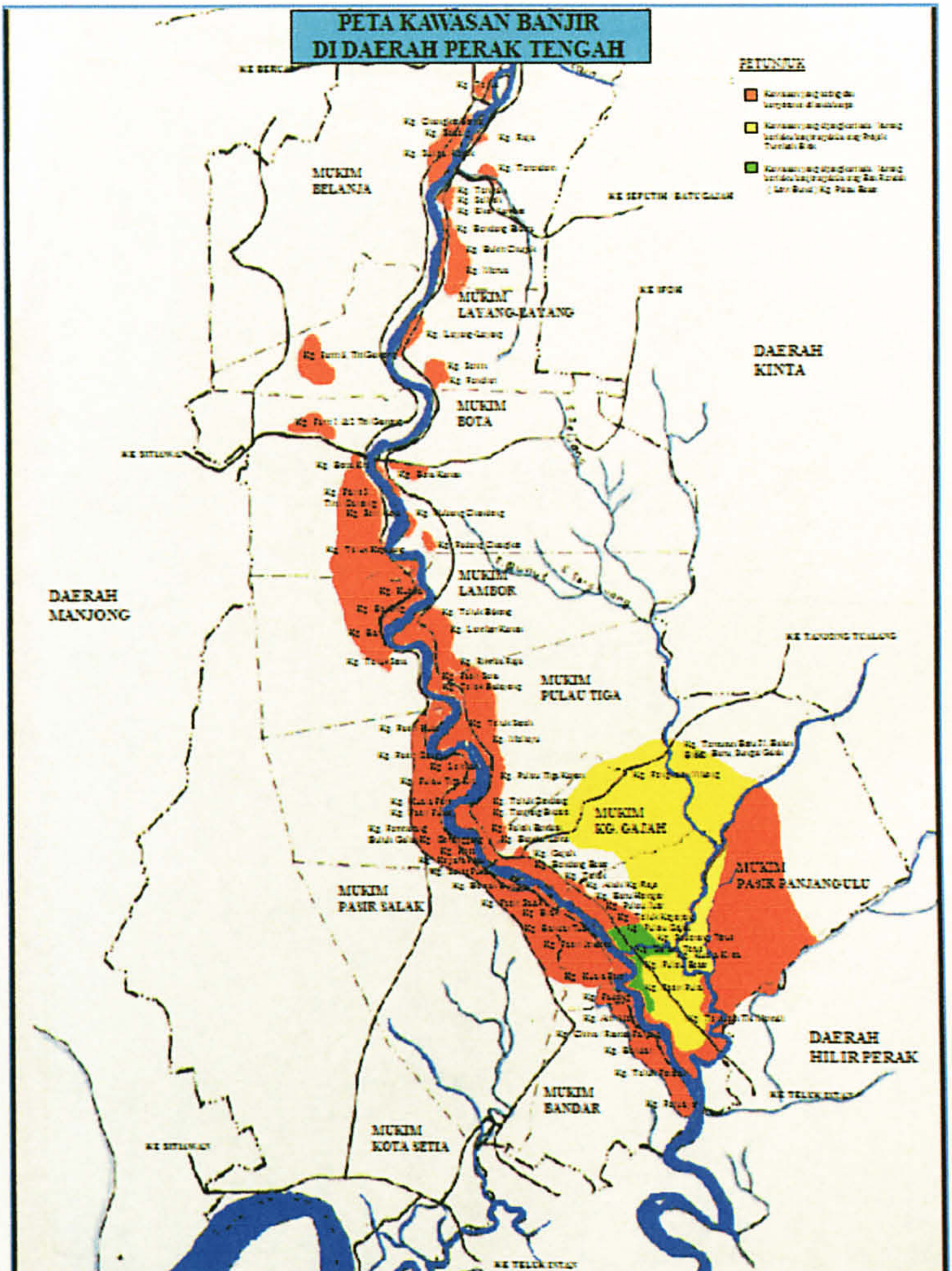
A house near Sungai Bata was flooded

Water from Sungai Bata overflows area nearby

APPENDIX 2

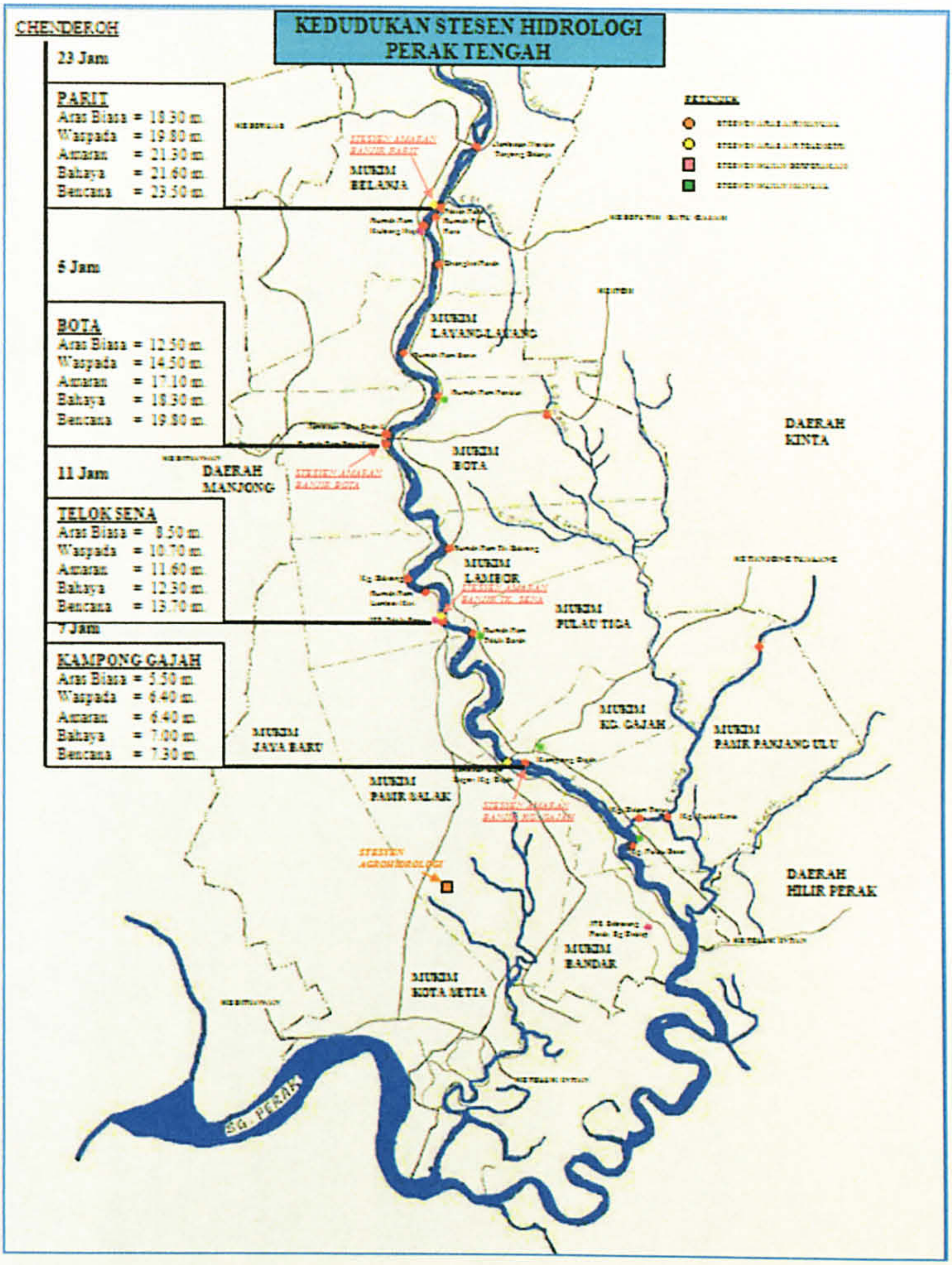
JPS MAPS AND PHOTO OF FLOOD IN BOTA, PERAK

Map of Flood Areas in Perak Tengah District



Courtesy image from Drainage and Irrigation Department of Malaysia (JPS) Perak Tengah

Location of Hydrology Station in Perak Tengah



Courtesy image from Drainage and Irrigation Department of Malaysia (JPS) Perak Tengah

Photos of the Flooded Areas

A house flooded by water in Kampung Parit 6

Road network is totally flooded at Kampung Parit 6

APPENDIX 3

ARTICLES AND PHOTO OF FLOOD IN SUNGAI SIPUT, PERAK

BERNAMA, 1st December 2008

Banjir Di Terengganu Semakin Pulih

KUALA TERENGGANU, 1 Dis (Bernama) -- Keadaan banjir di Terengganu semakin pulih, terutama di Hulu Terengganu apabila semua pusat pemindahan banjir di daerah itu ditutup hari ini.

Kesemua baki sembilan orang mangsa banjir yang ditempatkan di pusat pemindahan di Hulu Terengganu dibenar pulang ke rumah masing-masing malam tadi.

Jurucakap Bilik Gerakan Banjir Negeri berkata sehingga pukul 9 pagi ini seramai 292 orang masih berada di pusat pemindahan di tiga daerah di negeri ini.

Seramai 124 orang berada di pusat pemindahan di Besut, 143 orang di Marang dan 25 orang di Setiu, katanya ketika dihubungi di sini, Isnin.

Beliau bekata jumlah mangsa banjir di daerah Marang dijangka bertambah berikutan hujan lebat sejak pukul 2 pagi hingga 6 pagi ini dan pihaknya sedang mengumpul maklumat terkini mengenai jumlah mereka yang dipindahkan di daerah itu.

Paras air sungai Marang di Pengkalan Berangan kini berada pada paras waspada iaitu 12.73 meter manakala sungai Setiu di Kampung Bukit mencatat 12.13 meter iaitu melepasi paras, katanya.

Jalan-jalan yang masih ditutup ialah jalan Jertih-Hulu Besut, Jalan Pengkalan Berangan-Pulau Kerengga, Jalan Sungai Tong-Pelong, Jalan Marang-Telemong dan Jalan Permaisuri-Hulu Seladang kerana ditenggelami air sedalam antara 0.45 meter dan 1.5 meter.

Jalan Kuala Terengganu-Kuala Berang juga ditutup kepada semua kenderaan kerana Jambatan Temala rosak, kata jurucakap itu.

Di KUANTAN, jumlah mangsa banjir di Pahang sehingga pagi ini ialah 105 orang daripada 22 keluarga.

Jurucakap Bilik Gerakan Ibu Pejabat Polis Kontinjen Pahang berkata seramai 92 orang ditempatkan di pusat pemindahan Sekolah Kebangsaan Batu Kapur, Temerloh manakala 16 lagi mangsa daripada empat keluarga dari Lembah Bertam, Ringlet, Cameron Highlands ditempatkan di dewan orang ramai Ringlet.

Di KOTA BAHARU, jumlah mangsa banjir di Kelantan meningkat kepada 1,513 pagi ini berikutan hujan lebat malam tadi, berbanding 853 orang semalam.

Jurucakap Pusat Kawalan Operasi Bencana Banjir Kelantan berkata seramai 819 orang ditempatkan di pusat pemindahan banjir di Pasir Mas, Tanah Merah (305 orang), Kuala Krai (291 orang), Jeli (95 orang) dan Kota Baharu tiga orang.

Jalan Rantau Panjang-Panglima Bayu masih ditutup kepada kenderaan ringan, katanya ketika dihubungi di sini.

Beliau berkata paras air di Sungai Golok di Rantau Panjang melebihi paras bahaya manakala tujuh lagi sungai utama di Kelantan berada pada tahap berjaga-jaga.

Di SUNGAI SIPUT, Perak, seramai 52 orang daripada tujuh keluarga di Kampung Chor dan Kampung Lasah dekat sini dipindahkan ke pusat pemindahan berikutan kampung mereka dilanda banjir malam tadi.

Jurucakap Bilik Gerakan Balai Polis Sungai Siput berkata, mereka dipindahkan pada pukul 11.20 malam tadi setelah air naik sedalam 0.5 meter akibat hujan serta limpahan air dari Sungai Perlus.

Mereka dipindahkan di dewan orang ramai Kampung Lasah dengan bantuan Jabatan Bomba dan Penyelamat Sungai Siput.

Kesemua mangsa mungkin dibenarkan pulang ke rumah petang ini berikutan cuaca didapati cerah dan air di kampung terbabit sudah mula surut, katanya ketika dihubungi hari ini.

-- BERNAMA

27 november 2008

Menteri Besar Perak prihatin dengan mangsa banjir di Sungai Siput.

SUNGAI SIPUT, 27 Nov :- Mangsa banjir dibeberapa kawasan petempatan di Daerah Sungai Siput mendapat perhatian serius dari YAB Menteri Besar Perak apabila beliau menghantar wakilnya untuk meninjau dan memberi sedikit bantuan kepada 28 keluarga mangsa yang terlibat.

"Saya sampaikan salam dari YAB Menteri Besar dengan lafaz 'assalamualaikum' kepada semua mangsa yang terlibat, YAB Menteri Besar walaupun pada petang tadi berada di Pusat Ternak Sungai Siput merasmikan AgroFest namun beliau terpaksa bergegas balik ke Ipoh menghadiri program yang diatur terlebih dahulu, dan beliau memohon maaf kerana tidak dapat bersama dengan tuan-tuan pada malam ini " demikian antara ucapan Pengerusi Kelab Penyokong Kerajaan Perak, Drs. Khalil Idham Lim yang mewakili YAB Menteri Besar semasa menemui 15 keluarga mangsa yang dari PPRT Lintang yang ditempatkan di Pusat Perpindahan Kg. Tok Siraj.

Drs. Khalil menyampaikan Bantuan Kerajaan Negeri kepada mangsa di Kg. Tok Siraj.

Dalam ucapannya juga beliau menyatakan keperihatinan kerajaan negeri kepada mangsa banjir tersebut dan memohon semua mangsa bersabar dengan ujian tersebut.

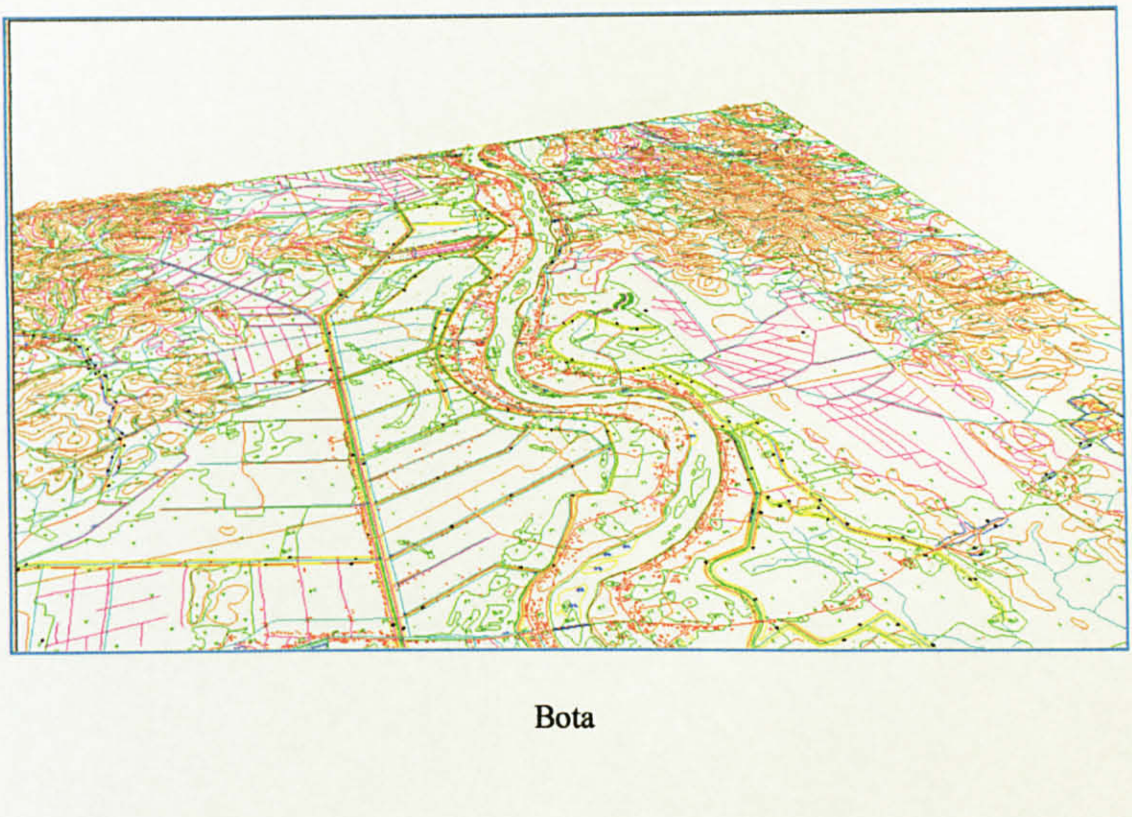
Photos of the Flooded Areas

Other villagers helping their neighbors escaped from flooded house using sampan in Kampung Trosor, Sungai Siput

APPENDIX 4

MAP OF KUBANG PASU, BOTA AND SUNGAI SIPUT IN 3D VIEW

Kubang Pasu



Bota

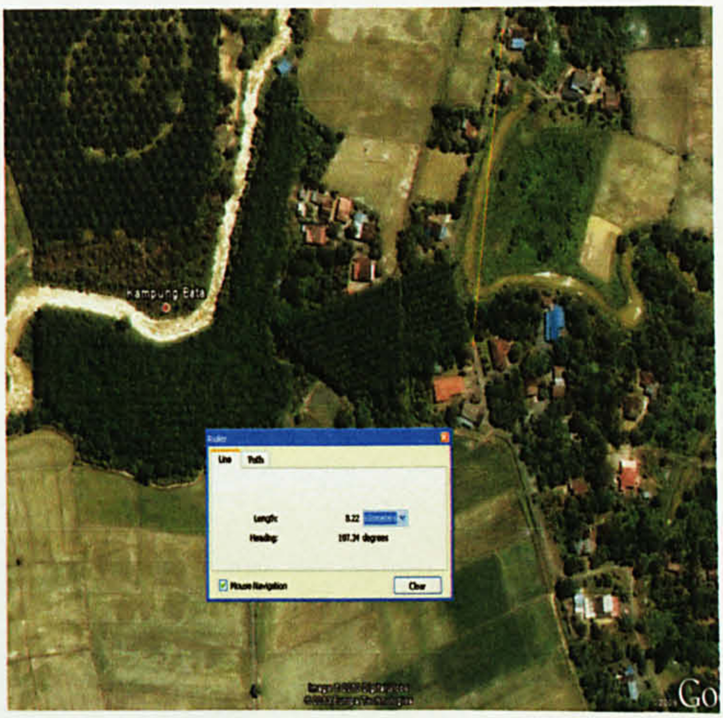
Sungai Siput

APPENDIX 5

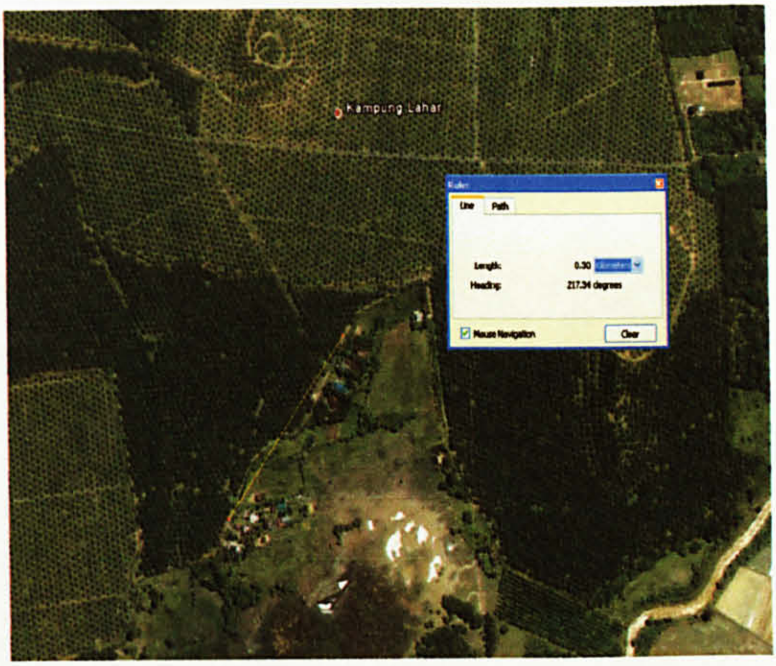
ESTIMATED LENGTH OF ROAD AFFECTED

Area 1: Kubang Pasu, Kedah

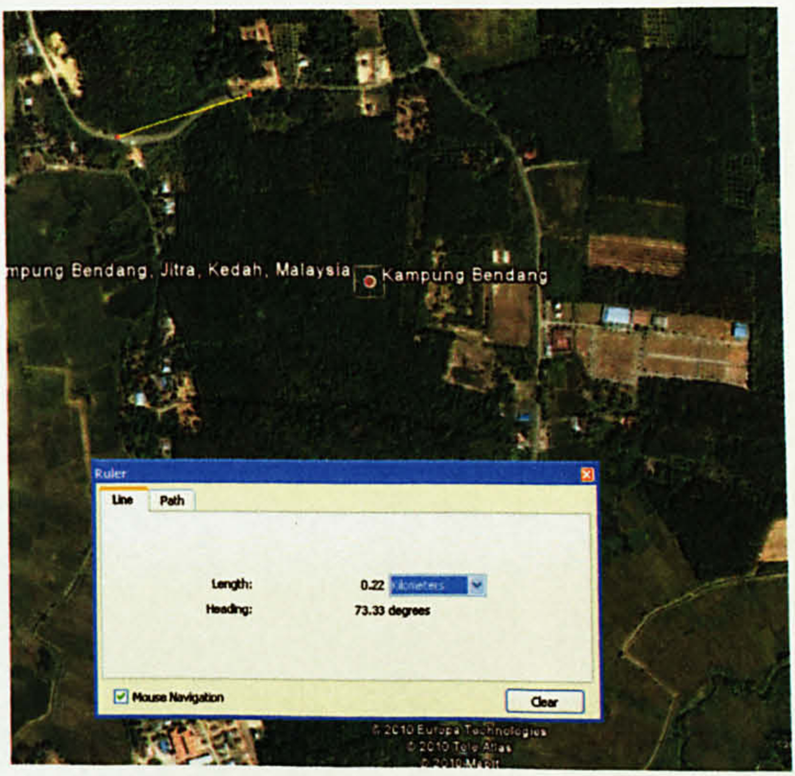
Kampung Bukit (0.45 km)



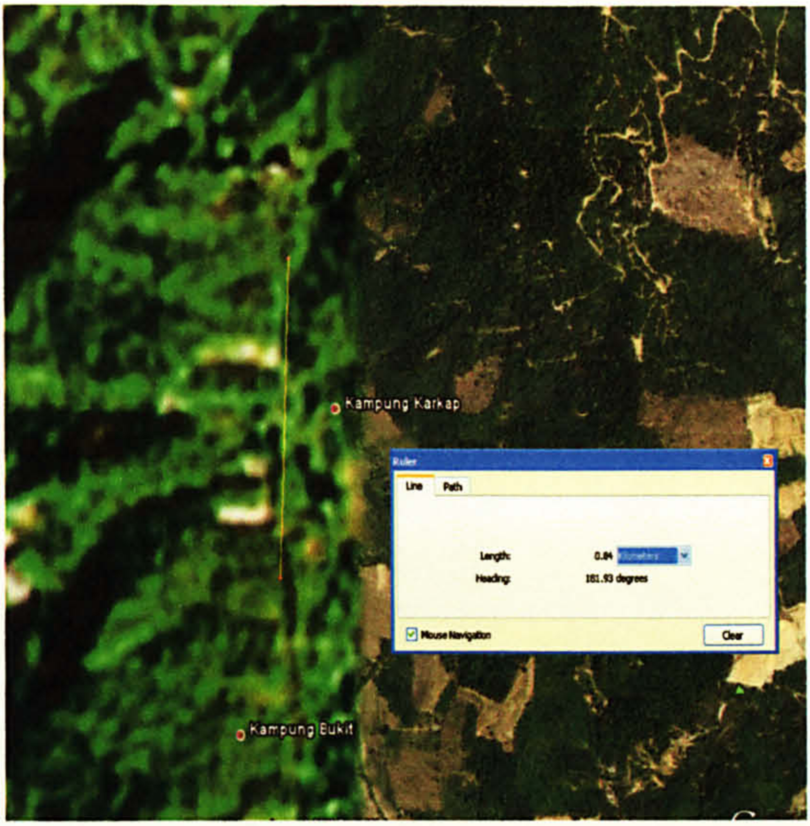
Kampung Bata (0.22 km)



Kampung Lahar (0.30 km)

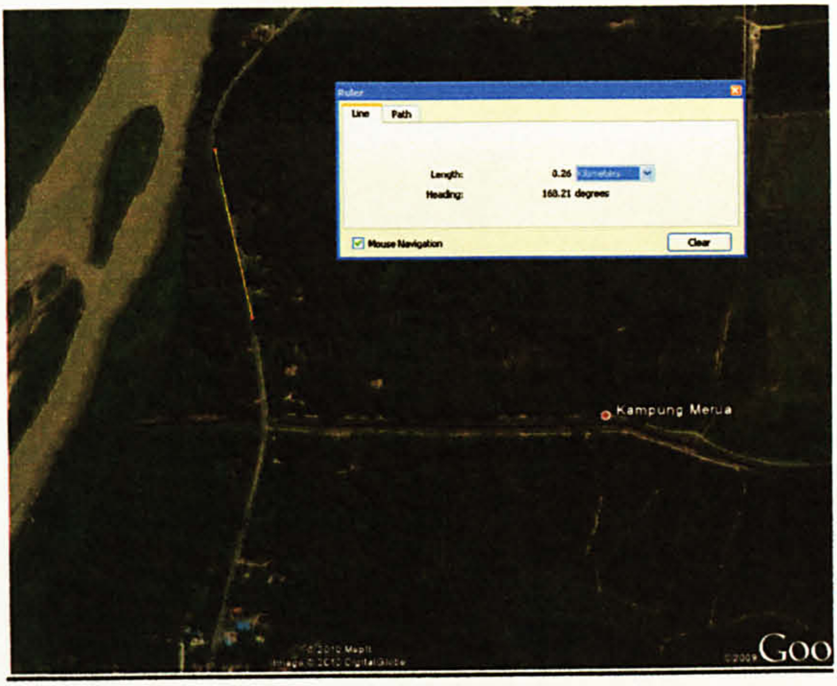


Kampung Bendang (0.22 km)

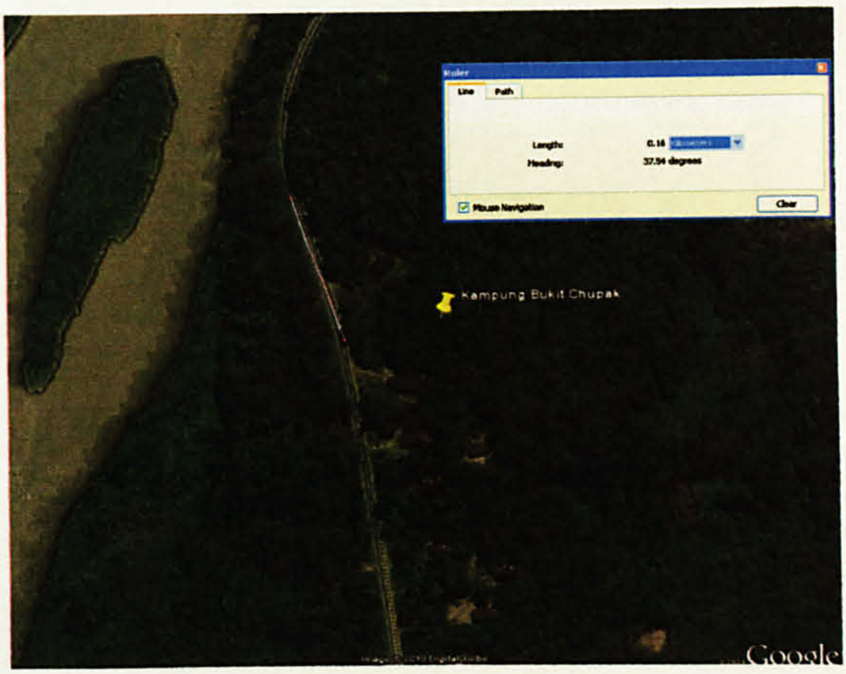


Kampung Kerkap (0.84 km)

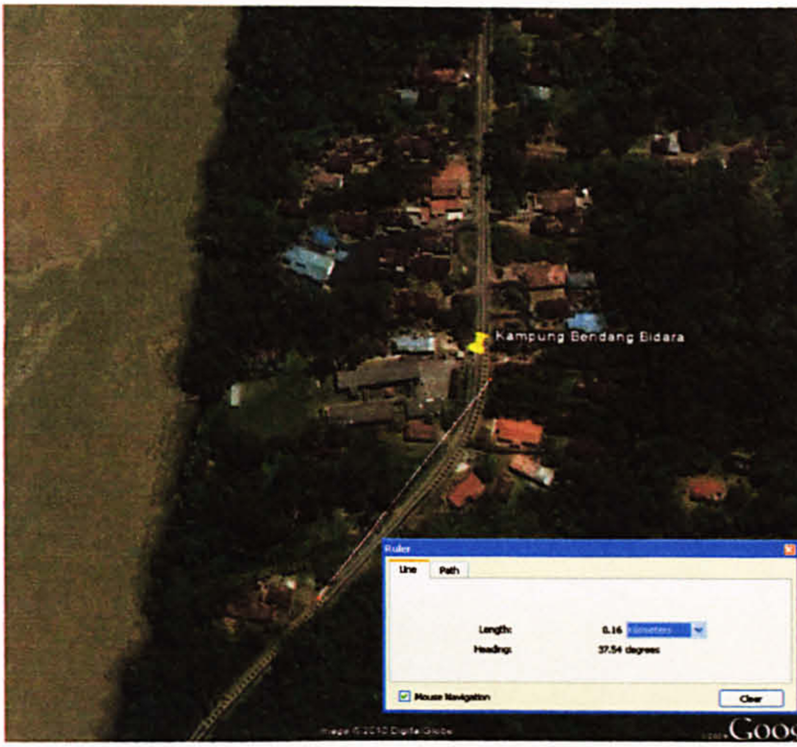
Area 2: Bota, Perak Darul Ridzuan



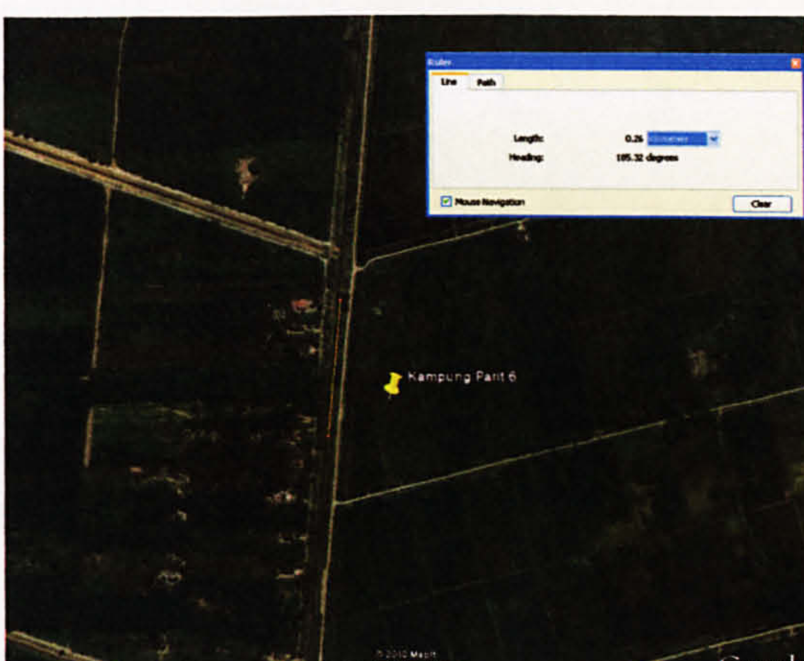
Kampung Merua (0.26 km)



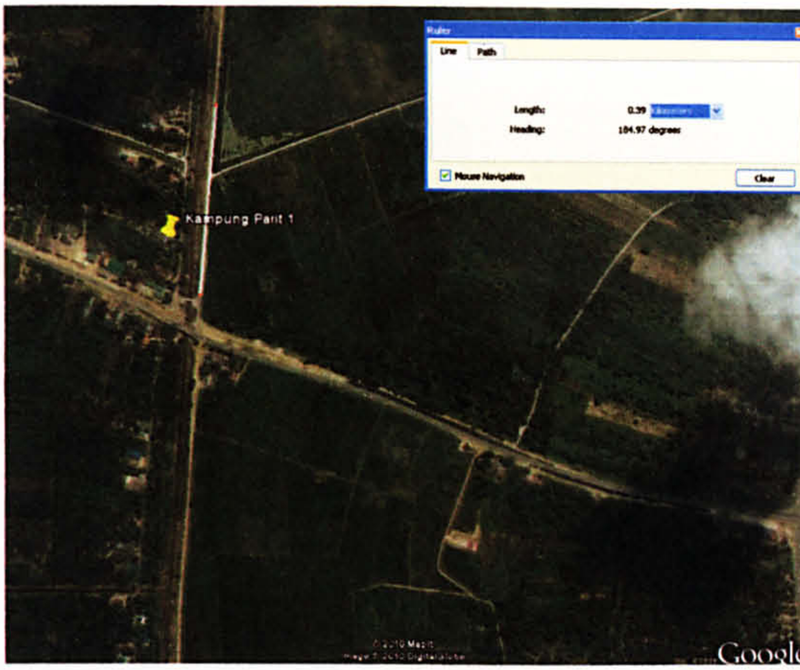
Kampung Bukit Chupak (0.16 km)



Kampung Bendang Bidara (0.16 km)

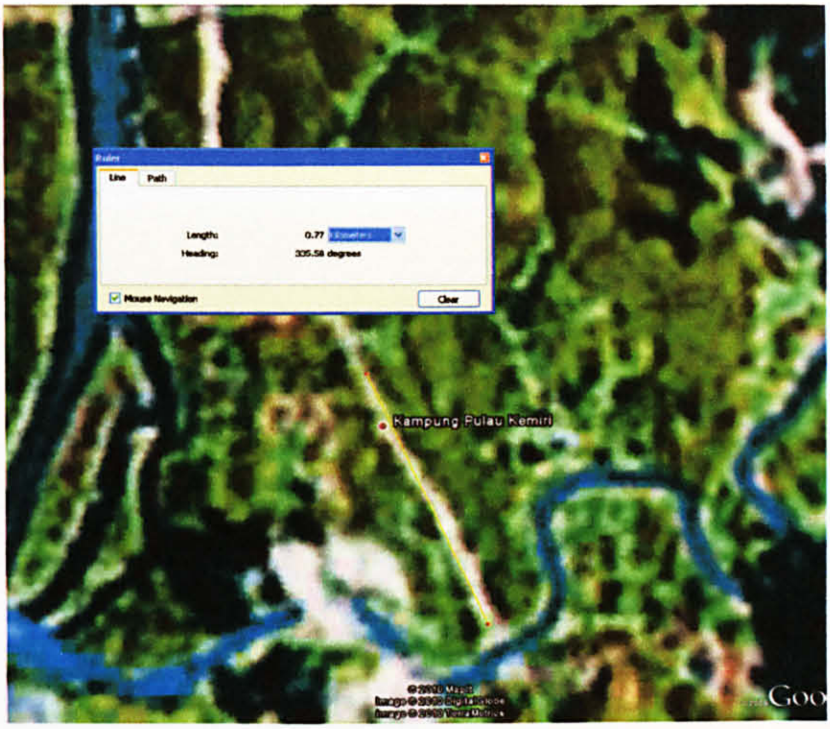


Kampung Parit 6 (0.26 km)

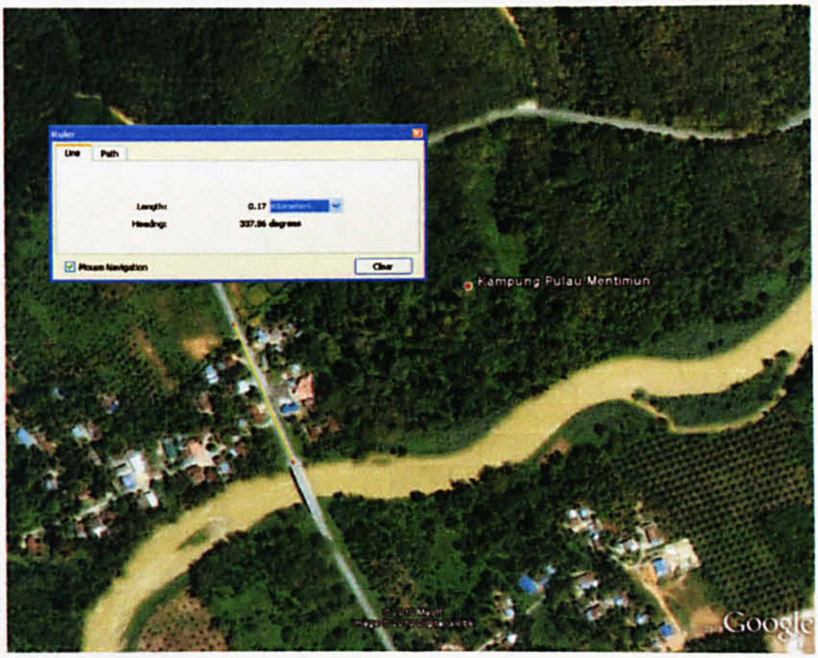


Kampung Parit 1 (0.39 km)

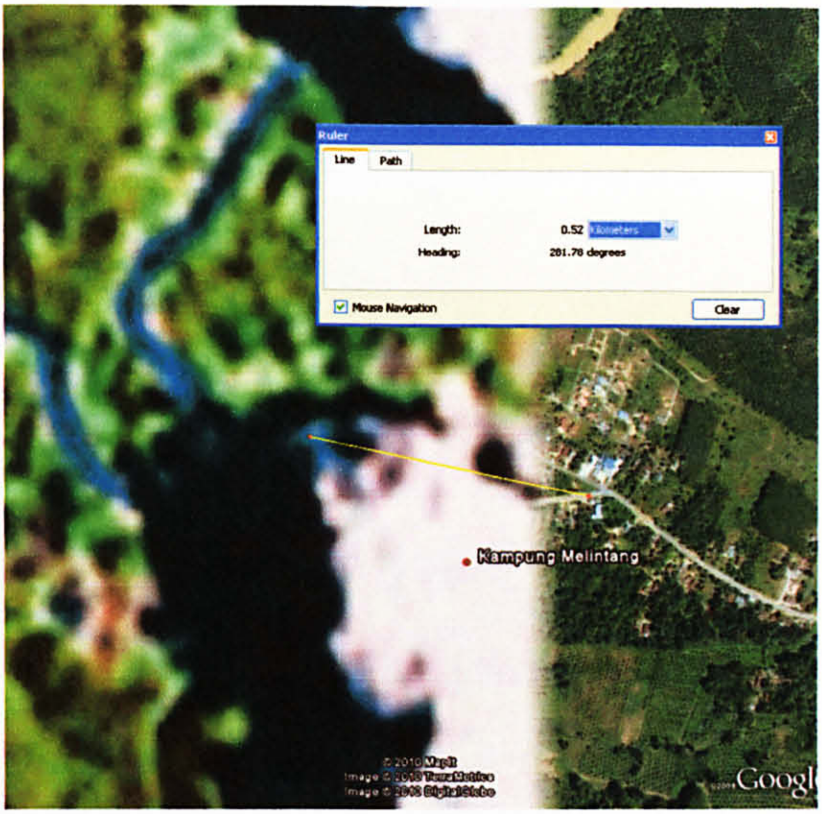
Area 3: Sungai Siput, Perak Darul Ridzuan



Kampung Kemiri (0.77 km)



Kampung Mentimun (0.17 km)



Kampung Melintang (0.52 km)

APPENDIX 6

SATELLITE PHOTOS

Area 1: Kubang Pasu

K1 – Kampung Bukit

K2 – Kampung Bendang

K3 – Kampung Bata

K4 – Kampung Lahar

Area 2: Bota

B1 – Kampung Merua

B2 – Kampung Bukit Chupak

B3 – Kampung Bendang Bidara

B4 – Kampung Parit 6

B5 – Kampung Parit 1

S1 – Kampung Pulau Kemiri

S2 – Kampung Melintang

S3 – Kampung Mentimun