Decision Support System in Flood Management

By

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Dissertation submitted in partial fulfillment of
the requirements for the
Bachelor of Technology (Hons)
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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Information Systems Programme
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(INFORMATION SYSTEMS)

Approved by,

(Foong Oi Mean)

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

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.

ASHRAF BIN AKASHAH

ABSTRACT

The objective of the research is to study the usage of Decision Support Systems for Flood Mitigation (DSSFM).The main objective of the project is to explore the extensive integration of Decision Support System and Geographical Information Systems in DSSFM. A prototype in DSSFM is developed to combine the application of Decision Support System and Geographical Information Systems. Its main function is to identify any flood-prone areas in Ipoh, Perak. From the flood identification process, the user will identify and take proactive measures to prevent damages occurred from the flood.In addition,it renders informed decision making for the authorities in managing flood mitigation effectively. As there are few applications and software that is used in GIS, the student need to identify how DSS elements are used in the related field and produce a prototype that combine DSS and GIS related data for the flood mitigation project.

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CHAPTER 1
INTRODUCTION

1. Background

Flood problem is one of the common problem exist and many specified measures has been taken to overcome the problem. Although there is a wide usage of GIS-based software such as Arc View and MapInfo Professional to digitize any maps, there is lack of decision support system usage in the geographical based problem. This project's purpose is to develop a decision support system that integrates with geographical information systems element .The main objective is to assist the user in solving the flood problem by using the proposed DSS for Flood Mitigation System.

1.1. What Is Geographical Information Systems (GIS)

According to Ellen Roy Herzfelder, Secretary for Executive Office of Environmental Affairs, State Government of Massachusetts Geographical Information Systems (GIS) is a computer system that is capable of assembling, storing, manipulating, and displaying geographically referenced information [9].Geography referenced information (also known as Geospatial data) is data that contain spatial components in it, such as distance between two points, topographical information, depth and length of a rive and etc [6].GIS is used in many purposes, such as creating an interactive map, searching for the nearest route that can be taken to arrive from one point to another and disaster management, such as detecting earthquake, or identify flood prone areas.

1.2. Flood Problems in Malaysia

As Malaysia is situated near to the Equator Line, the country enjoys monsoon climate all time through the year. In certain areas in Malaysia, especially in east coast states of Kelantan, Terengganu and Pahang, rainy season occurred between October and

February every year, while the other part of peninsula experience heavy rainy season between September and December. Due to the rainy season, most of the low area and heavily dense area suffers from flooding. Government declares flood as one of the natural disaster in Malaysia and has instructed its agencies to monitor all flood cases occurred. Flood management in Malaysia is under supervision of to different agencies:

- Department of Irrigation (Jabatan Pengairan dan Saliran) which under Ministry of Agriculture
- Local council (Majlis Bandaraya Ipoh) which under Ministry of Housing and Local Government

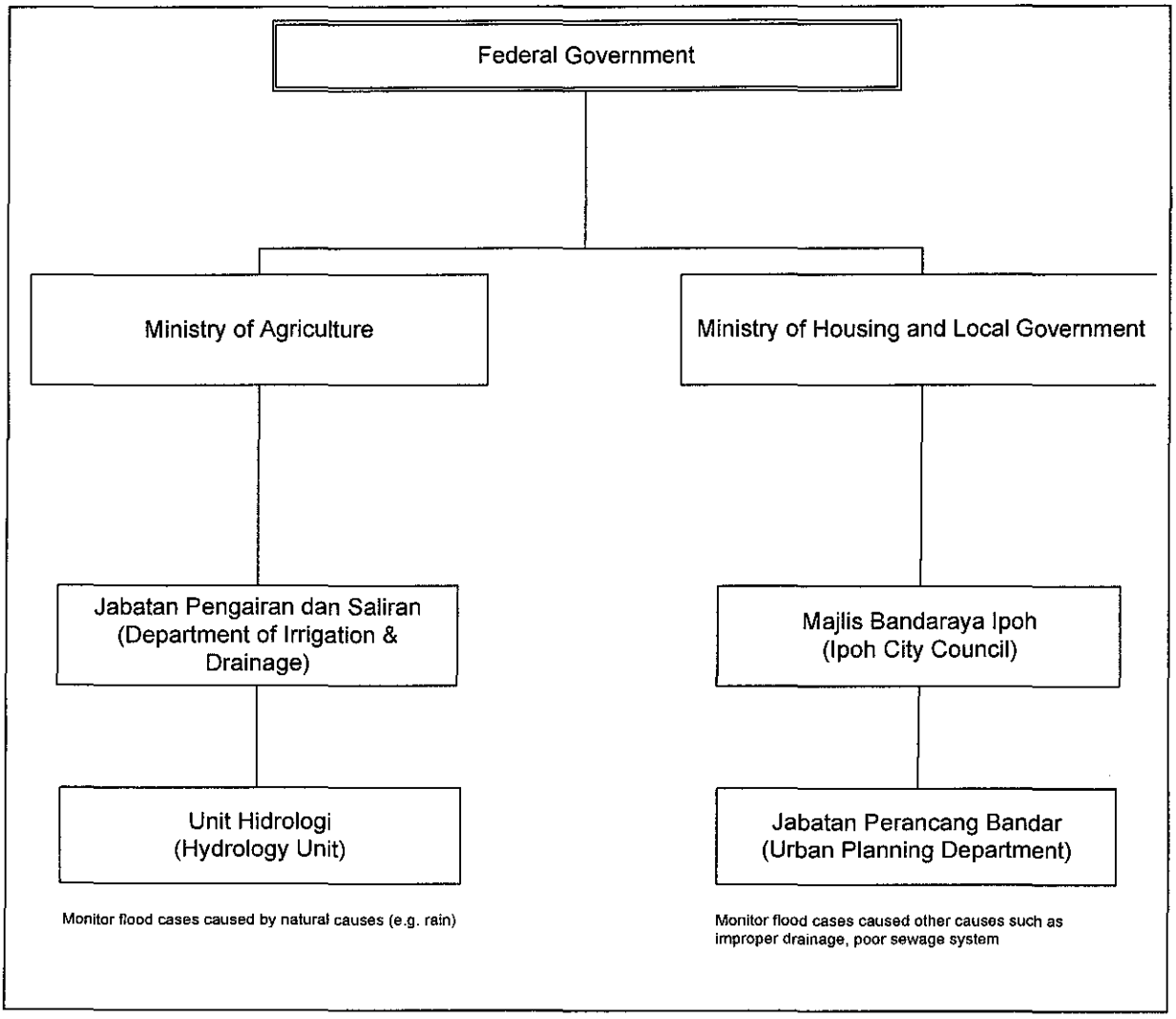

Figure 1: Flood Management in Malaysia

Department of Irrigation monitors flood event that caused by natural causes such as heavy rain while local council monitors flood caused by poor sewage and improper drainage systems. Although flood cases in Ipoh are monitored by Department of Irrigation and Majlis Bandaraya Ipoh, these agencies will monitor the cases in according to the flood cause. These agencies don't have a system that allows both agencies to view all data in Ipoh regardless of the reason.

Both of the agencies recorded the flood cases by using different methods. Department of Irrigation monitors flood cases based on the report made by District Office personnel. Upon receiving the report, technician from Hydrology Unit will save the flood information in a form. The form contains information such as date, areas affected, flood reason, damages caused by flood and number of houses affected. The department also monitors the water level of main rivers in Ipoh and by monitoring the river water station level in Kampung Sri Kinta, Kampung Kuala Pari and Kampung Temiang.

For Majlis Bandaraya Ipoh, flood management is under the Department of Urban Planning which monitors the urban development of the city area. They only monitor flash flood cases that occurred in the city area. For the flood mitigation, the City Council has a GIS department that monitor all the city planning including doing the flood mitigation process.

1.3. The usage of Decision Support Systems in GIS based analysis

Most of the decision support system function is mainly used to facilitate the use of data, models, and structured decision processes in decision making. Among the major disciplines that use decision support system are:

- Operations Research
- Management Science
- Artificial Intelligence.

There are few decision support systems elements used in Geographical Information Systems area and most of it is still under development. The systems mainly developed for a large scale area (e.g. DEcision Support system for Evaluation of River basin sTrategies (DESERT) was developed for decision support for water quality management on a river basin scale)[2].Further more, the system is not user friendly and quite complicated to use for a beginner. The project will emphasize on the combination usage of Decision Support System and GIS related database.

1.4. Problem Statement

As the flood mitigation process is managed by two different agencies, the flood monitoring and flood mitigation activities is handled by using different methods that unique to each other, depending to the way the agencies handle the procedure of monitoring the flood cases. The method used by both agencies in performing flood mitigation is also unique to each other. The Department of Irrigation still using a paper based systems to support their flood mitigation process. This creates a number of inconveniences and problems to the prospect user:

1.4.1. Inconsistency in data collecting and data retrieving

Both Department of Irrigation and Drainage (DID) and Ipoh City Council (MBI) collect and manage the flood data using their own ways. Department of Irrigation collect data based on the report given by District Office personnel, which later will be filled in a paper form designated to collect data. Ipoh City Council collecting data based on the report made by public on the flash flood, which frequently occurred after heavy rain. The differences in methods used by both agencies make integrated data

collecting and data retrieval impossible for public who wish to acquire information on flood.

1.4.2. Human error

Some of the methods used for collecting and retrieving data are still done manually. This will lead to high rate of human error. The usage of manual method in collecting and retrieving data during flood mitigation process is getting irrelevant because it may not be able to handle the increasing number of data collected and workload during the flood mitigation process.

1.4.3. Longer time taken in flood mitigation process

Data collecting and retrieving is one of the main processes in flood mitigation. The flood mitigation process will take a longer time if this process is done manually and all data is stored in traditional ways (in hardcopy paper and files).The mitigation process couldn't also be completed if it still using manual methods, such as using a hard copy map to view and refer to flood prone areas.

1.5. Objective of the Project

The objectives of conducting the project are:

1.5.1. To analyze the Geographical Information System (GIS) method used in the proposed system

A proposed system will be developed as a result of the project research. The proposed system will develop using GIS method that can be used in flood mitigation process. It will reflect the level of GIS usage that can be use in a decision support system (DSS).

1.5.2. To investigate the main reason for flood problem in Ipoh

The system will be use as DSS tools to identify main cause of flood in certain part of Ipoh. Flood prone areas in Ipoh are identified based on the information retrieved from DID and a digital map will be developed, showing areas that affected by flood in Ipoh for 4 year period from 2000 to 2004.

1.5.3. To analyze efficiency of manual flood mitigation.

The system will be used to analyze the efficiency of manual flood mitigation process that is done by DID and MBI. Although the solution for flood mitigation may be done manually, or by using other engineering related programs and application, the process of flood mitigation can benefit from the system as user can view all the flood record stored in the system and analyze it. By using the system, it will also reduce the number of processes that the system user will need to take during the flood mitigation process (i.e. the process of retrieving the flood data may take less time where user can retrieve data from the system compared to the manual process where user will need to retrieve

data from the two different agencies (Department of Irrigation and City Council of Ipoh).

1.5.4. To take proactive measures to prevent flood.

User can also take a proactive measure in doing the flood mitigation process as the system contains the information on previous flood cases in Ipoh. User can view information such as the cause of the flood and damages due to the flood. By viewing information on previous cases, users can make proactive decision based on information from previous flood cases.

1.6. Scope of Study

The study is conducted on the areas affected by flood in Ipoh. Based on information collected from DID, there are four (4) main areas in Ipoh that affected by flood. The areas are:

- Manjoi
- Sungai Rokam
- Buntong
- Tambun

There were flood cases recorded by DID in these areas since year .The main cause of flood in these areas are heavy rain due to rainy season. The study includes on the damages due to the flood. All the flood cases recorded is cause by natural causes (heavy rain) and not due to technical malfunctioning such as improper drainage or poor sewage systems. The study also includes the GIS methods that are used in developing the system and identifying the flood prone areas.

However, the main purpose of the project is to study the level of usage of DSS element in GIS based application in Malaysia. To narrow the scope, the project will focus on the usage of DSS element in a certain criteria only (e.g. flood mitigation).The research done by the student incorporates GIS analysis phase in it. The GIS analysis part is the

major part in the development of the proposed system as well as in the research .This includes methodologies used for the system as well as the GIS element used in developing the proposed system. The GIS analysis part in this project includes identify areas to be digitized in the map, learning GIS based application (MapInfo Professional).The analysis also includes the process of converting the graphic images of the map into digital map, editing the cosmetic layer of the graphic images and creating different layers for different themes in the map. The layer created includes:

- Building Layer
- Field Layer
- Road Layer
- River Layer
- Flooded Area Layer

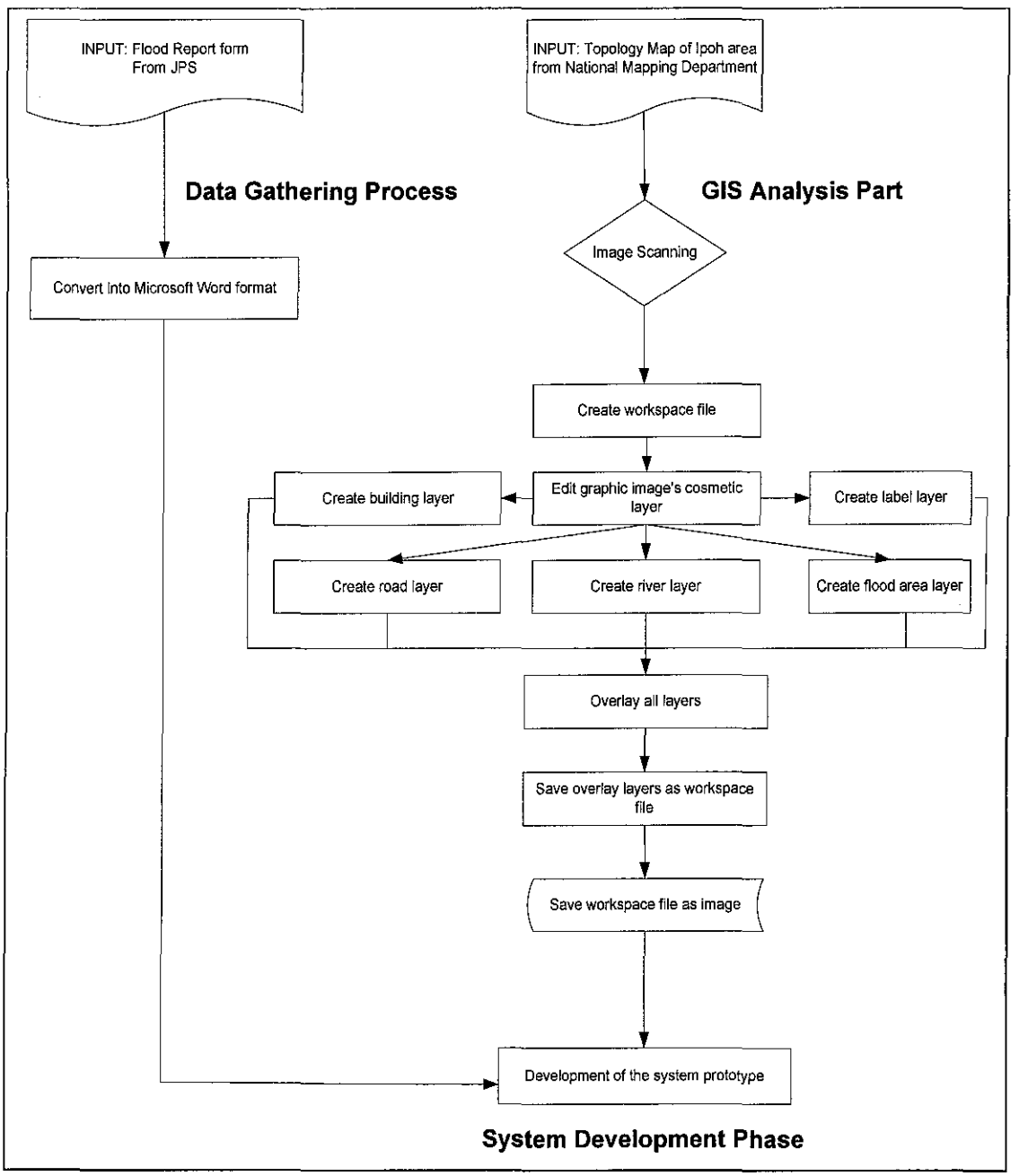

Figure 2: GIS Analysis Part in Decision Support System for Flood Mitigation

1.7. Significant of the project

By using Decision Support System and GIS based information in developing the flood mitigation project, User can make a better planning and better decision making during the flood mitigation project development. Usually user will have problem in retrieving possible solution in overcome the flood problem in a short period. By using the proposed system, user can identify the areas affected with the problem as well search for the possible solution for the problem. The system will integrates a vast amount of GIS based information (such as maps and statistical information) will be required by the system user for planning and developing the mitigation project to a certain areas.

CHAPTER 2
LITERATURE REVIEW

There are a number of references that has been done related to the topic. All the references discussed on the usage of the decision support systems for the Geographical Information System. Most of the references are obtained from research institutes and paperwork from other universities such as from International Institute for Applied Systems Analysis (IIASA) and Department of Information Systems and Computer Science, National University of Singapore [1].

These references explain more on the usage of DSS elements in a GIS based application and the foundation of model management in Decision Support System. There are also references on the modeling languages that commonly used in developing DSS (e.g. GAMS and AMPL) [2].

The GIS technology has been widely used by scientist and other professionals such as engineer, town planner in various fields including disaster management. IS application is being applied extensively in hazard management, including in flood related hazard. Among the key area of study that use GIS application extensively are flood hazard mapping, the development of flood warning system, flood risk zone mapping, and floods hazard analysis, GIS also used in developing application in order to provide a convenient, highly integrated tool for decision support for water quality management on a river basin scale.

2.1. Usage of Geographical Information System in Disaster Management

Geographical Information System is being used extensively for flood related project in most of the flood prone area in the world. The GIS related information is extensively used in studies in done by GIS experts in the related region. Most of the studies are done in Bangladesh, flood prone areas in India (e.g. West Bengal, Dikrong sub basin in Assam,), United States (Warwick, Rhode Island), Laos (Vientiane Plain, the

Bolikhamsay Plain, Champassak Plain, SebangFai Plain in Mekong River Basin) and Thailand. These analysis and studies using various techniques including case studies, data gathering, data analysis and integrating GIS methodology use to develop a system based on the area of study.

2.2. GIS in developing flood warning systems

A clear example of extensive usage of GIS in the development of flood mitigation system is in the development of flood warning system in Bangladesh (Development of flood warning system, Farah Aziz, Nitin Tripathi, Mark Ole and Michiru Kusanagi, Bangkok, Thailand) [3].GIS is used in developing methodology for the system by integrating the GIS with Danish Hydrodynamic Model MIKE 11 (a flood forecasting system). GIS is proven to be useful in developing the flood warning system. It is proven to be an effective tool for describing, analyzing, modeling and integrating forecasted flood levels with other related information such as topographic, thematic and attribute information. By using GIS system developers have opportunities to develop and implement a user-friendly, interactive decision support system for flood forecasting and identifying the affected areas using dynamic spatial modeling.

2.3. Extracting GIS Information in Developing Flood Warning System

Information from GIS can be used to extract some types of information, which are otherwise difficult to access by traditional methods, particularly for flood-forecasting and floodwater movement. This study implies the application of Geographic information Systems technologies in developing a flood warning model for forecasting floods rather than flood mapping for flood risk assessment in flood prone countries for regular monitoring of damages GIS application is used in providing supplementary data in Hydrology for such analysis .The usage of GIS in the development of flood warning system makes interpretation and understanding of flood phenomena and characteristics easier. Overall, the usage of GIS is important in developing the system

where it was integrated with hydrologic models, emergency response strategies, and expert knowledge (refer Appendix 1).

2.4. Mapping Flood Risk Zone Using GIS

GIS also being used in mapping of flood risk zone in Assam, India (Flood risk zone mapping of Dikrong sub basin in Assam, P. Sarma, A.E.E, Brahmaputra Board, Assam, India).In this project, GIS is use to determine area affected by floods and for forecasting areas that are likely to be flooded due to high water level in a river. The GIS module used in this project includes the usage of spatial data which consists of physical dimension and geographic location. The spatial data, such as digital elevation model (DEM) is stored in the GIS database.

The GIS database also stores GIS data that may contain agriculture, socio-economic, communication, population and infrastructural data. These data can be used with flood data, which can be used in a critical flood situation to adopt an evacuation strategy, rehabilitation planning and damage assessment for the affected area. GIS is used in the project because of several advantages such as fast accessibility, data manipulation without disturbing original data, quick retrieval of information, sharing/using of data by many users and the safety and security of the data.

2.5. GIS as Tools for Flood Risk Zone Assessment

The main usage of GIS in this project is as tools for assessment of flood risk zones in Assam at different flood levels. The usage of GIS in this project is different form the earlier project discussed.It is more on the data manipulation for flood frequency analysis where materials used are Survey of India toposheet on 1:50,000 scale 83 E/16, 83 F/13, 83 I/4 & 83 J/I, Literature and Maps on various themes of the area from Brahmaputra Board, Hydrologic data from Brahmaputra Board, Ministry of Water Resources, Govt. of India, Landuse map of Lakhimpur district, Assam prepared by Assam Remote Sensing Application Centre.

CHAPTER 3
METHODOLOGIES

The development of the proposed systems will use some major steps of the normal system development life cycle (SDLC) process. SDLC also known as Classic Life Cycle Model (or) Linear Sequential Model (or) Waterfall Method.SDLC consists of several stages:

- Software Requirements Analysis
- Systems Analysis and Design
- Testing

The reasons for using the major steps derived from SDLC model are due to certain factor:

1. Easy to use and to develop.
2. Suitable for small application development.

3.1. Tools used

There are several material used in this project:

- Information on flood in Ipoh City area (April 2000 – December 2003).The information is retrieved from Unit Hidrologi,Jabatan Parit Saliran Negeri Perak (Department of Irrigation and Drainage) ,Ipoh.
- Topology map of Ipoh area (scale 1:15000).The map was obtained from Jabatan Ukur dan Pemetaan Negara (National Mapping Department),Ipoh.
- ACDSee version 5.0 –for image editing
- Microsoft Access – for data conversion
- Microsoft Excel – for data conversion
- MapInfo Professional version 7.0 – for map digitizing process

- *Visual Basic 6.0*

3.2. Software Requirement Analysis

This is the first stage of the system development, where a requirement analysis is being made on the system. The purpose of the process is to identify the system requirement. From the analysis stage, some materials and information required need to obtain from government agencies like Unit Hidrologi,Jabatan Parit Saliran Negeri Perak (provides information on flood) and Jabatan Ukur dan Pemetaan Negara (provides topology map of area of study).From the analysis stage, tools such as MapInfo Professional version 7.0 and ACDSee version 5.0 required for the system development, as well as other basic tools (Microsoft Access,Microsoft Excel and Visual Basic 6).

3.3. System Analysis

An analysis on the proposed system was made to identify the main purpose of the system and its proposed user. The main objective of the system is to assist the system user in making decision on flood mitigation based from the information from the system. The information on the flood will be display on the systems page. A digital map showing areas affected by the flood will also be displayed in the systems page.

3.4. Design Phase

Design phase is divided into several major steps:

- Story board design
- Map digitising
- Coding and System Construction
- System Testing and validation
- System implementation

3.4.1. Story board design

A story board was constructed for the system. The story board contains the proposed pages and flows of the system.

3.4.2. Map digitising

There are several steps taken in digitising a map. A topological map of Ipoh (scale 1:15000 and in hard copy form) was used for digitising process. There are several choices in digitising the map; digitising it manually by using digitising table that available in Geomatic Laboratory or digitise it by using available software. The latter was chosen because it has several advantages (it digitising process can be done at anytime, comparing it with the first choice where the process can only be done in the lab during the office hour). The digitising process was done by using MapInfo Professional V 7.0, software that is mainly used for digitising map.

3.4.2.1 Scanning

The topology map was scanned. Because of the size of the map (A0 in paper form), the topology map was scanned for several times and the scanned images was combined together to produce a whole image of the scanned topology map. The scanned image was saved in JPEG format. The scanned image is considered as a raster image where it is still in raw format. A raster image needs to be digitised as a digital map where a digital map allows information and data related to the map attributes (e.g. data on a specific road in a digital map) to be stored in the digital map.

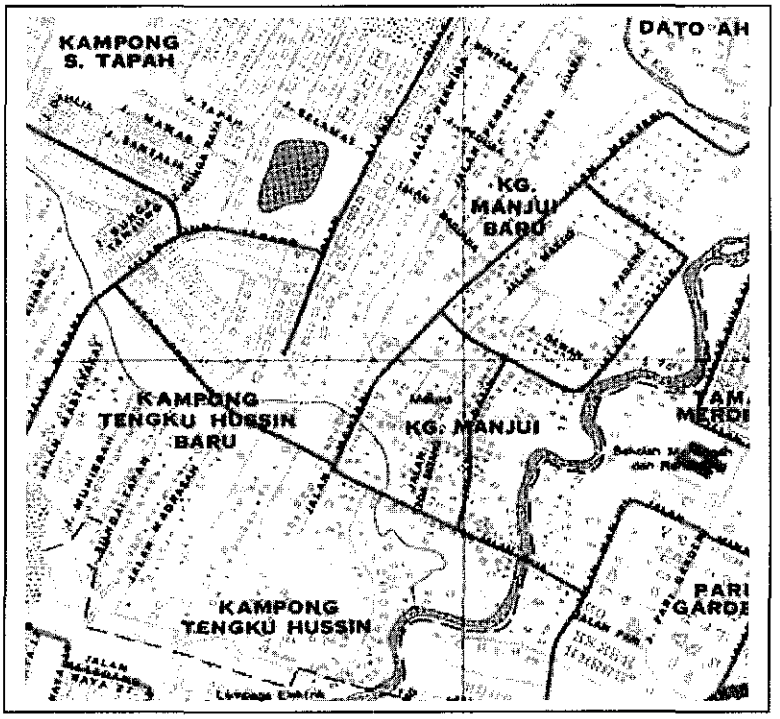

Figure 3: Example of raster image in JPEG Format

3.4.2.2 Layering

Layering is one of the important parts in the digitising process. It is the process of converting the raster image (scanned map) into a series of layer (active layer) that is editable. Each editable layer contains information based on the data related to the map. Before digitising process start, a series of coordinates X, Y, and Z need to be register according to the map coordinates. If no coordinates was registered, MapInfo will automatically register default coordinates to the map with dummy coordinates. Then a table file (.TAB) will be opened for the raster image where this file will contain data to the raster images (e.g. map coordinates). This file describes the structure of the table. It is a small text file describing the format of the file containing data. A process of

layer editing is done where the cosmetic layer of the raster image will be edited according to the map data. When the process of editing the cosmetic layer of the raster image completed, the layer will be saved as new layer which contains information (e.g. building, roads, rivers).There will be a series of layer created containing different information of the map (e.g. layer contains road information, layer contains information on rivers and drainage).These layers then will be combine together and the layers will be rearranged to order. These combinations of layers will be saved as a new digital map, showing all the attributes and information related to it.

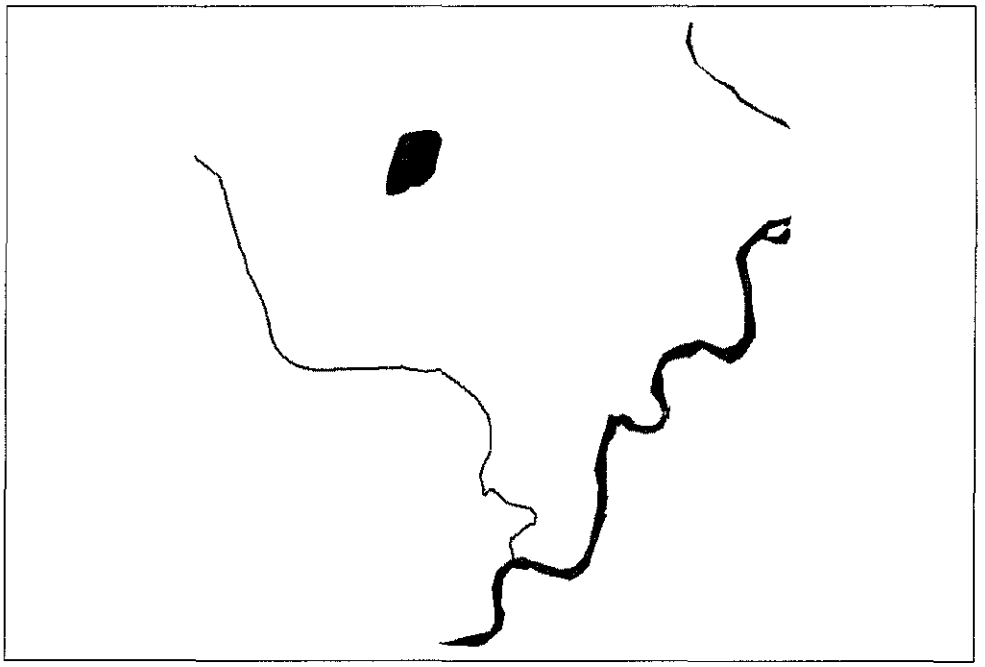

Figure 4: River Layer for Manjoi, Ipoh

Figure 5: Road layer for Manjoi, Ipoh

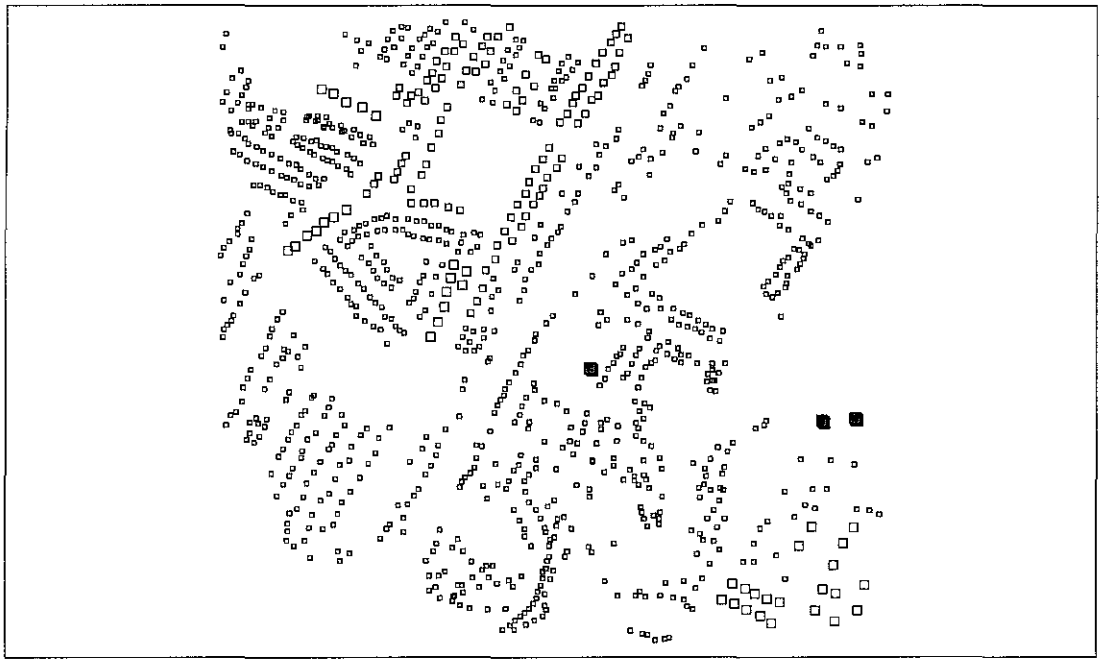

Figure 6: Building layer for Manjoi, Ipoh

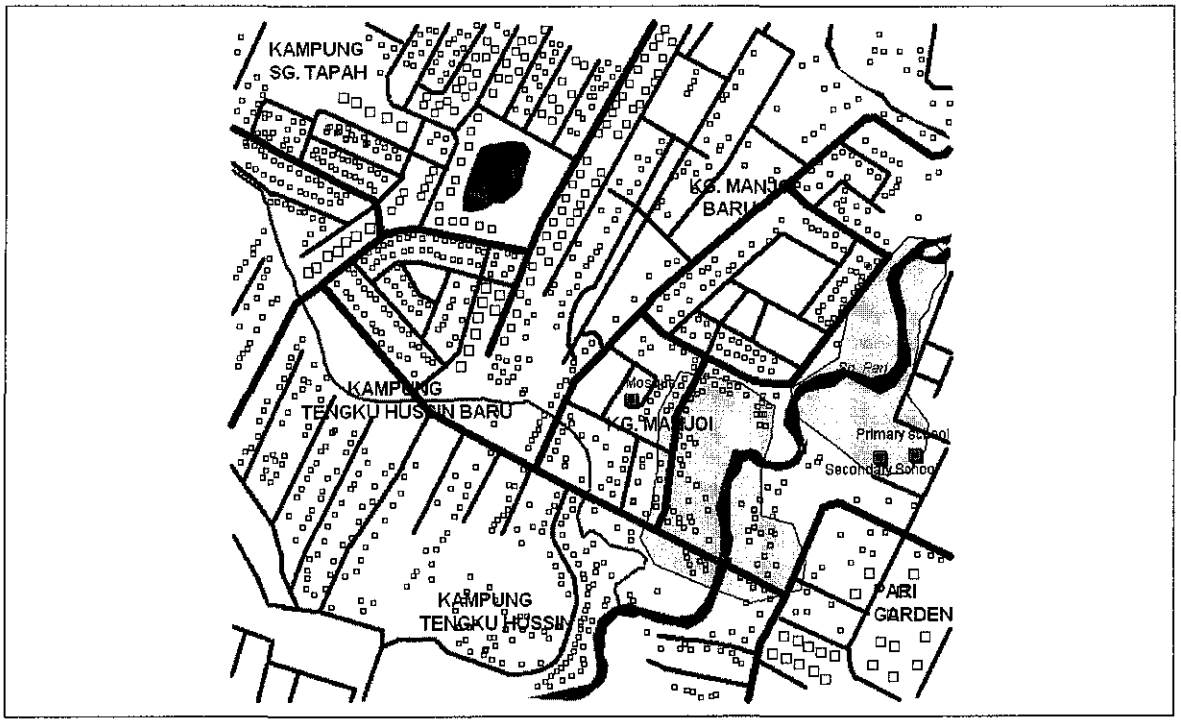

Figure 7: Complete digital map of Manjoi, Ipoh

3.5. Coding and System Construction

Coding and system construction is an important phase where the constructions of the systems commence. This includes the process of loading the digital map and it related info into the proposed system.

3.6. System Testing

There will be a system testing after the construction phase completed. This is to ensure that the system works properly.

CHAPTER 4

RESULTS AND DISCUSSION

There are a number of flood mitigation systems that use GIS as one of the component. These systems are using GIS in various tasks such as in system construction and data manipulating. There are also a number of decision support systems models that available. One of the support systems that available is DEcision Support system for Evaluation of River basin sTrategies (DESERT). The main purpose of this package is to provide a convenient, highly integrated tool for decision support for water quality management on a river basin scale. The systems concept is similar the proposed system's concept. The proposed systems are using GIS for area mapping and to identify areas affected by flood. It will feature a number of important features that is suitable for the systems:

- Friendly user environment based upon Microsoft Windows interface.
- Information on the flood incidents occurred in the respective area.

The system is developed by using programming languages that easily can be extended (Visual Basic 6) and other software such as MapInfo Professional V7.0 (for digital mapping) and ACDSee 5.0 (for image manipulation).

4.1 Flood Mitigation System

The system is called Flood Mitigation System. The main purpose of the system is to assists user in making decision on the flood problem that occurred in Ipoh .The system contains information on floods that occurred in Ipoh since year 2000.The system has search function where the user can make his/her search by selecting the criteria desired and then clicking on the search button to view the result that matched to the search key. The system also contains graphical information (digital map) that has been developed using MapInfo. The map displays areas affected by the flood since year 2000.The system also displays information on every flood case that occurred includes:

- Date

- Areas affected
- Possible cause
- Possible damages

4.1.1 Flood Mitigation System Workflow

User can search the flood information based on two (2) main criteria:

- Area – areas in Ipoh that affected by flood
- Year – all information on flood that has occurred in a certain period of year

The criteria selection is done by the user at the systems main page.

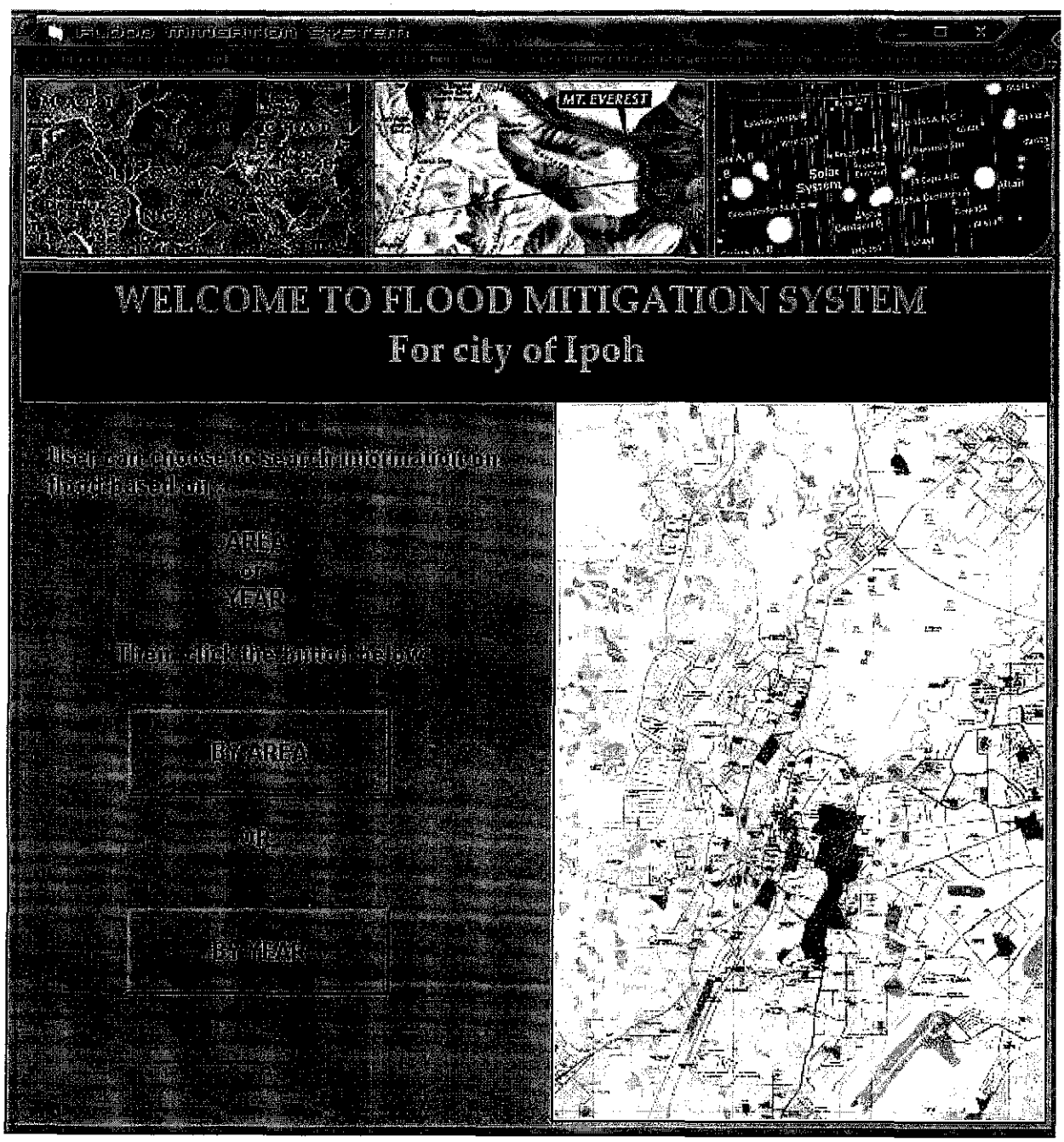

Figure 8: Main Page of Flood Mitigation System

User then will be directed to the next page where the user needs to refine the search criteria. For example, if a user has select to search information based on the area.

He/she need to refine the search criteria by selecting the areas that the user wishes to view to.

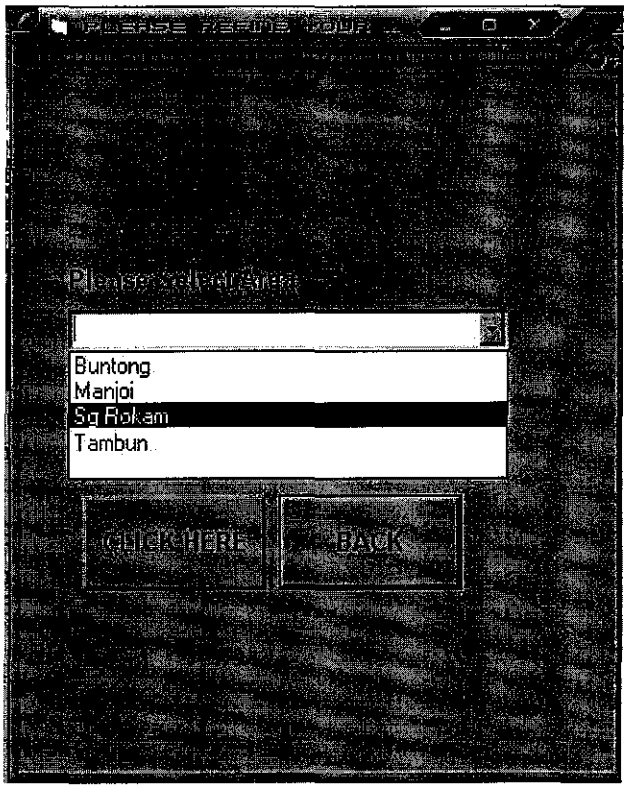

Figure 9: Selection by Area

The user will require refining their search criteria based on the criteria that they have chosen. In refining the search criteria, user will need to make precise selection based on the search criteria that he/she has chosen. For area, they city is divided into four (4) major areas which flood prone every raining season. For year period, the user can view the record based on the year. The system only displays flood information from year 2000 onwards.

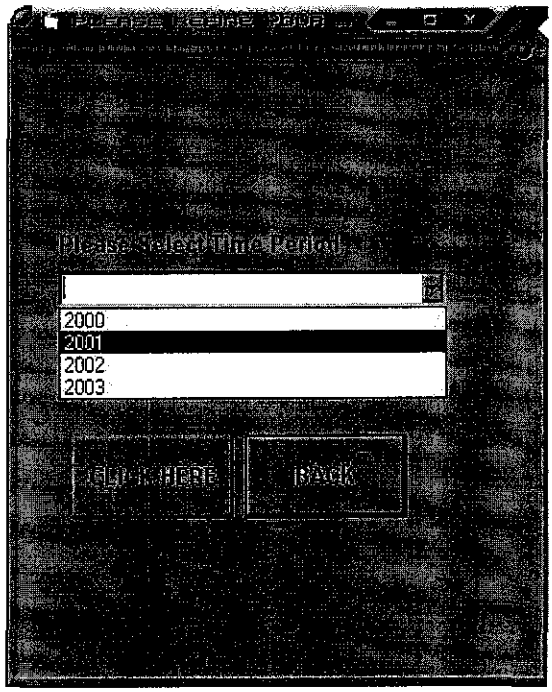

Figure 10: Selection by Year

If there is no record that available based on the user search, a message box will appears with message "No record found" and the user need to go back to the main page (Figure 10). The system will display search result based on user search criteria (Figure 11).

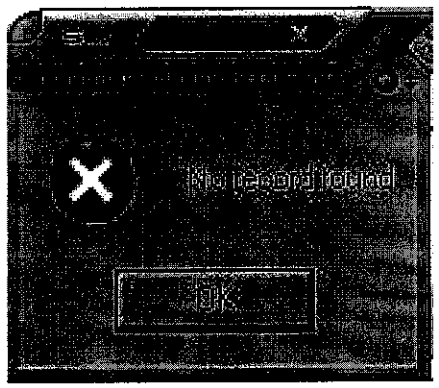

Figure 11: Message Box Displays "No Record Found"

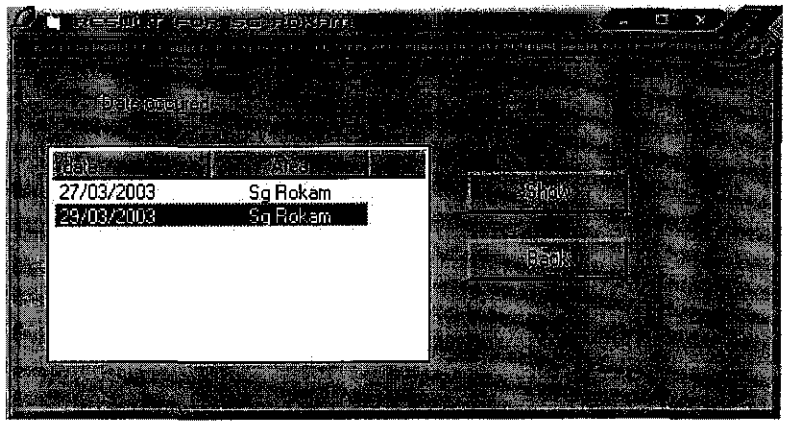

Figure 12: Result Displayed For Search by Area

User then will make choice to view the information desired by select on the available option displayed in the list box. The system then will load a new page containing flood information based on the search criteria (Figure 12).The information displayed consists of:

- Digital Map (showing areas affected by flood on certain area and date)
- Date
- Possible Cause for the flood

- Areas affected by the flood
- Damages recorded from the flood.

The systems design will allow the user to view the information on flood cases as well as identifying the affected areas through the map displayed at left part of the result page.

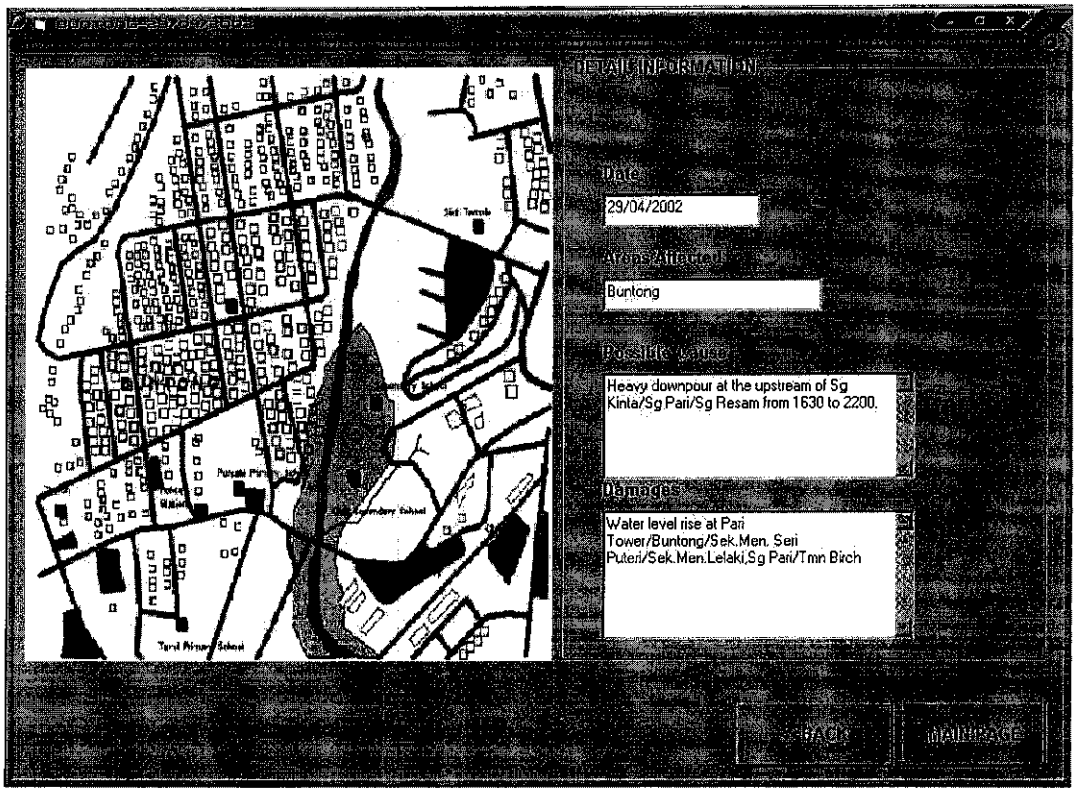

Figure 13: Detail Information

4.1.2 System Benefits

The proposed system allowed user to reduce the time taken in flood mitigation process by:

- Reducing time taken to view flood information as user can view all the flood information stored in the system by just entering a search key and clicking the

search result to get the desired result. In manual process, user need to do several steps in retrieving the flood data which may includes more than 1 personnel to retrieve the data. This may includes searching and retrieving data that is stored at different units of the agency. The manual process should take more than 30 minutes for a user to retrieve flood data.

- Allow user to make faster decision making as user can view all the flood cases in a single system. The speedier information retrieval process from the system also allows user to make decision making process faster.

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1. Conclusion

Although there are a lot of decision support system exists, there are only focused on the decision support system important stages such as:

- data management
- model calibration
- simulation
- optimization
- plotting results of simulation

The student has conduct a research on certain numbers of decision support systems that incorporated GIS based elements through the internet and found only a small numbers of decision support systems that incorporated GIS based element. One of them is DEcision Support system for Evaluation of River basin sTrategies (DESERT).The student also has made research through the internet on the appropriate modelling languages that can be use in developing the decision support systems.Modelling languages such as GAMS- General Algebraic Modeling System and AMPL- Algebraic Modeling Languages Preview. However, the student has decided to use object oriented programming (e.g. Visual Basics) as it can be expandable.

Based on the research in the internet, there is a numbers of flood related system that has been developed-mostly in flood prone area. The extensive usage of GIS in the system and in the development of the system shows the advantages of using GIS.It is also shows the importance of GIS in flood management process. Thus the development of the system are mainly consists of the usage of GIS application and

techniques, such as using MapInfo in map digitizing process and registering coordinates for the map. In the Flood Mitigation System, GIS is used as one of the method for flood mitigation, through the map digitizing process. The map is used to identify areas affected by flood through the information stored in the system. The Flood Mitigation System is a result of combining Decision Support System (DSS) elements and GIS. Information is stored in the systems database and retrieved using DSS functions and the raw data is processed using GIS method to produce information on flood cases.

5.2 Recommendation

It is highly recommended that they should be more research done on Geographical Information System as the function of GIS is greatly diversified. The system developed for the research gives benefit not only to the system user, but to other people especially the student on the usage of GIS in flood mitigation (specifically) and hazard management (generally).

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[4] Application of GIS in flood hazard mapping: A case study of Gangetic West Bengal, India, Joy Sanyal and Xi Xi Lu, Department of Geography, National University of Singapore.

[5] Flood risk zone mapping of Dikrong sub basin in Assam, P. Sarma A.E.E, Brahmaputra Board, Assam, India.

[6] The Use of GIS in Flood Hazard Analysis: A Report for the City of Warwick and Project Impact , Noah Raford,Brown University,June, 1999

[7] Data integration for flood risk analysis by using GIS/RS as tools, Mr. Falak Nawaz,Research Associate, National Centre of Excellence in Geology,University of Peshawar, Pakistan

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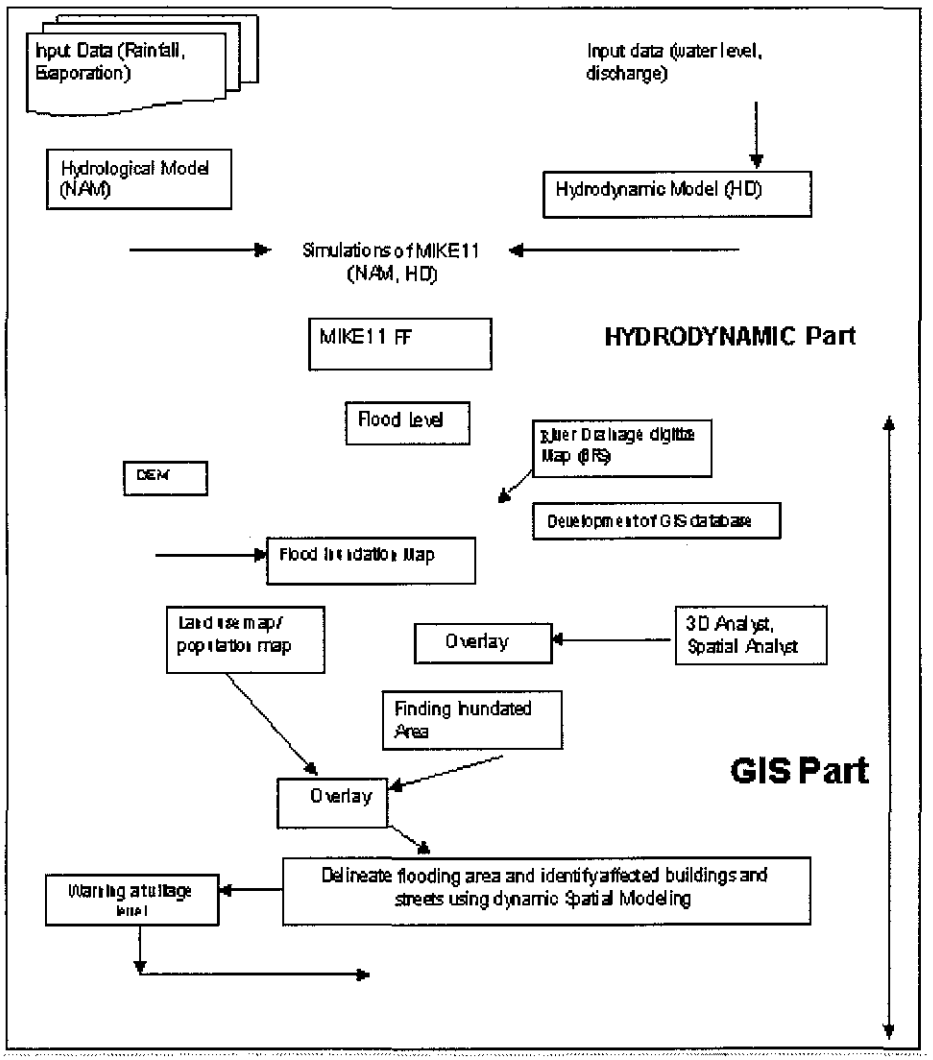
[9] http://commpres.env.state.ma.us/content/glossary.asp

APPENDIX 1

THE USAGE OF GIS IN DEVELOPING FLOOD WARNING SYSTEM IN BANGLADESH



APPENDIX 1: The usage of GIS in developing of flood warning system in Bangladesh

APPENDIX 2

FLOOD INFORMATION COLLECTED FROM HYDROLOGY UNIT, DEPARTMENT OF IRRIGATION AND DRAINAGE

LAMPIRAN A

LAPORAN BANJIR SEMASA

NEGERI: PERAK   SUNGAI: PARI   DI SEK. MEN. SRI PUTERI (Poh)

STESEN A ______   ARAS WASPADA ______ (m)
B ______   ARAS AMARAN ______ (m)
C ______   ARAS BAHAYA ______ (m)

1. TARIKH DAN MASA	2. CURAHAN HUJAN (mm) A	B	C	3. ARAS AIR (m)	4. AKIBAT BANJIR I. Nama Kawasan Dibanjiri dan keluasan (m)	II. Penyelamatan	III. Jalan dibanjiri dan kedalaman (m)	IV. Kerosakan lain	5. CATATAN	6. PEGAWAI PELAPOR	7. TARIKH LAPORAN
25-4-2001 RABTU					SEK. MEN. SRI PUTERI & SEK. MEN. CASCAIS SG. PARI (Poh)		0.5 m S. Jam DI DALAM BILIK DARJAH KEDUA-DUA SEKOLAH		HUJAN LEBAT LAMA 10.00 MALAM DAN BERHENTI MULA JAM 1.00 PAGI	MOHD. HATTA	25-4-2001

PERCUBAAN ARAHAN BANJIR

Catatan: Tindakan segera TKCA

[illegible]

LAPORAN BANJIR SEMASA BULAN MAC 2003

Tempat Banjir/ Tarikh	Sistem Sungai Yang Terlibat	Stn.Hujan/ Jangka Hujan	Stn.Aras Air Sungai	Kawasan Dibanjiri (Kpg. Daerah Bandar etc)	Sebab-sebab Utama Banjir Berlaku	Bil.Rumah Terlibat	Jumlah Mangsa Dipindahkan	Jumlah Kematian Terlibat Banjir	Keluasan Kawasan Yang Dibanjiri Anggaran
27.03.2003 (Khamis)	i) Bahagian Muara Sg.Rokam/Sg.Pinji Kg.Sg.Rokam		Ditenggelami air diantara 0.6m - 0.9m	Jalan Pesuh dan Jalan Salak,Kg.Sg.Rokam.	Berlaku hujan lebat di Bahagian Hulu Sungai Rokam mulai jam 3.30 ptg hingga 10.30 malam pada 27.03.2003 (Khamis)	12 Rumah - Jalan Pesuh dan Jalan Salak.	Tiada	Tidak di ketahui	1.5 Ha.
	ii) Bahagian Hulu Sg.Rapat,Kampung Berhampiran Stesen Petronas,Jalan Gopeng,Ipoh.		0.3m-0.6m	Kawasan Stesen Petronas dan dihilir Kembung Jalan raya Jalan Gopeng, Tambahan Gunung Rapat.	-sda-	3 buah rumah Sg.Rapat Tambahan 113,Jalan Gopeng	Tiada	Tidak di ketahui	1.0 Ha.

LAPORAN BANJIR SEMASA BULAN MAC 2003

Tempoh Banjir/ Tarikh	Sistem Sungai Yang Terlibat	Sukatan/ Jangka Hujan	Sta./ Aras Air Sungai	Kawasan Dibanjiri (Kpg. Daerah Bandar etc)	Sebab-sebab Utama Banjir Berlaku	Bil.Rumah Terlibat	Jumlah Mangsa Dipindahkan	Jumlah Kerosakan Terlibat Banjir	Keluasan Kawasan Yang Dibanjiri Kediaman
29.03.2003 (Sabtu)	i) Bahagian Hulu Sg.Rokam/Sg.Pinji Kg.Sg.Rokam		Ketinggian air diantara 0.5m – 0.9m	Jalan Pasah dan Jalan Salak,Kg.Sg.Rokam.	Sebab hujan lebat di Bahagian Hulu Sungai Rokam mulai jam 4.30 ptg hingga 10.30 malam pada 27.03.2003 (Khusus)	12 Rumah – Jalan Pasah dan Jalan Salak.	Tiada	Tidak di ketahui	2.5 Ha.
	ii) Bahagian Hulu Sg.Rapat,Kelubong Bersebelahan Stesen Petronas,Jalan Gopeng,Ipoh.		0.5m-0.8m	Kawasan Stesen Petronas dan dihilir Kelubong Jalanraya Jalan Gopeng, Tambahan Gunung Rapat.	-sda-	7 Buah rumah Sg.Rapat Tambahan XII,Jalan Gopeng	Tiada	Tidak di ketahui	1.0 Ha.
30.03.2003 (Ahad)	Sg.Kinon/Sg.Pulai		0.5m-0.8m	Kawasan Kleang Kopi Hansam dan sekitarnya.	Sentiasa hujan lebat di hulu sungai dan terdapat struktur kelubong dan sampah sarap tersangkut dimuka kelubong.	Kleang Kopi dan sekitarnya.	Tiada	Tidak di ketahui	0.2Ha.

HOME | Tambah Rekod | Semakan Untuk Kemaskini

333	Perak	Kinta	19-Dec-2002	18-Dec-2002	Ab Rahim Said	055375400

Telemetri Kuala Bari	0.0 mm	53.0 mm	0.0 mm
	mm	mm	mm
	mm	mm	mm

Jln Menteri, Manjoi	0.5 m	2400hrs	Yes	0	Sg. Tapah	m
Kg. Tengku Hussein Lama, Ipoh	0.5 m	2400hrs	Yes	0	Sg. Tapah	m
Jambatan Sg. Tapah, Ipoh	0.5 m	2400hrs	Yes	0	Sg. Tapah	m
	m	hrs	No			m
	m	hrs	No			m
	m	hrs	No			m
	m	hrs	No			m
	m	hrs	No			m
	m	hrs	No			m
	m	hrs	No			m

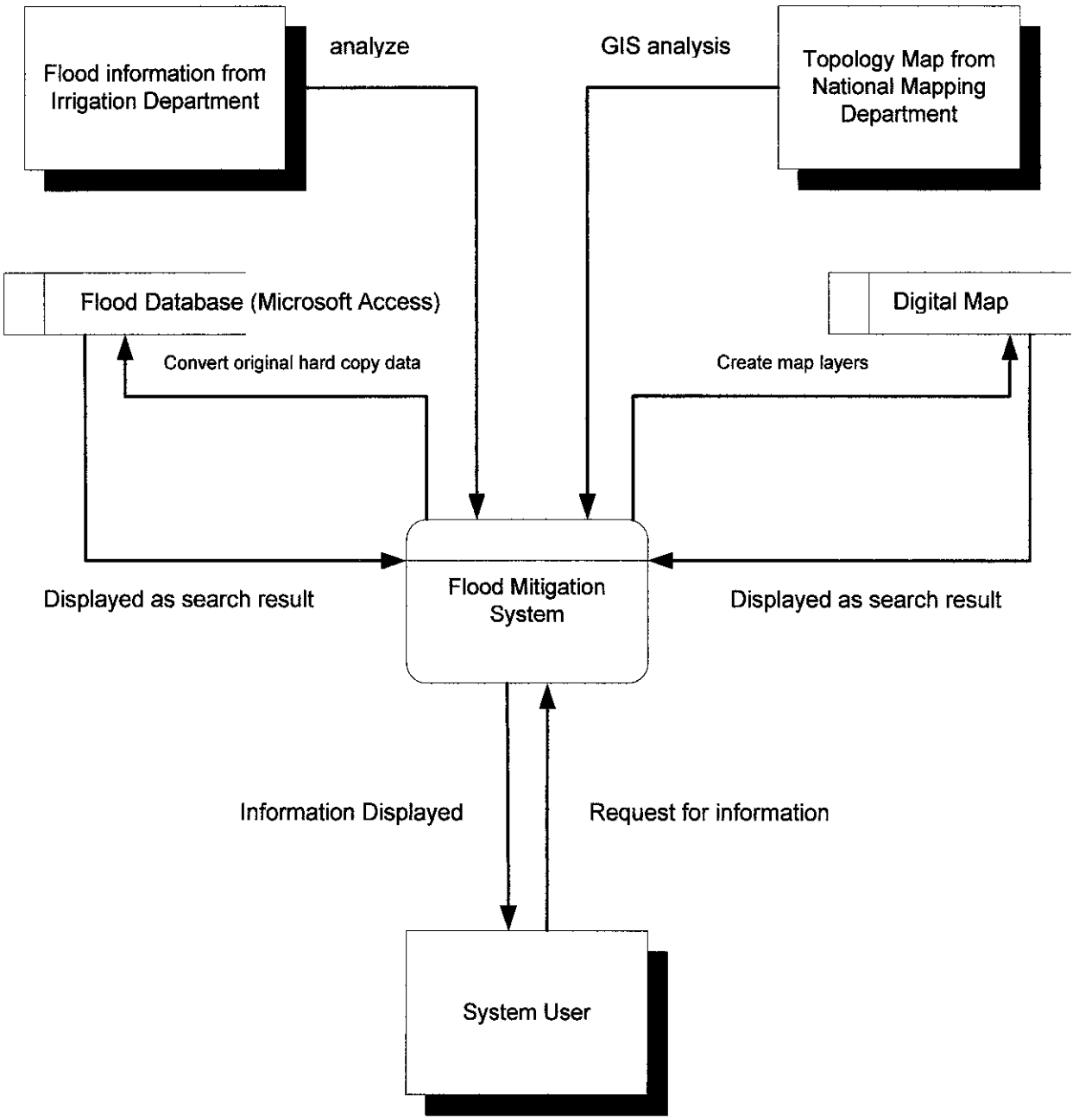
23	Perak	Kinta	14-Jun-2001	14-Jun-2001	Ab Rahim Said	055225409

Politeknik Ungku Omar, Ipoh	120 mm	80 mm	0 mm
Padang Kuda Kebangsaan, Tg Rambutan	100 mm	70 mm	0 mm
	mm	mm	mm

Gambia	0.6 m	0900hrs	Yes	0	Sg Pari	36.7
	m	hrs	No			m
	m	hrs	No			m
	m	hrs	No			m
	m	hrs	No			m
	m	hrs	No			m
	m	hrs	No			m
	m	hrs	No			m
	m	hrs	No			m
	m	hrs	No			m

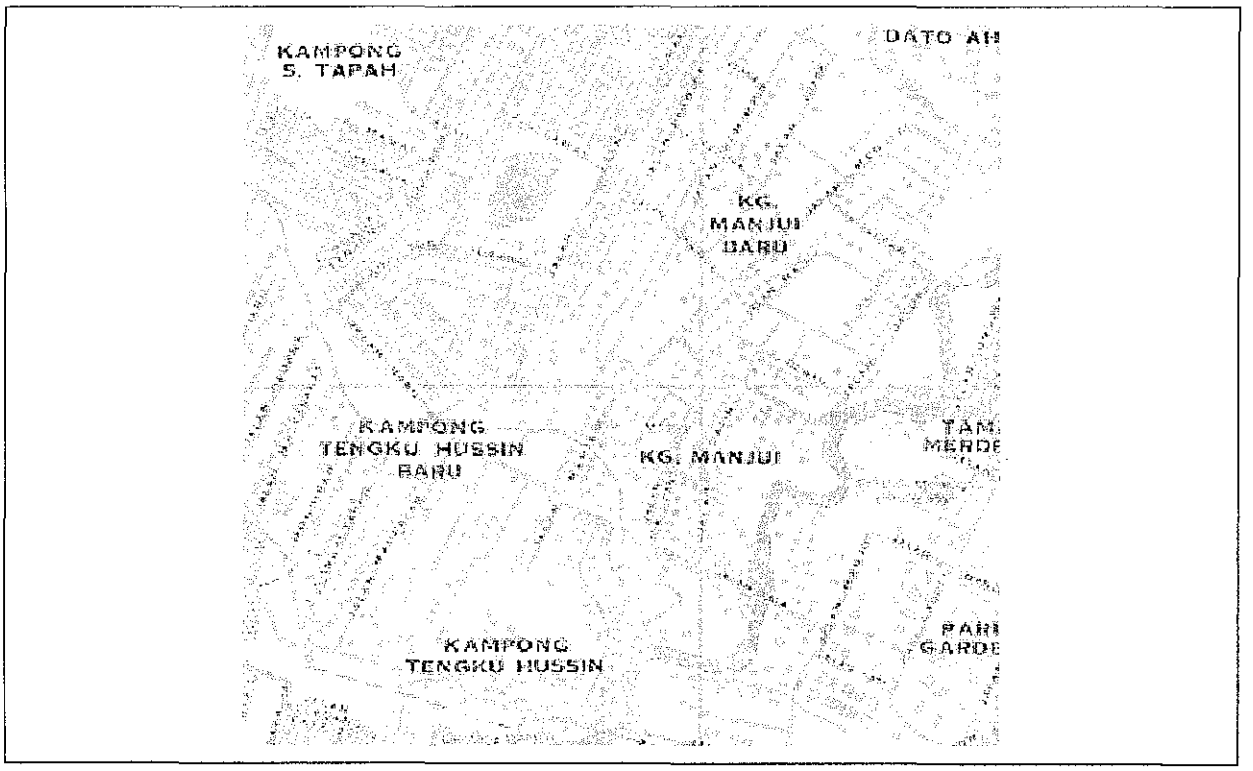
APPENDIX 3

DFD FOR FLOOD MITIGATION SYSTEM

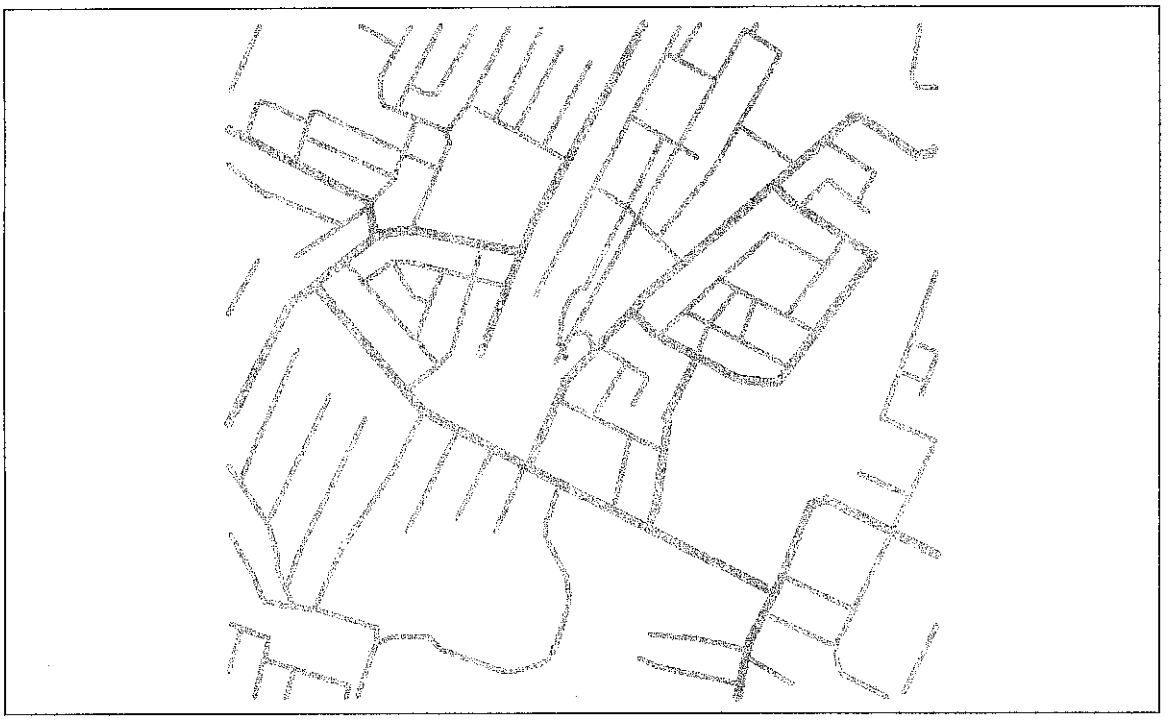

Flood information from Irrigation Department
analyze
GIS analysis
Topology Map from National Mapping Department
Flood Database (Microsoft Access)
Digital Map
Convert original hard copy data
Create map layers
Displayed as search result
Flood Mitigation System
Displayed as search result
Information Displayed
Request for information
System User

APPENDIX 4

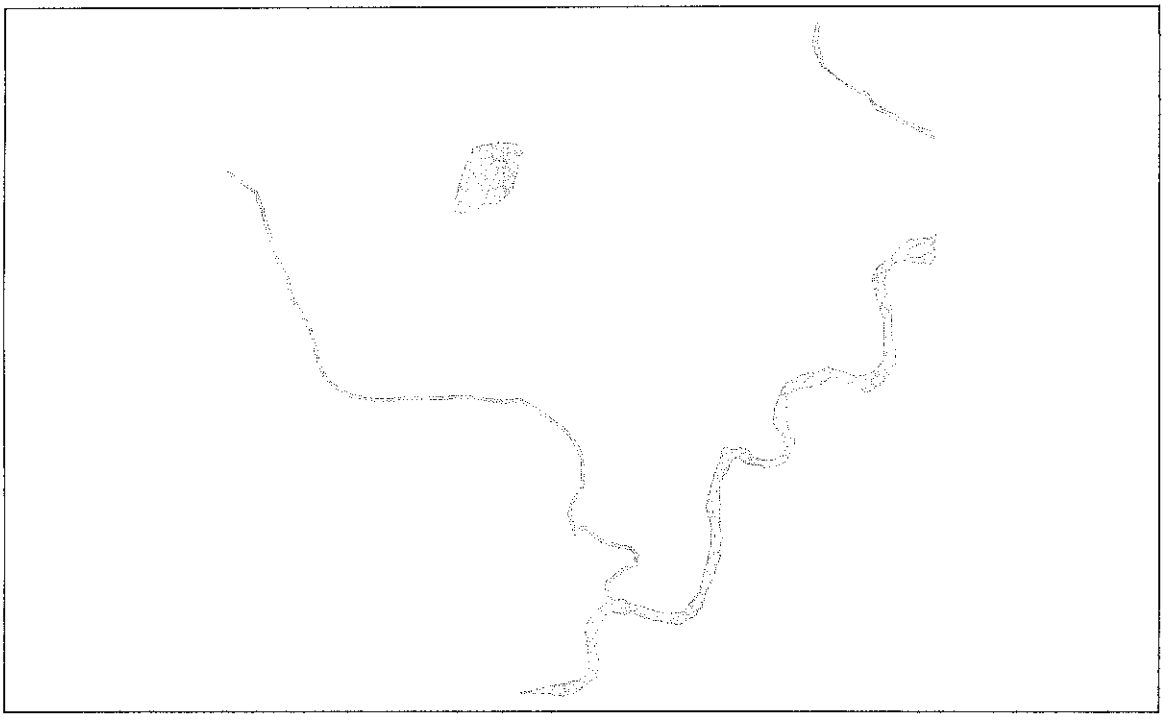
SAMPLE LAYERS DEVELOPED FOR THE DIGITAL MAP



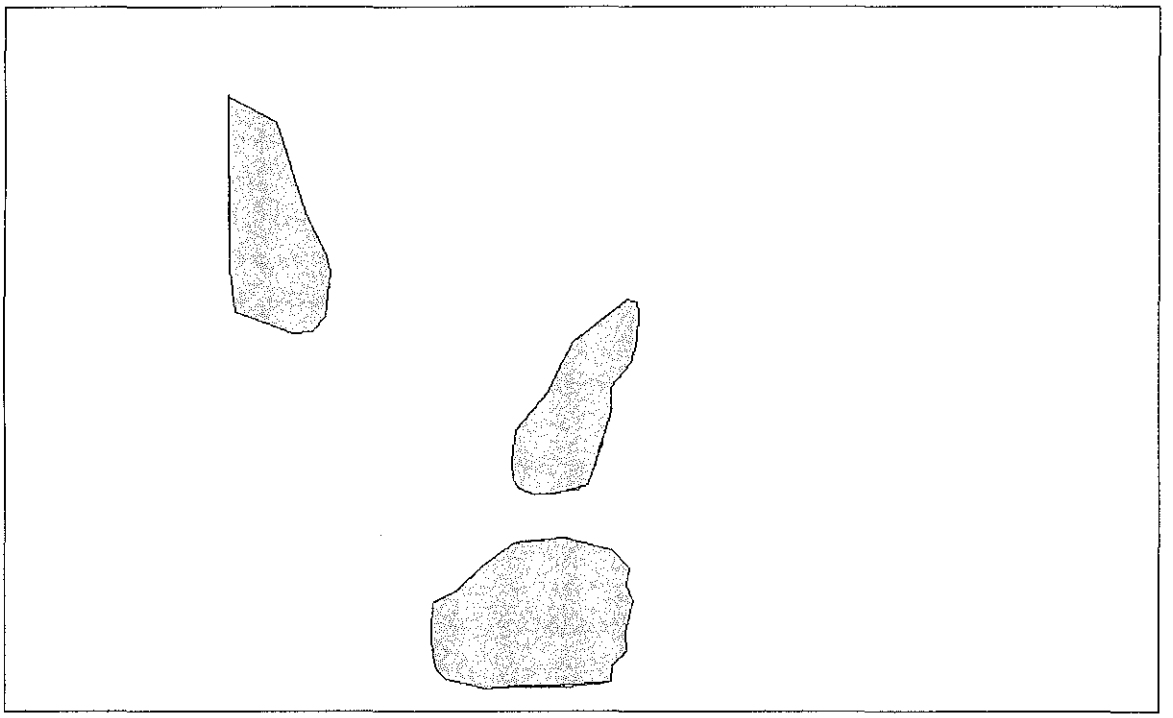
Original map for Manjoi,Ipoh



Road layer developed for Manjoi,Ipoh



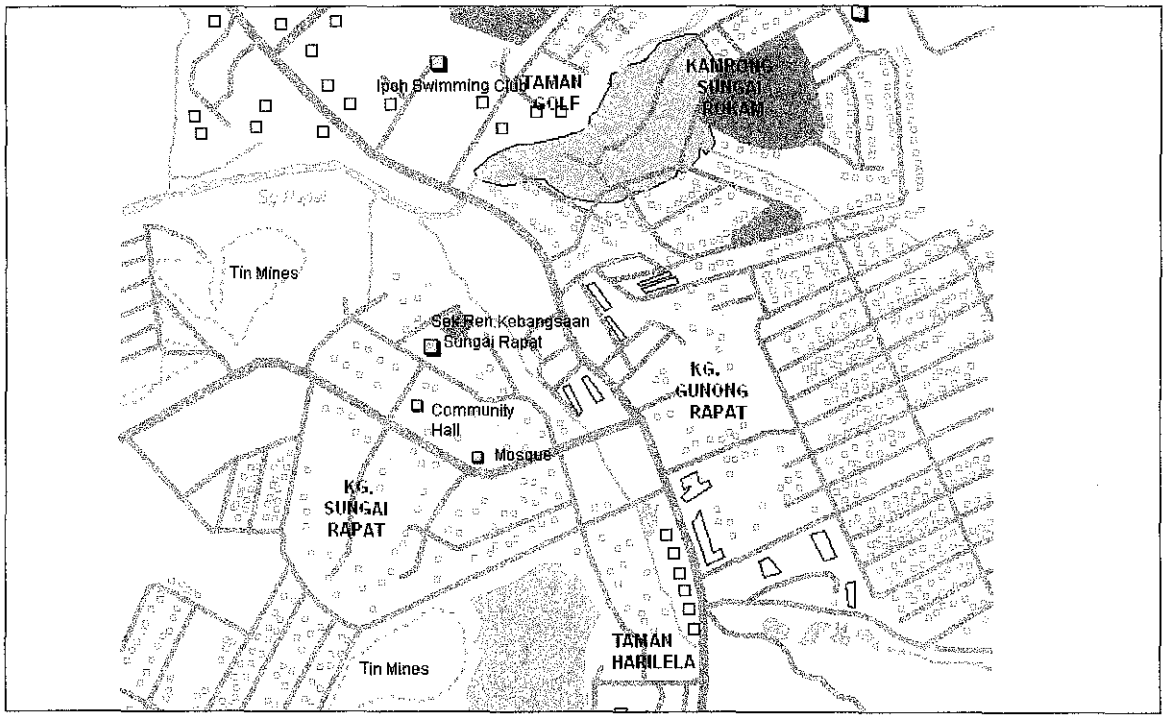
River layer developed for Manjoi,Ipoh



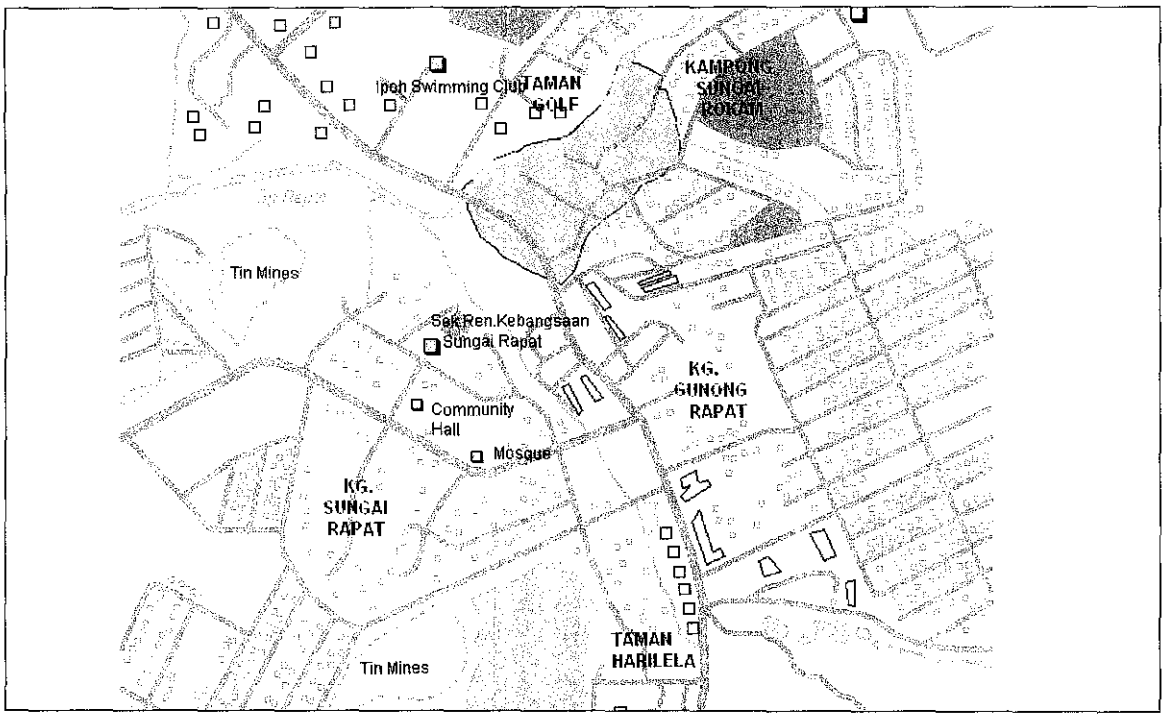
Flood area layer developed for Manjoi,Ipoh

APPENDIX 5

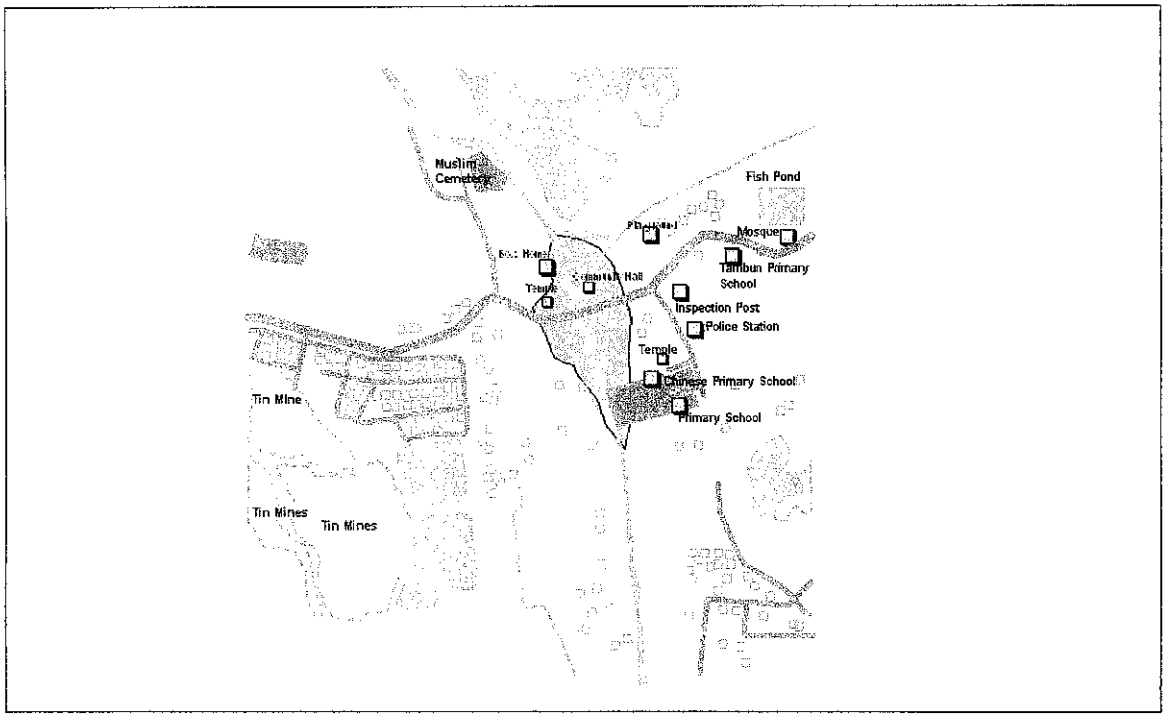
FINAL MAP DEVELOP FOR FLOOD MITIGATION SYSTEM



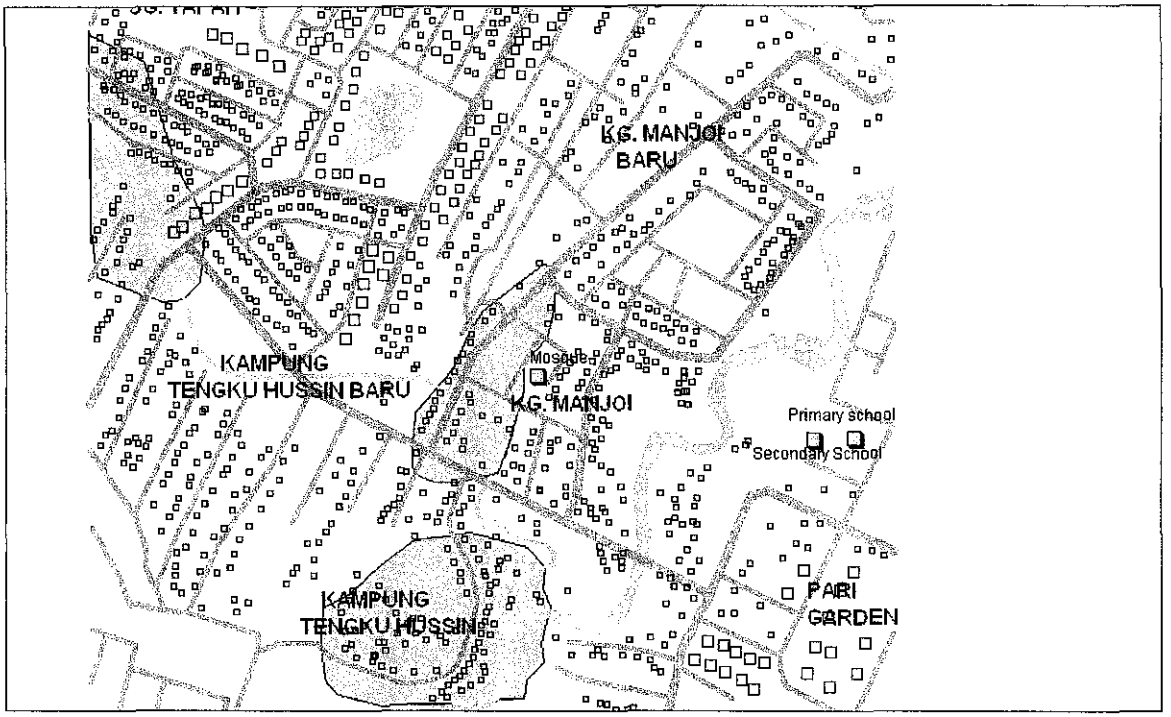
Map showing areas affected by flood in Sg Rokam on 21-12-2002



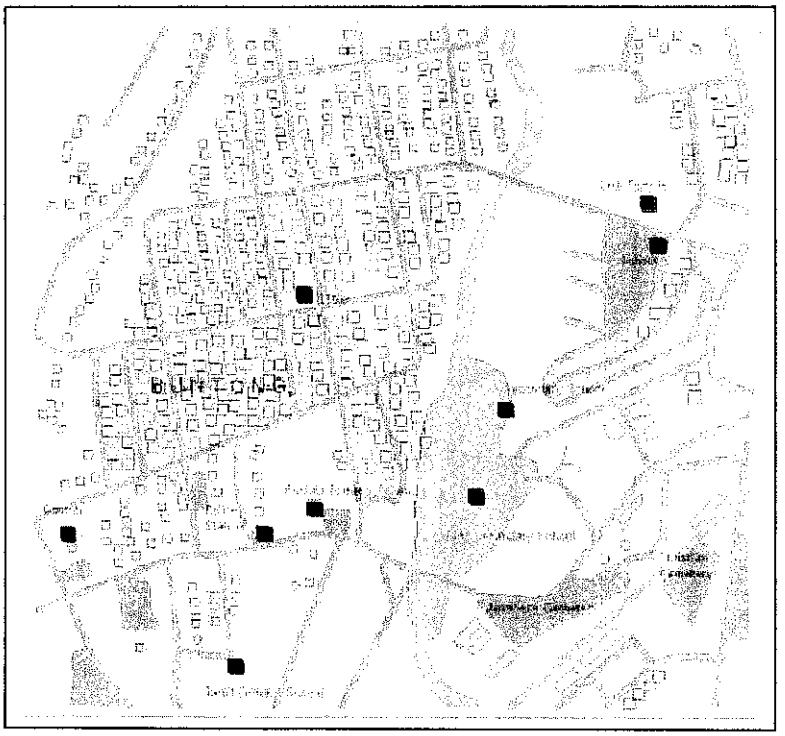
Map showing areas affected by flood in Sg Rokam on 27-03-2003



Map showing areas affected by flood in Tambun on 14-06-2001



Map showing areas affected by flood in Manjoi on 18-12-2002



Map showing areas ~~affected by~~ flood in Buntong on 27-04-2001

APPENDIX 6

CODING DEVELOPED FOR FLOOD MITIGATION SYSTEM

‘ frmArea (Main Form)

```
Private Sub Command1_Click()
strType = "area"
frmSelect.lblDate.Visible = False
'frmSelect.cboDate.Visible = False

Unload Me
frmSelect.Show
End Sub

Private Sub Command2_Click()
strType = "date"
frmSelect.lblSelect.Visible = False
'frmSelect.cboArea.Visible = False

Unload Me
frmSelect.Show
End Sub
```

‘frmDisplay

```
Private Sub cmdMain_Click()
Unload Me
frmArea.Show
End Sub

Private Sub cmdPrevious_Click()


If Label1.Caption = "yes" Then

frmyear.Show
Else
frmSelect.Show
End If
Unload Me
End Sub
```

'frmSelect

```
Private Sub cmdBack_Click()
Unload Me
frmArea.Show
End Sub

Private Sub cmdSelect_Click()
'On Error Resume Next
Dim dn As New ADODB.Connection
Dim rs As New ADODB.Recordset
Dim rs1 As New ADODB.Recordset

dn.Open "Provider=Microsoft.Jet.OLEDB.4.0;Data Source=" & App.Path &
"\gis.mdb;Persist Security Info=False"
If strType = "area" Then
rs.Open "select * from flood where area='" & cboArea.Text & "'", dn, adOpenDynamic,
adLockOptimistic
rs1.Open "select count(*) from flood where area='" & cboArea.Text & "'", dn,
adOpenDynamic, adLockOptimistic
Else
rs.Open "select * from flood where date >=#1-1-" & cboArea.Text & "# and
date<=#12/31/" & cboArea.Text & "#", dn, adOpenDynamic, adLockOptimistic
rs1.Open "select count(*) from flood where date >=#1-1-" & cboArea.Text & "# and
date<=#12/31/" & cboArea.Text & "#", dn, adOpenDynamic, adLockOptimistic
End If

If rs1.Fields(0) = 0 Then
MsgBox "No record found", vbCritical, "Searc Result"
Exit Sub
End If


frmyear.ListView1.ListItems.Clear
If rs1.Fields(0) > 1 Then
While Not rs.EOF()
Set itmx = frmyear.ListView1.ListItems.Add
Sum = Sum + 1
'frmyear.ListView1.ListItems.Add rs("date")
itmx.Text = rs("date")
itmx.SubItems(1) = rs("area")
rs.MoveNext
Wend
'frmyear.Label2 = cboArea.Text
frmyear.Caption = "Result For " & cboArea.Text
Unload Me
```

```
frmyear.Show
Else



Me.Hide
frmdisplay.Caption = cboArea.Text
frmdisplay.Label1.Caption = "no"
frmdisplay.Text1 = rs("date")
frmdisplay.Text2 = rs("area")
frmdisplay.Text3 = rs("cause")
frmdisplay.Text4 = rs("damage")
frmdisplay.Image1.Picture = LoadPicture(App.Path & "\images\" & rs("picture"))
frmdisplay.Show
'End Select
End If


rs.Close
dn.Close




End Sub
Private Sub cboDate_DropDown()

If cboDate.ListIndex = True Then
   cboArea.Visible = False
End If

cboDate.Text = "2000"
cboDate.Text = "2001"
cboDate.Text = "2002"
cboDate.Text = "2003"


End Sub

Private Sub cboArea_DropDown()

'If cboArea.ListIndex = True Then
   'cboDate.Visible = False
'End If
```

```
'cboArea.Text = "Buntong"
'cboArea.Text = "Gugusan Manjoi"
'cboArea.Text = "Sungai Rokam"
'cboArea.Text = "Tambun"

End Sub

Private Sub Form_Load()
Dim dn As New ADODB.Connection
Dim rs As New ADODB.Recordset


If strType = "date" Then

For i = 2000 To 2003
cboArea.AddItem i

Next i

Else
dn.Open "Provider=Microsoft.Jet.OLEDB.4.0;Data Source=" & App.Path &
"\gis.mdb;Persist Security Info=False"
rs.Open "select * from flood", dn, adOpenDynamic, adLockOptimistic

Sum = 0

While Not rs.EOF()
Sum = Sum + 1

For i = 0 To cboArea.ListCount

If rs("area") = cboArea.List(i) Then
Exit For
Else
'MsgBox cboArea.List(i)
cboArea.AddItem rs("area")
Exit For
End If

Next i

rs.MoveNext
Wend

rs.Close
```

```
dn.Close
End If

End Sub
```

'frmYear

```
Private Sub Command1_Click()
Dim dn As New ADODB.Connection
Dim rs As New ADODB.Recordset


dn.Open "Provider=Microsoft.Jet.OLEDB.4.0;Data Source=" & App.Path &
"\gis.mdb;Persist Security Info=False"
rs.Open "select * from flood where area='" & ListView1.SelectedItem.SubItems(1) & "'
and date=#" & ListView1.SelectedItem.Text & "#", dn, adOpenDynamic,
adLockOptimistic

Me.Hide
frmdisplay.Caption = ListView1.SelectedItem.SubItems(1) & "-" &
ListView1.SelectedItem.Text
frmdisplay.Label1.Caption = "yes"
frmdisplay.Text1 = rs("date")
frmdisplay.Text2 = rs("area")
frmdisplay.Text3 = rs("cause")
frmdisplay.Text4 = rs("damage")
frmdisplay.Image1.Picture = LoadPicture(App.Path & "\images\" & rs("picture"))
frmdisplay.Show

rs.Close
dn.Close
End Sub

Private Sub Command2_Click()
Unload Me
frmSelect.Show
End Sub
```