ESTIMATION OF FLASH FLOOD PROPERTIES DAMAGE BY USING GIS SPATIAL ANALYSIS

by

MOHD KHUSYAIRI BIN KUSMANIIRAT

Dissertation submitted in partial fulfillment of
the requirements for the
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Universiti Teknologi PETRONAS
Bandar Seri Iskandar
31750 Tronoh
Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Civil Engineering Programme
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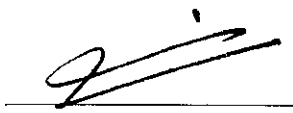
Approved by,



(A.P. Dr. Abdul Nasir bin Matori)

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK
January 2008

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.

MOHD KHUSYAIRI BIN KUSMANIIRAT

ABSTRACT

The paper describes the use of spatial analysis on Geographical Information System (GIS) in analyzing the impact of flash flood to the properties damages. Flood is a natural disaster in this country and many other parts of the world. Flood damages/losses is essential for the flood victims for insurance claiming purposes. For the authorities it is also importance n order to decide whether the flood mitigation of the affected area is worth spending. The common practice of flood damage estimation was through ground survey, which was very laborious and time consuming, where usually it would take around several months to years to complete the survey. On the other hand GIS technology would provide alternative method of such flood damage estimation through its spatial analysis capable features. This study was conducted at Kg. Melayu Subang and Taman Subang Jaya, at the outskirt of Kuala Lumpur, Malaysia. These two areas which are located in the river basin of Sg. Damansara and are prone to flash flood. The parameters applied for the estimation were average hous hold belonging, number of houses or offices, number of infrastructures involved and flood Annual Recurrence Interval (ARI). GIS techniques of overlaying, intersecting layers, spatial analysis and attributes matching with layers have been used in this the analysis. The estimated value of the flood damage derived from this method is comparable to those estimated by conventional method but cumbersome ground survey method. Hence, this study has revealed an alternative method that could provide faster flash flood damage estimation.

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LIST OF ABBREVIATIONS

GIS	Geographical Information System
SWM	Stormwater Management
DID	Drainage and Irrigation Department of Malaysia (JPS)
MASMA	Manual Saliran Mesra Alam
ARI	Annual Recurrence Interval
PMF	Probable Maximum Flood
RAM	Rapid Assessment Method
DAM	Detailed Assessment Method
DTM	Digital Terrain Model
CAD	Computer Aided Design
HSE	Health Safety and Environment
JKM	Jabatan Kebajikan Masyarakat
SI	International Standard Unit

CHAPTER 1

INTRODUCTION

Flood is one of the natural disasters that always happen in Malaysia. Flood behavior must well be understood before a proper measure can be taken for its mitigation[1]. Every natural disaster always relate to the losses and properties damage. Nowadays a further study has to be done to find a solution to predict value of losses that affected by flood. Geographical Information System (GIS) give wide framework where different discipline and topic can be accommodating into one database. By using GIS, hopefully this study can produce such a useful application that can be used to estimate and predict losses that causes by flash flood especially to the flood prone area.

1.1 Background of Study

Sg. Damansara Catchment is among the most important urban centre within the Klang Valley. Among the important features located in the catchment are Shah Alam, the capital of Selangor, Subang Airport, part of the NKVE, Federal Highway and the railway linking Klang to Kuala Lumpur. The area has undergone rapid development in the last 40 years whereby agriculture lands were converted into residential, commercial and industrial uses. Concurrent with these urbanizations, SWM Infrastructure was developed to drain storm runoff and returned waters. For developments approved before 2001, the drainage system was based on the older DID Urban Drainage Design Procedure 1975. The rapid disposal approach employed generally resulted in peak discharge increases of about 3 to 4 times compared to the pre-development values.

[1] Abd. Jalil bin Hasan (2007) – Development of Flood Risk Map for Sg. Selangor Basin. – Buletin Geospatial Sektor Awam 2007

The catchment with its vast undeveloped areas continued to be developed due to the robust economy prevalent in Selangor. Estates are converted to built-up areas while forest reserves were alienated and opened up for development. The associated earthworks were mostly not well managed resulting in massive erosion the land surface resulting in sedimentation of the river. SWM infrastructure for the recent land developments were based on the newly established Manual Saliran Mesra Alam (MSMA). Ponds were constructed as part of the new compliance requirements. However several of these ponds were either not designed, constructed or maintained properly resulting in failures in meeting peak discharge reduction desired. Consequent to these developments, the catchment area has experienced increased and worsening floods causing hardship to the local population and significant damages to the economy[2].

Geographical Information System (GIS) is a collection of computer hardware, software, and geographic data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. With this system, information or attributes can be linked to location data, such as people to address, buildings to parcels, or streets within a network. It gives a better understanding of information before analysis is done. GIS also allows us to see relationship, patterns, or trends intuitively that are not possible to see with traditional charts, graphs, and spreadsheets.

A GIS application for water, wastewater and stormwater systems is becoming widely used by engineer to monitor, design, research analysis, research hypothesis and solving solutions. The aim of the study is mainly to develop GIS database that contains numbers of layers that to be used in determining flood disaster and it effects to the properties damage.

[2] Jurutera Perunding Zaaba Sdn. Bhd. (2007) - Preparation of Flood Mitigation Master Plan for Sungai Damansara Catchment – Interim Report No. 1.

1.2 Problem Statement

The rapid urbanization and industrial growth in the Klang Valley has resulted in increased pressure on the flow capacities of the Sg. Klang and its tributaries, resulting in frequent occurrence of flooding causing damage to property, disruption of services and general inconvenience to the Klang Valley population.

Flooding in the Klang Valley is mainly attributed to thunderstorms and depression-type monsoon storms. Depression-type monsoon rains are generally low in intensity, long duration and are wide spreads over the whole catchment causing the rivers to overflow their banks, such as the event that contributed to the largest recorded flood in 1971 in the Klang Valley. Thunderstorms, on the other hand, occur more frequently, are short in duration with high intensity rainfall giving rise to flash flood as a result of the inability of localized drainage systems to cope with the high flows[3]. The flood event on 26th February 2006 is example of such occurrence, which caused fairly significant damage and disruption of services, mainly in the Shah Alam and extending to some of the surrounding areas.

Some of peoples that already involved in the flash flood could not estimate their losses in term of properties damage and it will give them a problem while their request for insuring. Because of that, this study is conducted in order to develop a flood damage database by using GIS application. At present, there is no other development of geospatial analysis on flood damage since it is a difficult process that requires information from hydraulic analyses that to be exported and combined with the flood plain. Therefore the use of GIS in processing raw data and combined with the hydraulic analyses and also to be integrated with properties damage could be further studied in this project.

[3] KTA Tenaga Sdn. Bhd. (2003) Flood Damage Assessment of 26 April 2001 Flooding Affecting The Klang Valley and the generalized procedures and guideline for assessment of flood damages – Draft Final Report

1.3 Objectives

The objectives of this study had been identified and can be seen as follows:

1. To develop the GIS database by integrating the value of public/private properties that exposed to be damaged with relevant return period with related spatial data and attribute data.
2. To develop the relevant geospatial analysis of the flash flood scenario (relevant ARIs) and try to convert the result to the monetary term (RM).
3. To give roughly estimate losses of properties so that peoples in the area can be insured.
4. To give roughly estimate losses of properties so assist in providing the economic rationale for flood mitigation project.

1.4 Scope of Studies

The study on Estimation of Flash Flood Properties Damage by Using GIS Spatial Analysis is to be completed within the time frame given which is approximately 2 semesters. The scope of for first semester is to get familiarize with the GIS software and also data collection for the database.

This study is more related and focused to water resources. Basically, the main role of the first part of this project, are the data gathering and the hydraulic simulation with hydraulic and hydrology simulation software such as XP-SWMM, InfoWorks, and etc in order to get the design of flood. But, according to the time limit, data of the design flood is requested from Jurutera Perunding Zaaba (JPZ) Sdn. Bhd.

Database of the properties damage is the main job scope for this project as well as the map collection for the study area. All the maps and database are integrated together in the GIS software in order to conduct the analysis. The outcome of the analysis is used to estimate the losses with the projected flood design.

CHAPTER 2

LITERATURE REVIEW

2.1 Geographical Information System (GIS)

GIS give a wide framework where different discipline and topic can be accommodating into one database. The specific application play an important role in adapting different type of GIS tool and in many instance provide the basis for unification of these system. GIS can act like central information hub. Figure 1 shows the architecture of GIS Spatial Analysis.

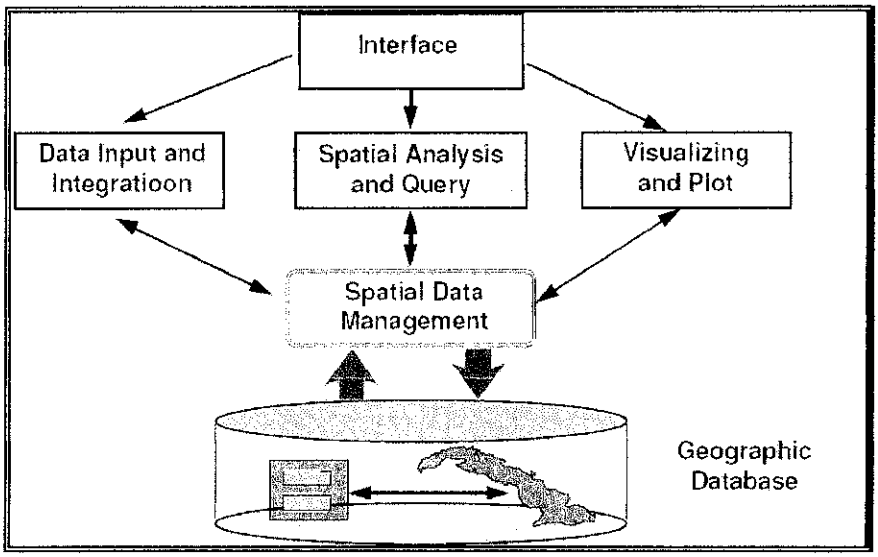

Figure 1: Architecture of GIS

In general we can say that a GIS has the following components[4]:

- User interface;
- Data input and integration;
- Graph and image processing functions;
- Visualization and plotting;
- Data storage and retrieval (organized in the form of a geographic database).

[4] Spatial Analysis and GIS: A Primer

GIS actually can organize geographic data in the map, chart or table form to visualize spatial pattern in order to stimulate visual thinking. Some more, GIS can query geographic point of interest and associates attributes to answer the question, "what and where?". GIS also can provide new information by building geographic theme from older layers. Finally, GIS also can track pattern in space and time to aid in the function of analysis, decision making and workflow.

2.2 Flash Flood

Flash flood refer to flood that rises very quickly, occurring suddenly, within a short time (from minutes to less than 6 hours), and usually is characterized by high flow velocities. Flash floods often result from intense rainfall over a small area, usually in areas of steep terrain. Flash flooding occurs when the ground becomes saturated with water that has fallen too quickly to be absorbed. The runoff collects in low-lying areas and rapidly flows downhill.

In Malaysia, flash flood becomes common to urban area especially in Klang Valley. Flash flood is always related to urbanization. When a catchment is urbanized, development containing a high percentage of impervious surfaces such as roads, roofs, car parks, and surface paving replaced large areas of natural vegetation then result to the increases of impervious areas. Impervious areas decrease the natural occurrence of rainfall infiltration and depression storage, which increases runoff volumes. They also accelerate overland flow velocities, which reduce flow travel times. In addition, urban stormwater conveyance systems can be more hydraulically efficient than natural watercourses, which further reduce flow travel times. The consequence is a significant increase in peak discharge due to a larger runoff volume occurring over a shorter time. This increase in peak discharge for any storm means that a related high discharge occurs more frequently.

Urbanization has a greater impact on frequent storm events than on rare events. Figure 2(a) illustrates typical changes in catchment hydrology that can be expected as a result of urbanization. This figure shows that the post-development hydrograph differs from the pre-development hydrograph in three important ways; firstly, the total runoff volume is greater, secondly, the runoff occurs more rapidly, and thirdly,

the peak discharge is greater. After the urban development, a given rainstorm may produce 2 to 10 times higher peak discharge than before (Roesner, 1999). As such, the overall effect is that the flow frequency curve for a developed area is significantly higher than for an undeveloped area as shown in Figure 2(b)[5].

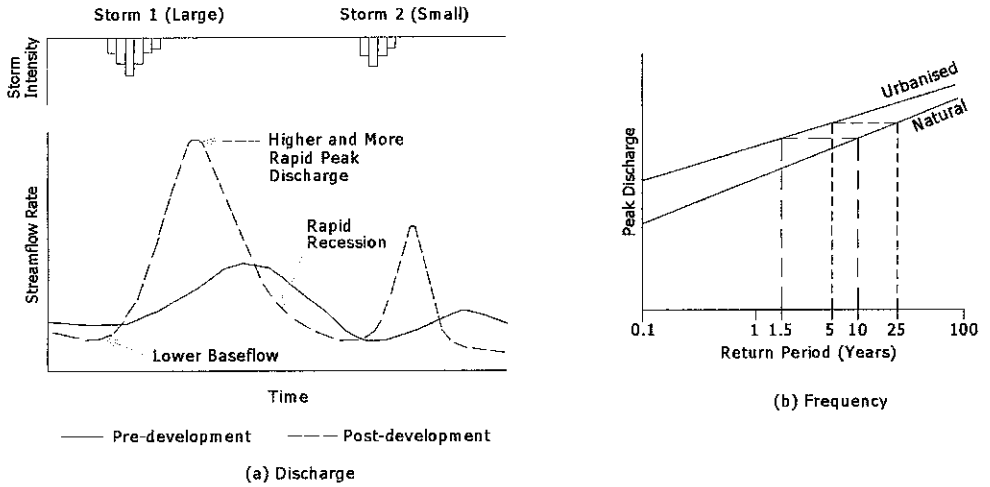

Figure 2: Impact of Urbanisation on Streamflow Quantity

(Source: Manual Saliran Mesra Alam, DID Malaysia)

2.3 Flood in Klang Valley

Flash flood in Klang Valley can be happened in every time especially in a period of intermonsoon which is on April, Mei, September and October[6]. The rapid urbanization and industrial growth in the Klang Valley has resulted in increased pressure occurrence of flooding causing damage to property, disruption of services and general inconvenience to the Klang Valley population.

Flooding in the Klang Valley is mainly attributed to thunderstorms and depression-type monsoon storms. Depression-type monsoon rains are generally low in intensity, long duration and are wide spreads over the whole catchment causing the rivers to overflow their banks, such as the event that contributed to the largest recorded flood in 1971 in the Klang Valley. Thunderstorms, on the other hand, occur more frequently, are short in duration with high intensity rainfall giving rise to flash flood as a result of the inability of localized drainage systems to cope with the high flows[7].

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[5] JPS Malaysia. (2000) Environmental Processes. In: *Manual Saliran Mesra Alam (MASMA)*. 2-9.

[6] http://www.water.gov.my

[7] See footnote 3

2.4 Flood in Sg. Damansara Catchment on 26th February 2006

An unusually heavy rainfall occurred on the 26th Feb 2006 over Klang Valley, Perak, Melaka and Johor arising from the convergence of winds from the South China Sea and the Indian Ocean at the Strait of Malacca. Based on the rainfall data from the rainfall station at TTDI Jaya, the rain began at about 3am on the 26 February 2006 and continued right up to about 6am. The rain appeared to be slightly heavy at the eastern part of the catchment which recorded a maximum intensity of 132.9mm/hour. At 7am a total of 118mm rain was recorded at The Subang Station. Based on a frequency analysis by Jurutera Perunding Zaaba Sdn. Bhd, the annual recurrence interval of the rain event is estimated at 8 years.

As a result of the heavy rainfall, water level in Sg Da,mansara at TTDI Jaya quickly rose to the danger level (7.30m) at about 4 am. The highest water level recorded at TTDI is 8.71 at around 6 am. From the analysis conducted it can be seen that water level rose very quickly within about 2 hours but it took about 18 hours for the flood to recede.

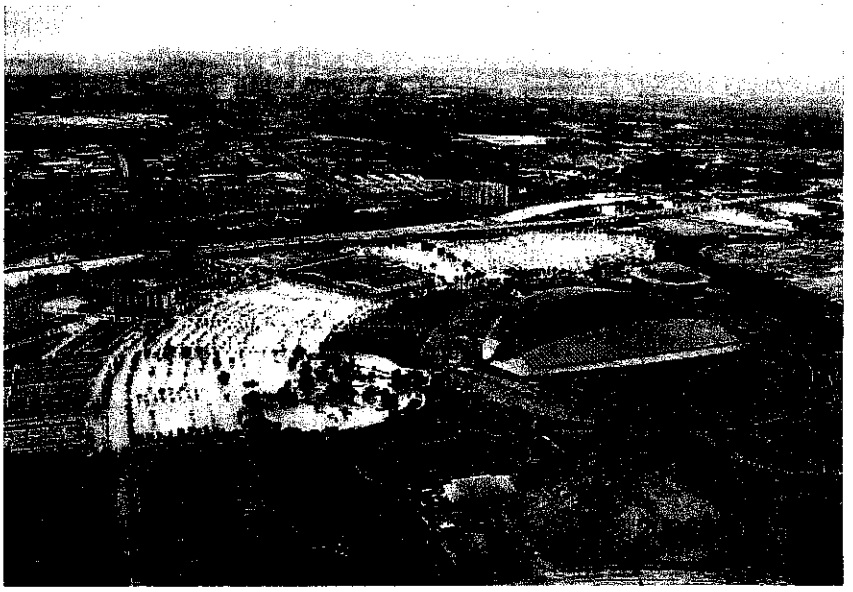


Figure 3: Flooded Area near to Shah Alam Stadium

It should be noted that at about the same time, rainstorm was also observed at the upstream of Sg. Klang. The resulting flood discharge travelling downstream along Sg. Klang is represented by the water level at Puchong Drop. It takes around 3.5 hours to travel the peak from Puchong drop to the confluence at Taman Sri Muda. The combined effect of flooding from Sg. Klang and Sg. Damansara can also be

seen at the confluence of both the river at Taman Sri Muda where the peak of the flood water was recorded at around 10: 30 am.

Tidal records at station Bandar Klang shows that the tidal peak 1.88 m was reached at around 5.00 am and remain quite high for sometime without going to its normal low tide level and had another peak at around 6:00 pm which finally subsided to its normal low tide of around -0.72 m at early hours (12:15 am) of 27th February.

From the above, it is quite clear that the high water levels at Sg.Klang arising from upstream floods and high tide conspired to hinder the discharge of the Sg. Damansara Flood water. There is also a likelihood of backwater effect from the massive floodwater of Sg. Klang that flowed upstream into Sg. Damansara to contribute towards the flooding of the areas along Sg. Damansara up to TDDI Jaya. It also appears that Sg Batu Tiga is similarly affected by the backwater and caused flooding at the railway station and the surrounding areas[8].

2.5 Recent Flood Damages at Study Area

Kg. Melayu Subang and Taman Subang Jaya, is located at the upstream of Sg. Damansara catchment, which is near to the Subang Airport. Since, it is situated at the outlet of Sungai Pelampas and Sungai Pelumut as shown in Figure 4, it covers a very large amount of total runoff that contributed to the area. Details about the catchment properties can be seen in Table 1.

[8] Jurutera Perunding Zaaba Sdn. Bhd. (2007) - Preparation of Flood Mitigation Master Plan for Sungai Damansara Catchment – Interim Report No. 1 (Chapter 7)

Figure 4: Satelite Photo Study Area

Source: GoogleEarth

Table 1: River Catchment that contributed to the flood at Kg. Melayu Subang

Name of the River	Length (km)	Catchment Area (sq.km2)
Sg. Pelampas	9.00	21.17
Sg. Pelumut	5.50	7.99

Kg. Melayu Subang is selected as study area because it is one of the most severe floods happen on 26th February 2006 (Figure 4) event except TTDI Jaya. Besides that, it also experienced 4 major floods events since 2002 to 2006 that is recorded as shown in Table 2.

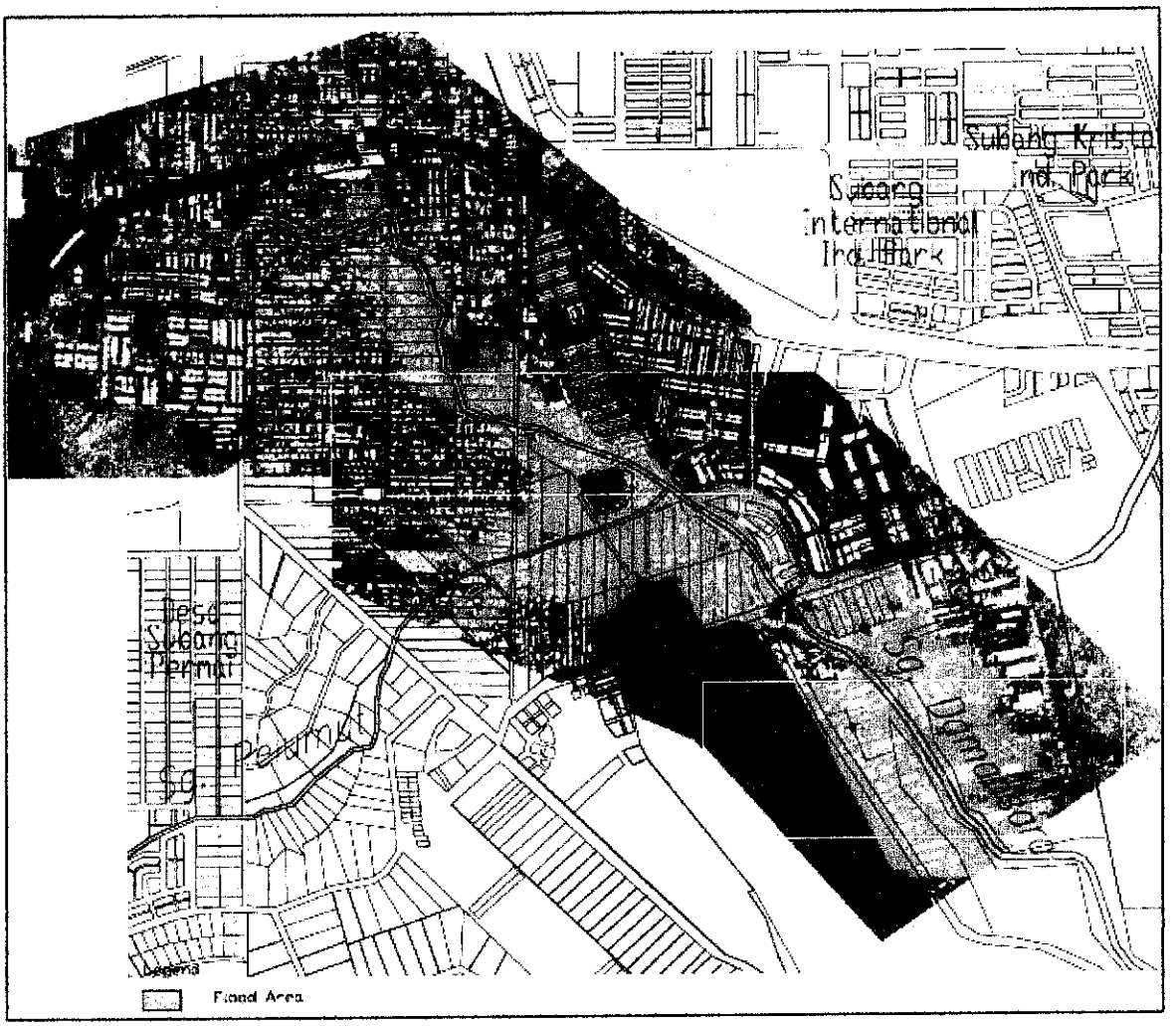


Figure 5: Flood on 26th February 2006 at study area

Source: Figure 7-8, Jurutera Perunding Zaaba Sdn. Bhd. (2007) - Preparation of Flood Mitigation Master Plan for Sungai Damansara Catchment – Interim Report No. 1, 63

Table 2: Major Flood Events Related to Kampung Melayu Subang from 2002 - 2006

Flood Date	Rainfall Depth	Remark
26th Feb 2006	104mm	Heavy rain started around 3:00 am and continued for 3 hours almost over half of the catchment. Water level raised up to 4.8 m in TTDI Jaya and submerged the surrounding areas for about more than 10 hours. Also affected areas were causing **Kg. Melayu Subang**, Batu Tiga, NKVE, Kg. Kebun Bunga, Shah Alam Stadium, Giant, Makro, Subang Permai, Subang Perdana, Federal Highway, etc.
26th Oct 2005	88mm	Flood affected areas were Tmn TTDI Jaya and Kg. Kebun Bunga. 88 mm rainfall was recorded at **Kg. Melayu Subang**
28th May 2004	95mm	Kg. Cempaka was flooded
31st Oct 2003	89mm	Taman Mesra, Balai Poli Bt3 and Federal Highway were heavily flooded due to heavy rainfall as well as tidal impact from Sg. Klang
6th Oct 2002	N/A	Flooded area comprises **Kg.Melayu Subang** Ihsan, Sg. Cempaka, Upstream part of Bridge at Jalan SS 25/23, Taman Mesra, Pekan Batu 3 Lama, Kg.Kebun Bunga and Jalan Jubli Perak.
1st Sept 2002	N/A	**Kg.Melayu Subang** Ihsan was flooded

Source: JPZ (2007) Preparation of Flood Mitigation Master Plan for Sungai Damansara Catchment Interim Report No. 1

Flood on 26th Feb 2006 recorded total estimates losses about RM 34,542,800[9]. At Kg. Melayu Subang, there were 76 families that contains 416 peoples need to be relocated at Kg. Melayu Subang hall as relocation centre. There are also 163 of household damage affected by the flood[10]. The average estimated damage of each family is as follows.

a. Kampung families/households: RM 2,800 per family
b. Non-kampung familes/households (apartments/flats): RM 5,000 per family
c. Non-kampung familes/households (houses): RM 20,000 per family

The cost of damage is expected to be relatively higher because the households are likely to own more costly motor vehicles and consumer durables.

[9] Refer footnote no. 2

[10] Jabatan Kebajikan Masyarakat.

2.6 Properties Damage

The most basic division of flood damages is into tangible and intangible damage categories. Figure 3 illustrates the various damage types commonly estimated/assessed in flood studies and their inter-relationships.

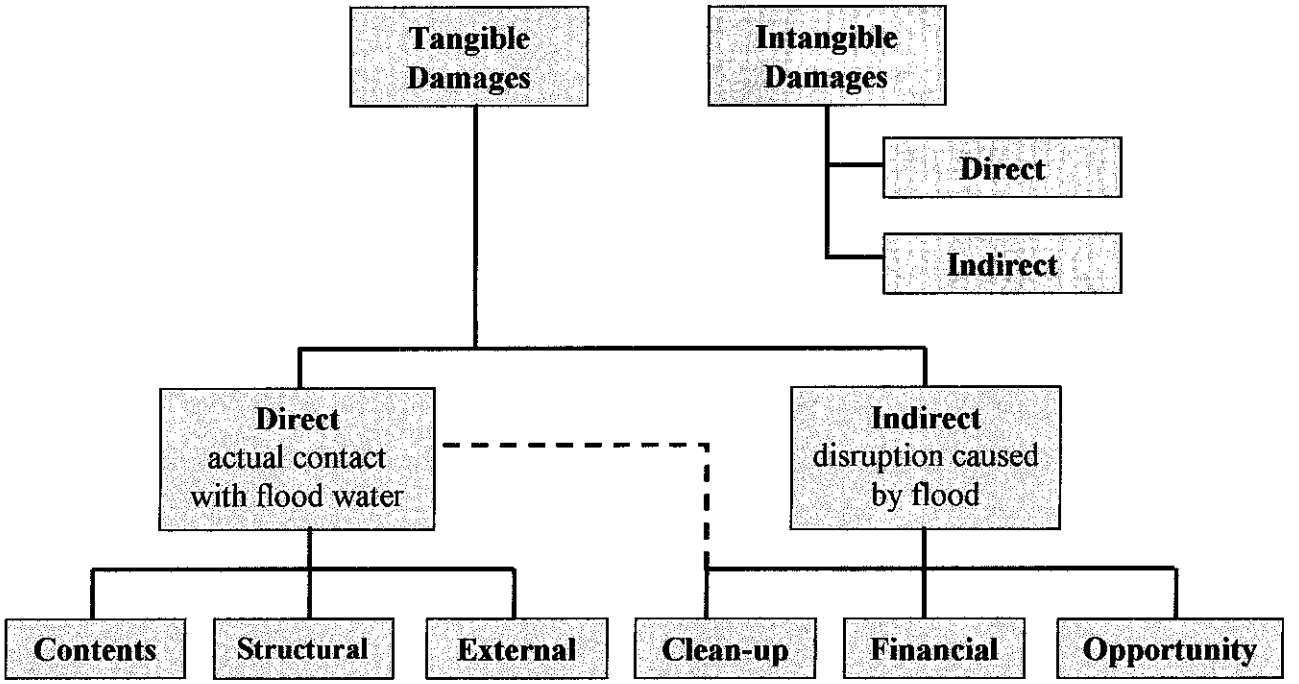


Figure 6: Types of Flood Damage

Tangible damages are readily measured in monetary terms. Tangible damages include, among others, the damage or costs caused by floodwaters wetting goods and possessions and damage to roads and other infrastructures, the loss of commercial income, the loss of production in industrial concerns (direct tangible damages) and the loss of wages and extra outlays incurred during clean-up operations and in the post-flood recovery period (indirect tangible damages).

Intangible damages include damage to the environment and the increased levels of emotional stress and mental and physical illness caused by a flood, such as large financial outlays to replace flood damaged possessions or possibly having to find new means of earning a living.

It is difficult to quantify intangible damages in financial terms, however intangible damage are real and represent a significant cost to flood affected persons and the community. It is possible to dimension the problem, approximately, by estimating

how many flood-affected people may require additional medical treatment for depression or the ecological cost of the loss of a local environmental feature.

2.6.1 Actual and Potential Damages[11]

Flood damages can be divided into actual and potential damages. Actual damages refers to damages caused by an actual flood and are calculated directly through valuations of property lost, the cost required to repair and property and the costs met in satisfying the indirect costs associated with a flood. Potential damages are the maximum damages could eventuate should a flood occur. In assessing potential damages, it is initially assumed that no actions are taken by the flood-population before or during the flood to reduce damage, such as lifting or shifting items to flood free locations, and moving motor vehicles.

This study "Impact of Flash Flood to the Propertied Damages by Using GIS Spatial Analysis" is to determine the potential damages based on flood design with respected ARI (Annual Recurrence Interval) simulated by Hydrology and Hydraulic simulation software.

2.6.1.1 Actual Damages

There are two basic steps associated with an actual flood damage survey. The first step involves identifying every property that was flooded by floodwaters and recording the depth of flood or the level to which floodwaters rose. The second step involves recording in detail, the extent damage, to building and properties.

In the second step, the more detailed data collection is conducted a few weeks after the first data collection. Preliminary analysis of the initial data may be useful before the second survey, allowing the targeting of particular data in the second step.

[11]KTA Tenaga Sdn. Bhd. (2003) Flood Damage Assessment of 26 April 2001 Flooding Affecting The Klang Valley and the generalized procedures and guideline for assessment of flood damages – Draft Final Report pg. 6-11

Actual damages surveys are made difficult by the fact that, at the time of the survey, many flood-affected occupants are still dazed by the flood episode and confused as the contents of dwellings and work areas. Further, many items have to be identified and their value established, sight unseen. In these circumstances, the survey form needs to contain a detailed list of items likely to occur in each area. The person conducting the survey then leads the occupant through this list to ascertain the flood contents of the area and an indication of their value.

Basic flood damage data to be collected from urban areas relates to the number and type of flooded properties and depths of flooding within buildings and across grounds. Each property that is covered, either fully or partially, by floodwaters needs to be included in the survey, irrespective of whether or not buildings are flooded above floor level.

Some data need to be assessed subjectively, such as building size, which can be determined on a comparative basis. For example, an inspection of house sizes will provide broad guidelines for "small", "medium" and "large" dwellings. Similarly, house style will provide a reasonable guide to building age and economic range (the wealthier the property, the greater the damages, assuming similar levels of flooding for all buildings).

Commercial properties may also be assessed by size and type, once a valuation has been made of likely contents and size of operations. However, the initial assessment needs to be as detailed as possible so that there is confidence in the applicability of the size/type and value relationship. Industrial properties must, however, be assessed individually as the variations in value are not dependent on size.

2.6.1.2 Potential Damages

Studies to determine potential flood damages either can be done at area that always affected by flood or to the area that has not experienced any flood. The potential damages are based on the worst flood that may occur by referring to some flood design simulation. Some surveys have to be conducted where sample representative properties are first identified and then damages to these properties are determined.

In conducting the survey, the valuer estimates damage on an item-by-item basis for each room of selected types of buildings. This is typically done for three or four possible flood depths (typically about 5cm, 0.5m, 1.0m and 2.0m above the flood level). For this study, the student will use the flood designed by ARI (20 years, 50 years and 100 years). The damage estimates are made on the basis that no furniture and/or fitting in the house are shifted should a flood occur.

To determine the flood damage over a specific area, it is necessary to know the number of flooded properties, the type of flooded properties and the depth of flooding above floor level. The number of flooded properties can be determined from flood studies, flood maps, aerial photographs or from a street-by-street inspection. It is generally very difficult to discriminate property types or floor levels from aerial photographs. Knowledge of flood levels and floor levels throughout the flooded area will enable flood depths over the floor to be calculated for each building.

Floor level data may be estimated from building plans (if available), by measuring floor height above ground level or by estimation based in contour maps. The appropriate stage-damage curve allows the damage to be estimated for each property. A computer model or a spreadsheet is typically used to combine all these data and estimate the flood damage for different flood levels up to and including the PMF (Probable Maximum Flood).

2.7 Methods of Conducting Properties Damage Estimation[12]

There are several methods of assessment to conduct the potential flood damage which was applied internationally and Malaysian practice;

[12] KTA Tenaga Sdn. Bhd. (2003) Flood Damage Assessment of 26 April 2001 Flooding Affecting The Klang Valley and the generalized procedures and guideline for assessment of flood damages – Draft Final Report pg. 14-18

2.7.1 International Procedure

2.7.1.1 Actual Damages

The majority of published information on damages collection and analysis comes from the United States, the United Kingdom and Australia. All literature examined indicates that the collection of actual damages is approached consistently across nations and follows the approach adopted in flood damages assessment. The approach is

i. Identify areas affected by flooding during the event (or events) being assessed
ii. Record the depth of flood or the level to which floodwaters rose; and
iii. Record, in detail, the extent of damage for all of the building and properties involved, accounting for all items damaged.

The total damages recorded are the actual damages for that particular flood only. These damages cannot be applied to any other flood as actual damages but they can be used as an indicative value for future floods of a similar nature.

2.7.1.2 Potential Damage

Internationally, the practice for determining potential damage is very consistent and is based on the property data collection and the estimation of ground and floor levels and the estimation of damages through the application of Stage/Damage curves to each property in the affected area. The procedures adopted in all methods use information from a detailed site survey of all residential, commercial and industrial building located on land that exposed to the flood waters up to a probable maximum flood.

2.7.1.3 Flood Damage Survey

In international approach, either actual or potential damages, flood damage survey is an integral component of flood studies for all areas affected by flooding. Such damages studies not only assist in providing the economic rationale for flood mitigation project. It is recommended that Malaysia should adopt this approach when addressing flood related project.

2.7.2 Malaysian Approach

Essentially, the wide range of flood circumstances and conditions in Malaysia may make a detailed flood damages assessment approach for each location time consuming and economically unviable. Accordingly, a Two-tier National Approach is recommended. These two tiers can be described as:

2.7.2.1 Rapid Assessment Method (RAM)

RAM involves a limited amount of work to provide first level approximation of the flood damages in a particular study area. RAM can be:

i. Quick, once the practitioner has experience with the process;
ii. Easy' provided there is sufficient information to work through;
iii. Desk based, with only one inspection of the study area usually required; and
iv. A preliminary step in determining the need for the application of the Detailed Assessment.

2.7.2.2 Detailed Assessment Method.

This method is actually follows the same procedures as an actual damage study generally that without having the actual flood levels and actual flood damages.

2.7.3 Factors considered in estimation of flood damages[13].

There are several factors to be considered in estimating the flood damage which are:

a. The frequency (or probability) of occurrence;
b. The number of properties at risk (as per above);
c. The depth of water in various areas;
d. The velocity of flows, particularly the identification of floodway areas;
e. Warning time, both actual and effective; and
f. The community's flood awareness.

[13] Refer footnote 3

CHAPTER 3

METHODOLOGY

This study was based on the research and development approach which some method of flood assessment had been studied and another method of flood assessment and prediction of looses by using GIS tools try to be proposed. A number of steps are taken to carry out this project in order to complete while some HSE (Health, Safety and Environment) procedures which is ergonomics seating be considered. The project flow can be viewed in figure below.

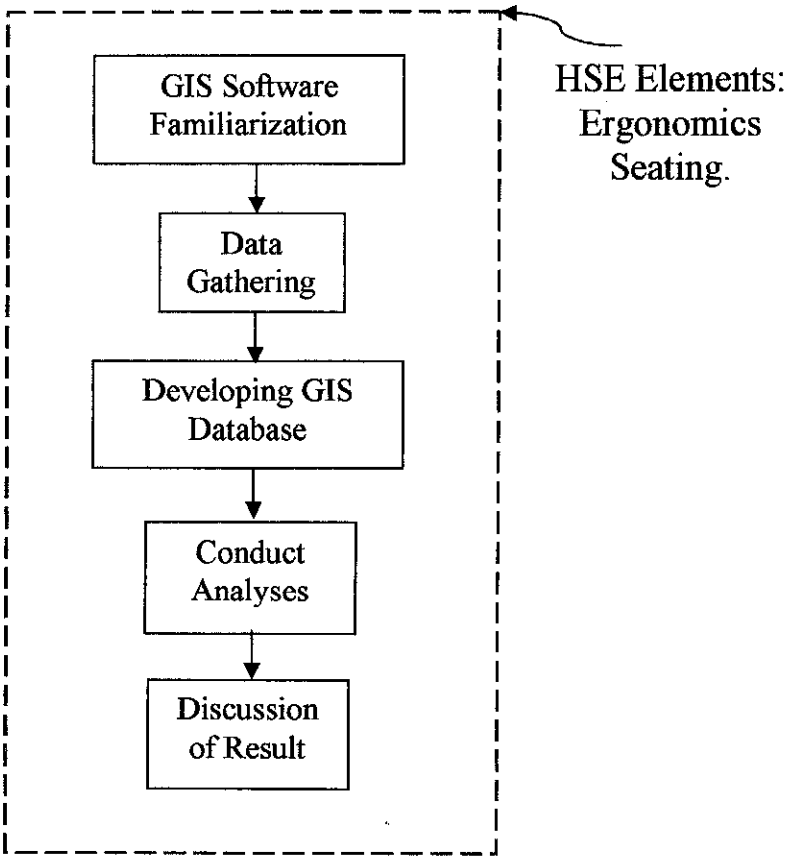


Figure 7: Project's Flow (Methodology)

Details of the project flow will be further discussed later in this chapter.

The input parameters for the flood damage estimation applied in this study are predicted flood output from 3rd party software, topographical map of the study area, estimated cost of personal belonging in every house, estimated cost of office facilities and residential area map. And the GIS spatial analysis features of overlaying and intersection were utilized to perform the flood damage estimation. The process flow of the flood damage estimation is also shown in Figure 8.

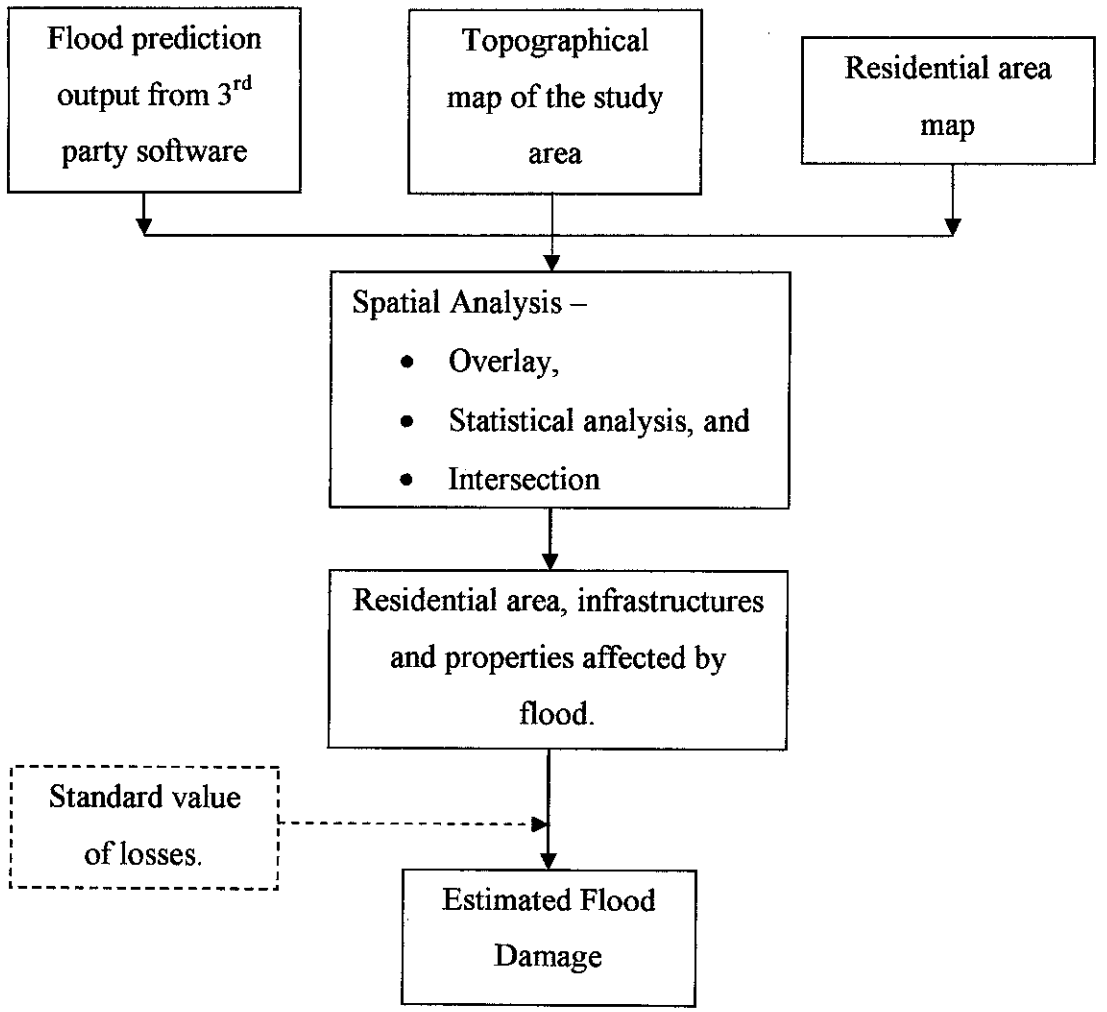


Figure 8: The process flow of the flood damage estimation

3.1 GIS Software Familiarization

Geographical Information System is quite new. As this subject matter was in no way taught in Civil Engineering programme, an initiative taken in order to familiarize with the software. Several books, paperwork, and manual were reviewed in order to acquire some ideas on how to run the software.

ArcGIS Desktop by ESRI was been using to carry out this studies. GIS analysis encompasses a wide variety of operations that you can do with a geographic information system. These range from simple display of features to complex, multistep analytical models. The operations are conducted are:

i. Showing the geographic distribution of data
ii. Querying GIS data
iii. Identifying what is nearby
iv. Overlaying different layers
v. Doing a complex analysis

Overlaying different layers had been identified as techniques to be applied in doing the analyses.

3.2 Data Gathering

All the geospatial data and it attributes has to gather in one database. The database will consist of two main groups of data which is maps and value of properties. This can be concluded in Table 1 and Table 2:

Table 3: Table of Data Map

Item	Data Map	Format	Remark
1	Map of House and Building of Study Area	AutoCAD	Appendix 7.2
2	Topographic Map of Study Area	JPEG Image	Appendix 7.3
3	Satellite Image of Study Area	JPEG Image	Appendix 7.4
4	Map of Design Flood	JPEG Image	Appendix 7.5

Table 4: Value of Properties

Item	Value of Properties	Remark
1	Houses and Building Properties	Table 5
2	Cost of Repairing Road	Table 6
3	Damage Rate with Flood Depth	Table 7
4	Repair Cost for Cars and Motorcycles	Table 8

Table 5: Houses and Building Properties

Item	Properties	Value / Cost (RM)		
		Kampung House	2-Storey Terrace	Apartments
1	Cleaning Up	484.00	1,539.00	1,263.00
2	Related Medical Expenses	115.00	300.00	-
3	External House Repairs & Replacements	742.00	2,761.00	1,375.00
4	Furniture and Related Items	2,015.00	4,675.00	1,350.00
5	Kitchen & Related Accessories	737.00	2,131.00	681.00
6	Electrical Items & Accessories	3,081.00	4,728.00	803.00
	Total	**7,174.00**	**16,134.00**	**5,472.00**

Source: Sg. Damansara Flood Impact Survey, 2007

Table 6: Cost of Repairing Road

Item	Repair Method	Cost (RM/km)		
		Residential Road	Normal Road	Highway
1	Resurface	200000	300000	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 7: 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

Table 8: Repair Cost for Cars and Motorcycles

Car / Motocycle	Estimated Repair Cost (RM)	
	Car	Motorcylce
Small	2,500.00	200.00
Medium	5,000.00	250.00
Luxury / Large	12,500.00	500.00

Source: KTA Tenaga Sdn. Bhd. "Flood Assesment of 26 April 2001 Flooding Affecting The Klang Valley and Generalised Procedures and Guide Lines for Assessment of Flood Damages"

3.3 Developing GIS Database

All the data gathered will be keyed in to GIS Software and will arrange properly. Tables of attributes are also to be input into layers. All the layers are layered together in the software. As all the maps were drawn in AutoCAD, the CAD file format has to be converted to the shapefile format as required in GIS. Figure 1 shows the map layout in the software.

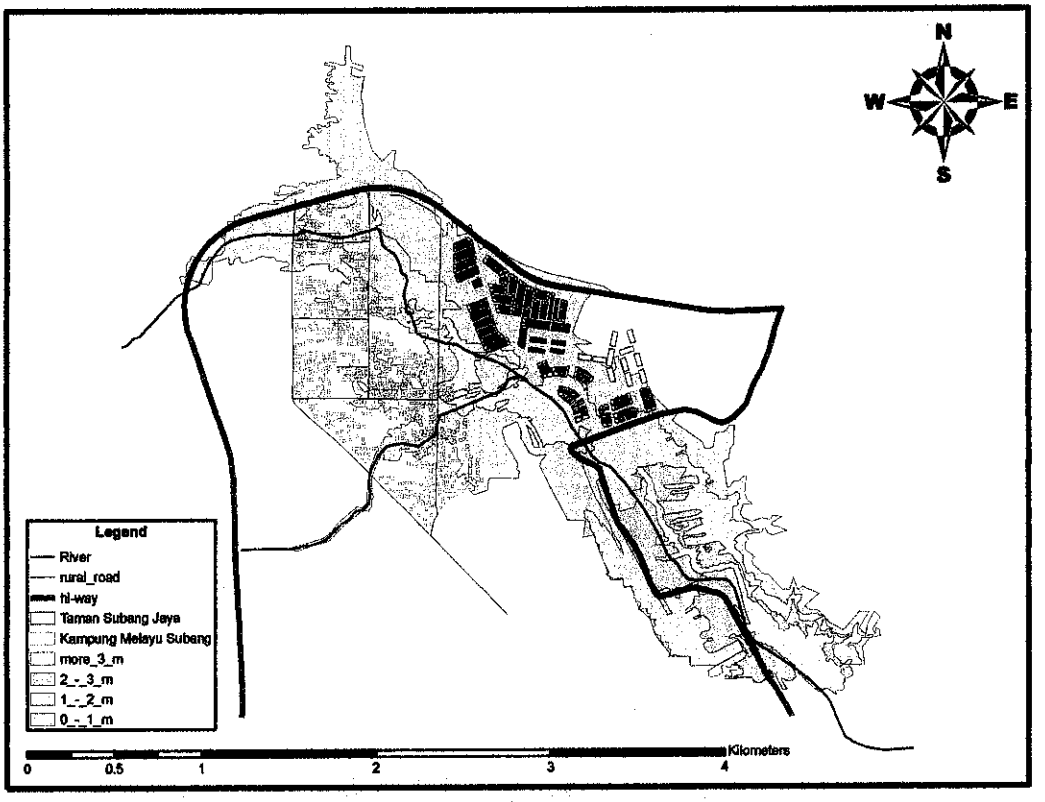


Figure 9: Map Layout

Jurutera Perunding Zaaba Sdn. Bhd. has provided map of design flood 100 years ARI. It will be easier to construct the GIS application because the hydrodynamic analysis that will take more time to complete the research no need to be done. However, another map of design flood needs to be drawn as advised by the consultant. The map also has to be interpolated so that there are various flood maps with 20 years and 50 years ARI.

Basically, to do the flood damage assessment to the study area, the required item that to be had is DTM (Digital Terrain Model) of the study area in order to establish the elevation of the ground surface. So, there are some assumptions has to be made in order to complete the study.

3.3.1 Assumptions Made

It is very difficult to estimate flood damage since there are many things to be consider as discussed in section 2.7.3. Because of that, as been advised and discussed with Ir. Hj. Zalin Amir (Managing Director of JPZ) and also with student's supervisor, Assoc. Prof. Dr. Abdul Nasir Matori, assumption made that the study area as a flat level. It would be easier to do the analysis as the factors to be considered reduced.

Besides, numbers of vehicles had been put randomly into each house/building since there was no real data to each house and properties.

3.3.2 Converting AutoCAD .dwg file into GIS shapefiles.

Early stage of completing the project, some minor problem had been faced which is unable to import and convert AutoCAD file into GIS. The problem finally rectified. A very useful article from internet named: *CAD to GIS, A Step by Step Guide to Converting .dwg CAD files to GIS shapefiles.* It really helps to complete the work.

The following flow chart illustrates the methodology used in this step-by-step guide.

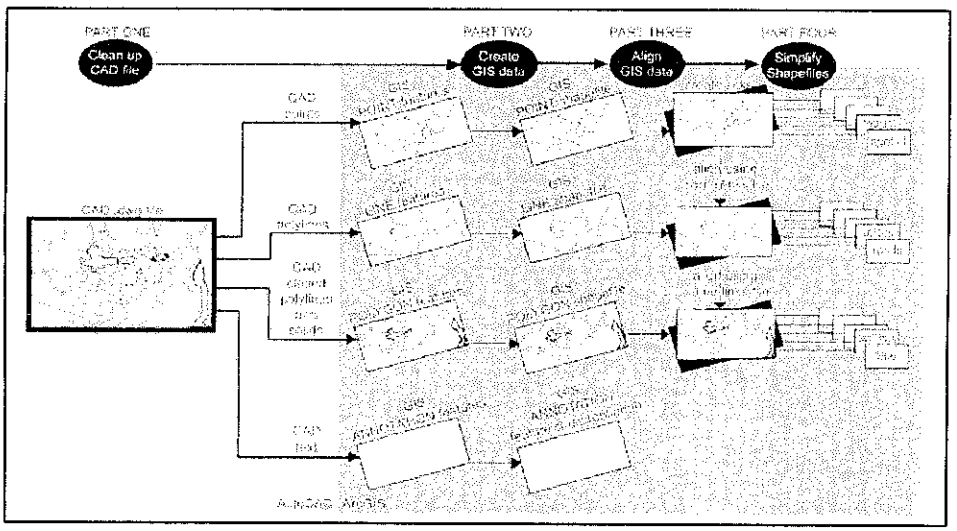


Figure 10: The step-by-step guideline to convert .dwg to shapefile.

3.3.3 Defining the Projection

All the maps gathered in the GIS database must have their reference coordinate in order to make the analysis easier. If the map has no projection such as UTM NAD83, the analysis cannot be done, specific measurement and calculation cannot be made. The coordinate system: WGS_1984_UTM_Zone_60N is decided as a referenced coordinate.

As written in National Park Service GIS - CAD to GIS, A Step by Step Guide to Converting .dwg CAD files to GIS shapefiles, there are certain procedure to project the map in GIS. These are the steps:

To define a shapefile's coordinate system;

a. Open ArcToolbox and select the Define Projection Wizard (under Data Management Tools -> Projection) for shapefiles. Follow the directions of the Wizard to define the coordinate system interactively.
b. Select the projection and specify its parameters.
c. Browse to the input shapefile.
d. Enter in the original coordinate system the CAD drawing was created in.
e. Next, use the Project Wizard to reproject the shapefile from its current coordinate system to UTM NAD83
f. If you have no knowledge of the CAD drawings coordinate system, choose UTM NAD83 and spatially adjust the shapefile.

3.3.4 Layering

All the maps that converted into shapefile were arranged into layers that will ease to conduct the analysis. There were two arrangements of layers which are arrangement to the various ARI and arrangement based on the flood depth of 100 years ARI. The arrangement of layers of ARI and flood depth can be seen in the next page, Figure 10 and Figure 11 respectively.

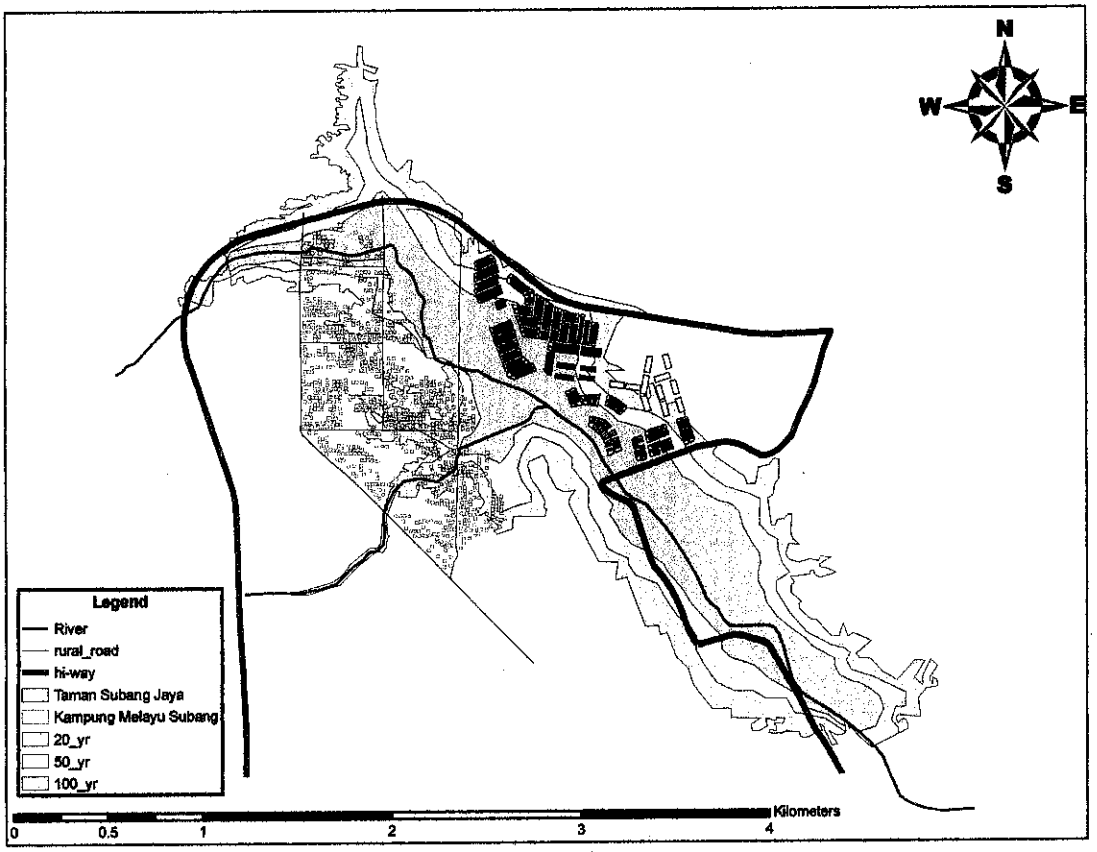


Figure 11: Arrangement of Layers (Flood Map based on ARI)

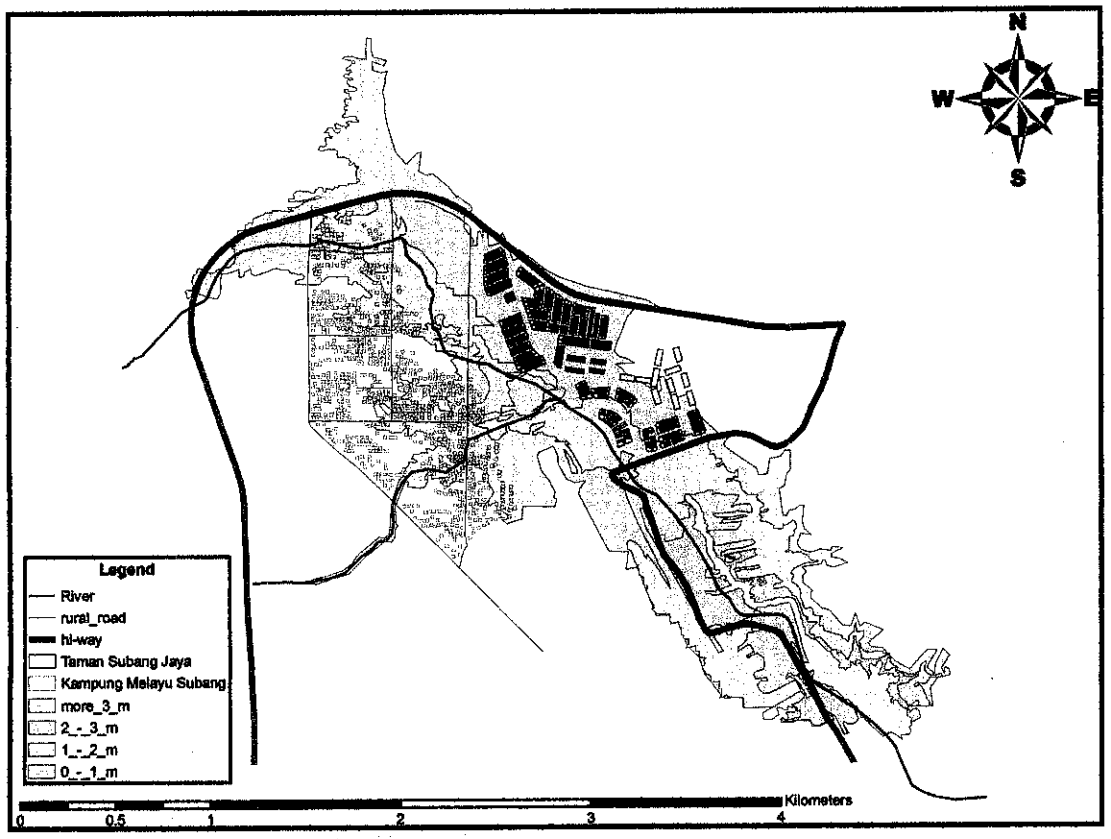


Figure 12: Arrangement of Layers (Flood Map based on Flood Depth)

3.4 Conduct Analyses

ArcGIS were provided a very much tools to run the analysis. There were many options to determine the value of losses and damages by using GIS. However, the Intersect option in Analysis Tools of ArcToolbox, and selection by attribute to determine houses affected by flood has decided to be used. Table 9 shows the procedures conducted during analysis phases.

Table 9: Analysis Conducted

Item	Tools	Analysis Conducted	Remark
1	Selection by location	1. Houses and building affected by flood 2. Vehicles affected by flood	Figure 12
2	Intersect	1. Region affected by flood 2. Roads affected by flood	Figure 13
3	Calculate areas	1. Total area being affected by flood	Figure 14

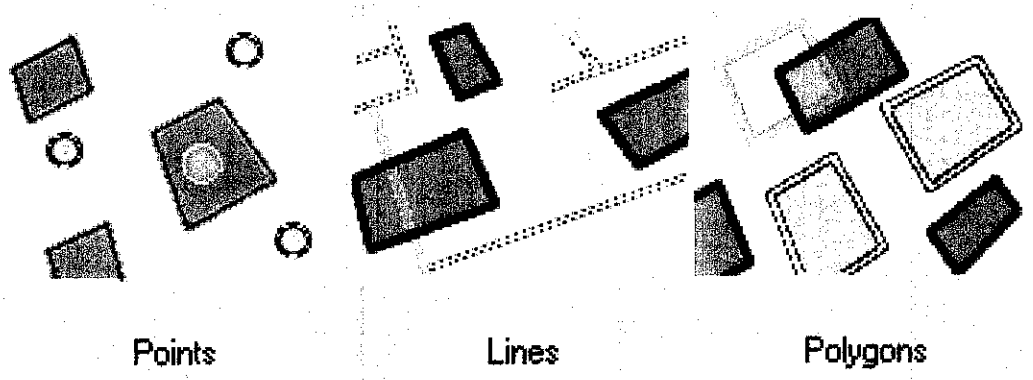


Figure 13: Selection by Location

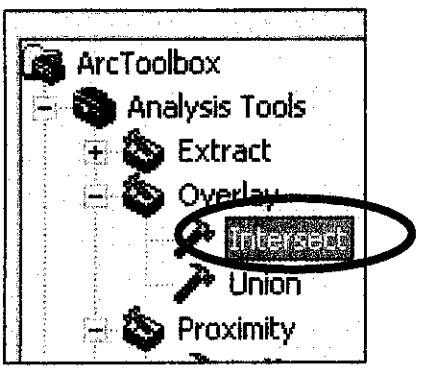


Figure 15: Intersect Tool

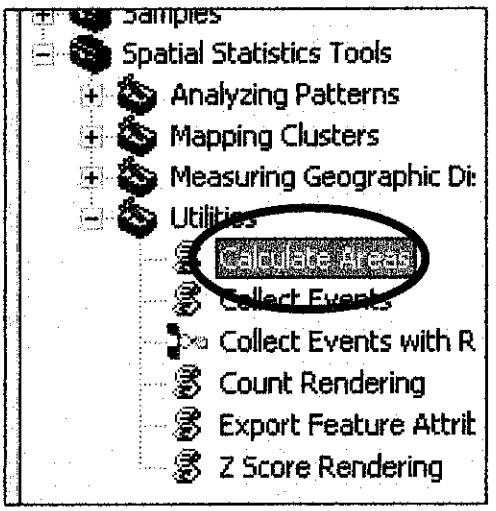


Figure 14: Area Calculation Tool

The procedure continues after all data determined and be keyed into spreadsheet (Microsoft Office Excel) for calculation and analysis phase. Items such as number of houses are multiplied by the values of losses that determined before this in order to obtain the losses of the properties.

Some graphs and pie chart be developed to vary the result of the analysis and to get different view of losses division.

3.5 Discussion of Results

Result of the analyses were discussed and be compared with the study that had be done by other party and report which is *"Sg. Damansara Flood Impact Survey 2007"* as a comparison of result. Discussions of the result were divided into three main groups which are:

i. Analysis by Categories
ii. Analysis of Houses Properties, and
iii. Analysis of the Total Losses

This step will further discuss in Chapter 4 of this report.

3.6 Ergonomics Seating.

As the project is conducted fully by software, the ergonomics procedures should be considered in order to avoid any injuries to the student. These below are some guidelines that can be followed.

i. Ensure that your hands, wrists, and forearms are in a row, straight, and almost parallel to the floor.
ii. Ensure that your head and torso are in-line with head slightly bent forward, facing towards the front, and balanced.
iii. Ensure that your shoulders are at ease with upper arms hanging normally at the sides of your body.
iv. Ensure that your elbows are close to your body and bent between 90 and 110 degrees.

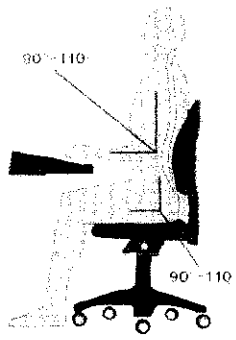


Figure 16: Ergonomic Seating- Elbow angle

v. The feet should be either supported by a footrest or should be relaxing on the floor.

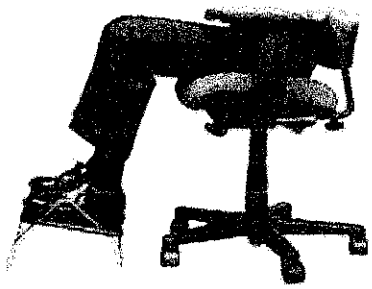


Figure 17: Ergonomic Seating - Footrest

vi. While leaning back or sitting in a vertical position, ensure that your back is supported fully with firm hold on the lumbosacral area.

vii. Your seat should be well padded in order to support your hips and thighs.

viii. Ensure that your knees and hips are in almost the same height with your feet slightly forward.

CHAPTER 4

RESULT AND DISCUSSION

This section will discuss about flood impact based on the flood with different ARI. It is because, the data of flood depth is not sufficient enough to make comparison and analysis. This chapter will discuss more about the value of the flood losses and the impact to the properties damage.

4.1 Analysis by Categories

There must be a discussion on which one of the properties is the main contribution to the flood losses. The analyses conducted have produced various data for the further discussion. The purpose of doing analysis by categories is the student can determined which part of losses can contribute more to the flood damages/losses.

4.1.1 Road

Road is one of the main contribution to the flood damage where it were exposed to flood water since almost residential drainage were located near to road.

Table 10: Losses of Road (Kg. Melayu Subang)

ARI	Length of Road Affected	Cost of Losses (RM/km)	Losses (RM)
20 Years	1.40	200000	280500.76
50 Years	2.80	200000	558680.80
100 Years	4.43	200000	886562.89

Table 11: Losses of Road (Taman Melayu Subang)

ARI	Length of Road Affected	Cost of Losses (RM/km)	Losses (RM)
20 Years	0.89	200000	178000.00
50 Years	2.20	200000	440000.00
100 Years	3.50	200000	700000.00

Table 10 and 11 is the analysis for road affected by flooded with different ARI of Kg. Melayu Subang and Taman Subang Jaya respectively. The lengths of the road were determined by method of intersect tools. The result showed that Kg. Melayu Subang contribute more losses to the flood damages for every ARI. It is because due to the flood extent to the area affected. Some more, if we see from the satellite photo, it is clear that, the total length of residential road at Kg. Melayu Subang involved in flood is longer compare to total road at Taman Subang Jaya.

The student considers that, the flood is not much to make the road to be reconstructed. Value of resurface from Table 6 of this report was taken as the factor value of losses. The total losses for road damages are RM458,500.76, RM998,680.80, and RM1,586,562.89 for 20 ARI, 50 ARI and 100 ARI respectively. The difference of losses between these two areas can clearly be shown in the figure below.

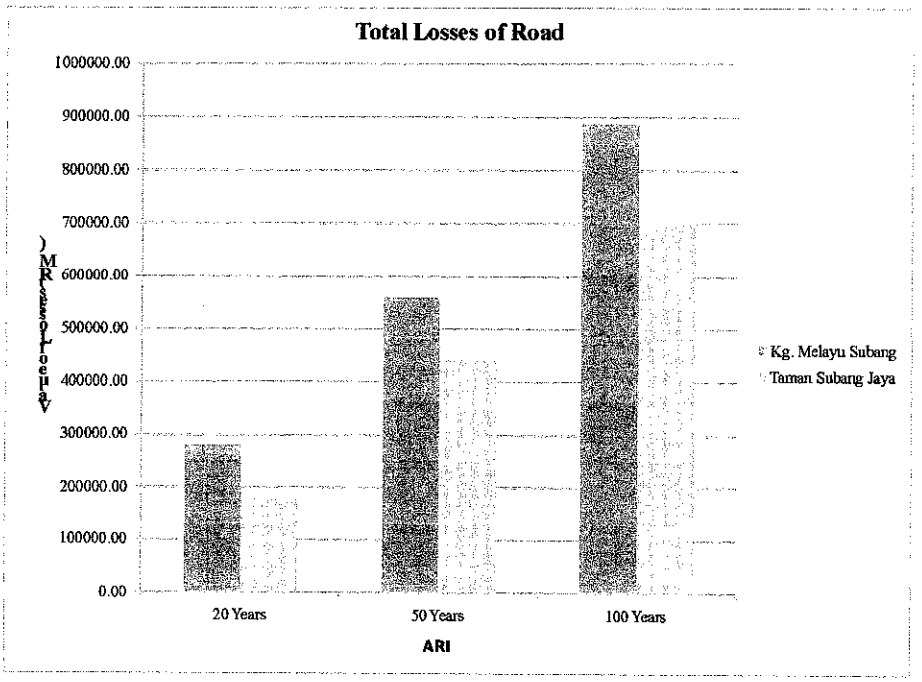


Figure 18: Total losses of road with respect to ARI

4.1.2 Houses

Based on survey conducted by Jabatan Kebajikan Masyarakat (JKM), there were 1,449 residential premises were directly affected by the flooding of Sg. Damansara in 26th February 2006. From the survey, it shows that there are 200 houses from Kg.

Melayu Subang and it is estimated that at least 880 persons (based on 4.4 persons per household) were directly impacted upon by the 2006 flood.

From the hydraulic analysis of flood design, the flood extent is wider compare to the real flood. It actually affects Taman Subang Jaya that previously not experienced flood. The student expects that the flood damage will greater compare to the flood. Table below shows number of houses and its losses based on calculation with reference of Table 5 of this report.

Table 12: Houses affected and its losses (Kg. Melayu Subang)

ARI	Houses Affected	Value of Losses (RM)	Total Losses (RM)
20 Years	250	7,174.00	1793500.00
50 Years	315	7,174.00	2259810.00
100 Years	373	7,174.00	2675902.00

Table 13: Houses affected and its losses (Taman Subang Jaya)

ARI	Type of House			Losses (RM)			Total Losses (RM)
	Single Storey	2-Storey	Shop	Single Storey	2-Storey	Shop	
20 Years	200	418	72	1434800.00	6744012.00	303048.00	8481860.00
50 Years	430	621	78	3084820.00	10019214.00	328302.00	13432336.00
100 Years	454	712	78	3256996.00	11487408.00	328302.00	15072706.00

There were 3 types of building located at Taman Subang Jaya which is Single-Storey House, 2-Storey House and Shop compare to the only Kampung House type at Kampung Melayu Subang. The student was make 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 single-storey house.

The tables above and graph (Figure 18) indicates that the more losses and damages will experience to the developed area such as Taman Subang Jaya when the flood happen. The total losses for houses/building properties damages are RM10,275,360.00, RM15,692,146.00, and RM17,748,608.00 for 20 ARI, 50 ARI and 100 ARI respectively.

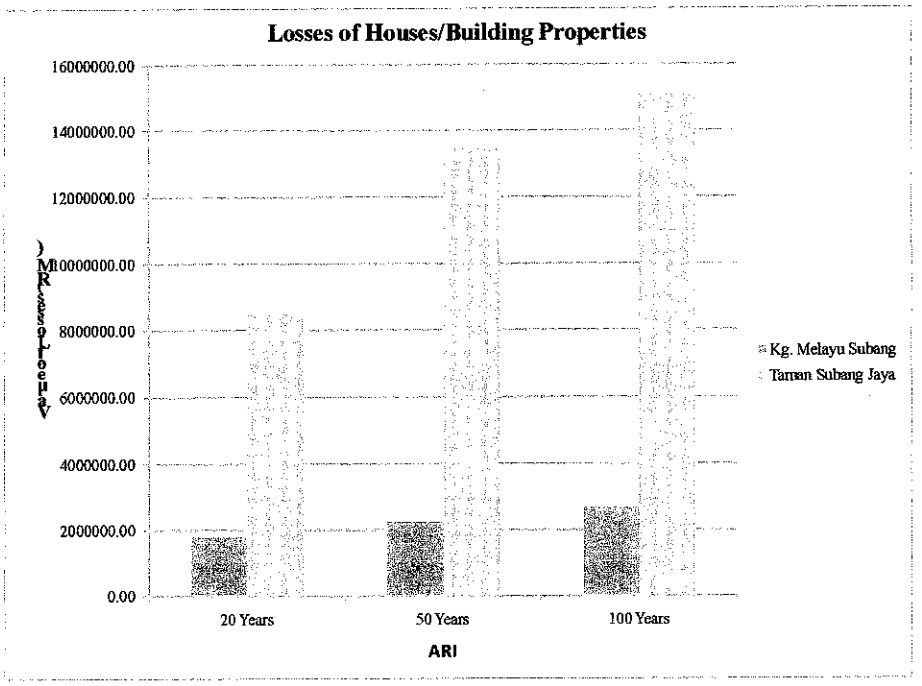


Figure 19: Total losses of house/building properties with respect to ARI

4.1.2.1 Analysis to the House Properties

Among the cost items, repair of road, repairs and replacement parts of motor vehicles, stand out as an expensive item dwellers in terrace houses and apartment buildings. This is not surprising as these groups are those in the higher income groups and would therefore own relatively expensive motorcars as opposed to those in the kampongs.

Table 5 of this report was shown the type of properties in the houses and building that might be damaged because of the flood that was based on Sg. Damansara Flood Impact Survey 2007. Basically, there is other items that be considered in the survey such as indirect losses (imputed loss in income, imputed depreciation in residential property value, and imputed loss in property values)

Figure 19 and 20 shows the losses of houses properties to the Kg. Melayu Subang and Taman Subang Jaya area and it were summarized in the Table 14. The Figure 21 will show the total of the losses for both areas with respect to flood ARI.

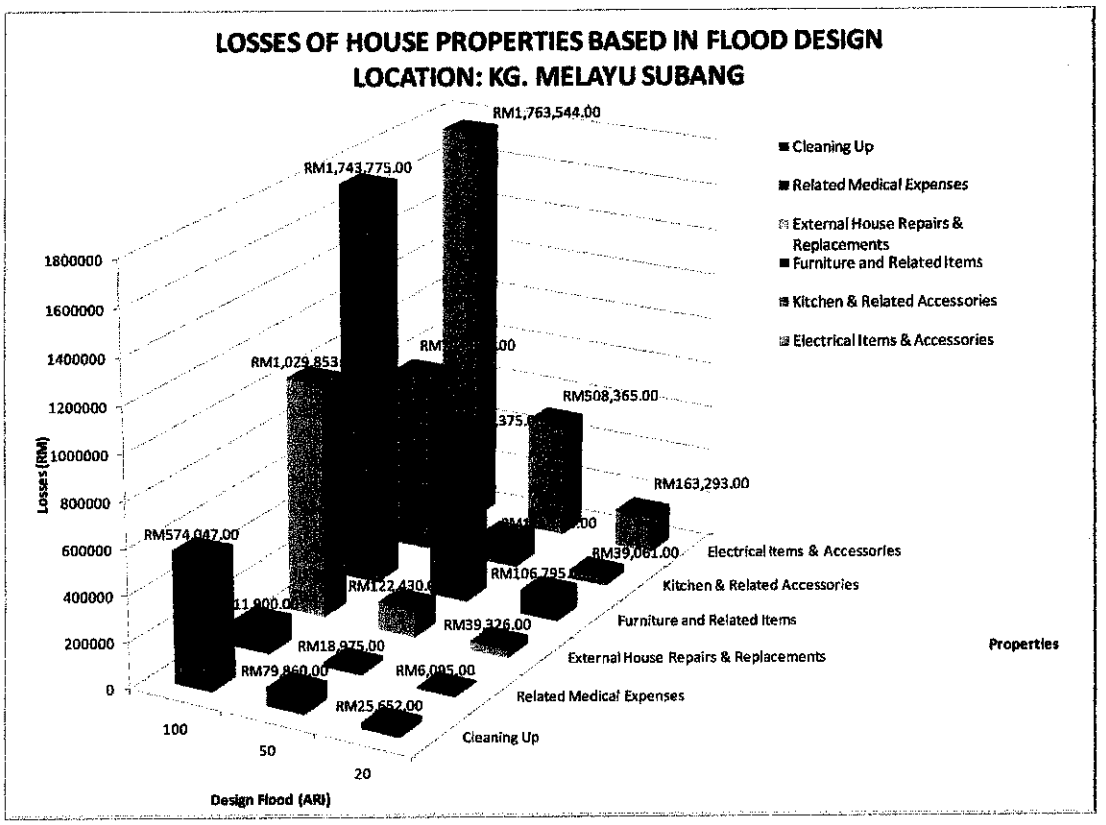


Figure 20: Losses of house/building properties with respect to ARI (Kg. Melayu Subang)

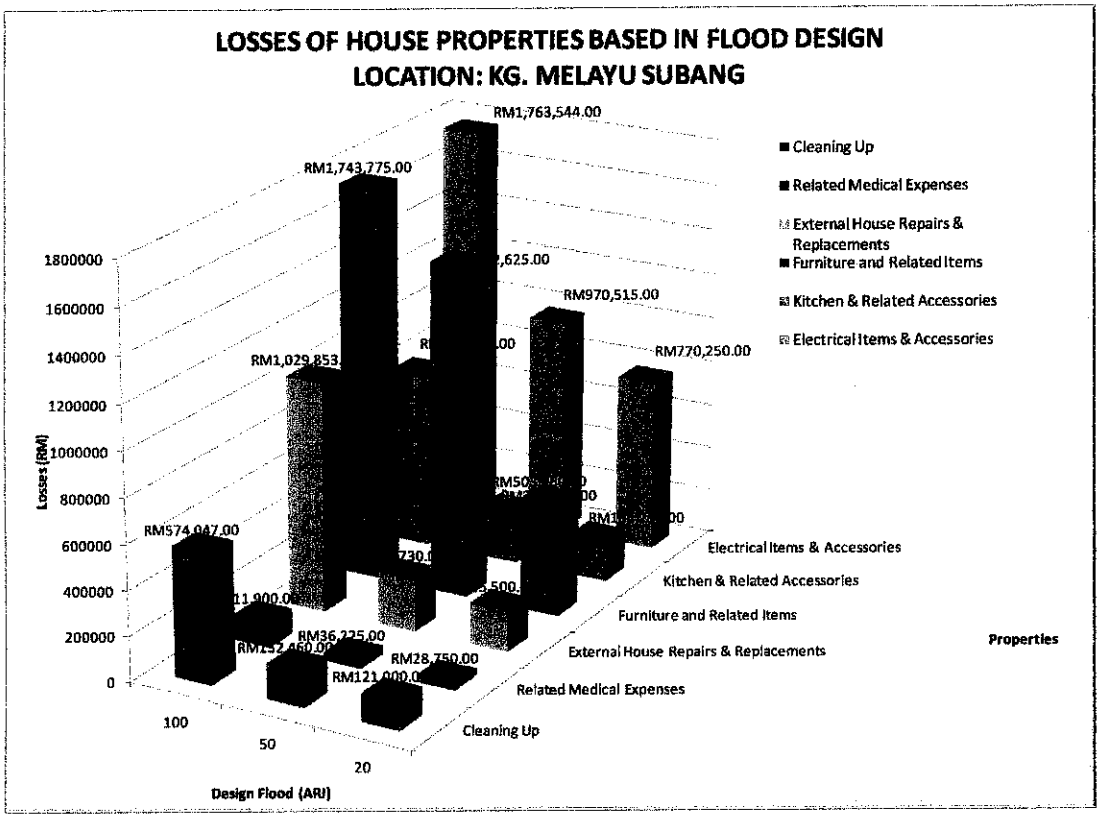


Figure 21: Losses of house/building properties with respect to ARI (Taman Subang Jaya)

Table 14: Analysis of houses and building properties

Item	Properties	Value / Cost (RM)		Houses Affected (According to ARI)										Total		
		Kampung House	2-Storey Terrace	Kg. Melayu Subang			Taman Subang Jaya									
				20	50	100	20		50		100			20	50	100
							1	2	1	2	1	2				
1	Cleaning Up	484.00	1,539.00	121000	152460	574047	96800	202312	661770	955719	698706	1095768		420112	1769949	2368521
2	Related Medical Expenses	115.00	300.00	28750	36225	111900	23000	48070	129000	186300	136200	213600		99820	351525	461700
3	External House Repairs & Replacements	742.00	2,761.00	185500	233730	1029853	148400	310156	1187230	1714581	1253494	1965832		644056	3135541	4249179
4	Furniture and Related Items	2,015.00	4,675.00	503750	1472625	1743775	403000	842270	2010250	2903175	2122450	3328600		1749020	6386050	7194825
5	Kitchen & Related Accessories	737.00	2,131.00	184250	232155	794863	147400	308066	916330	1323351	967474	1517272		639716	2471836	3279609
6	Electrical Items & Accessories	3,081.00	4,728.00	770250	970515	1763544	2193672	2193672	2033040	2936088	2146512	3366336		5157594	5939643	7276392

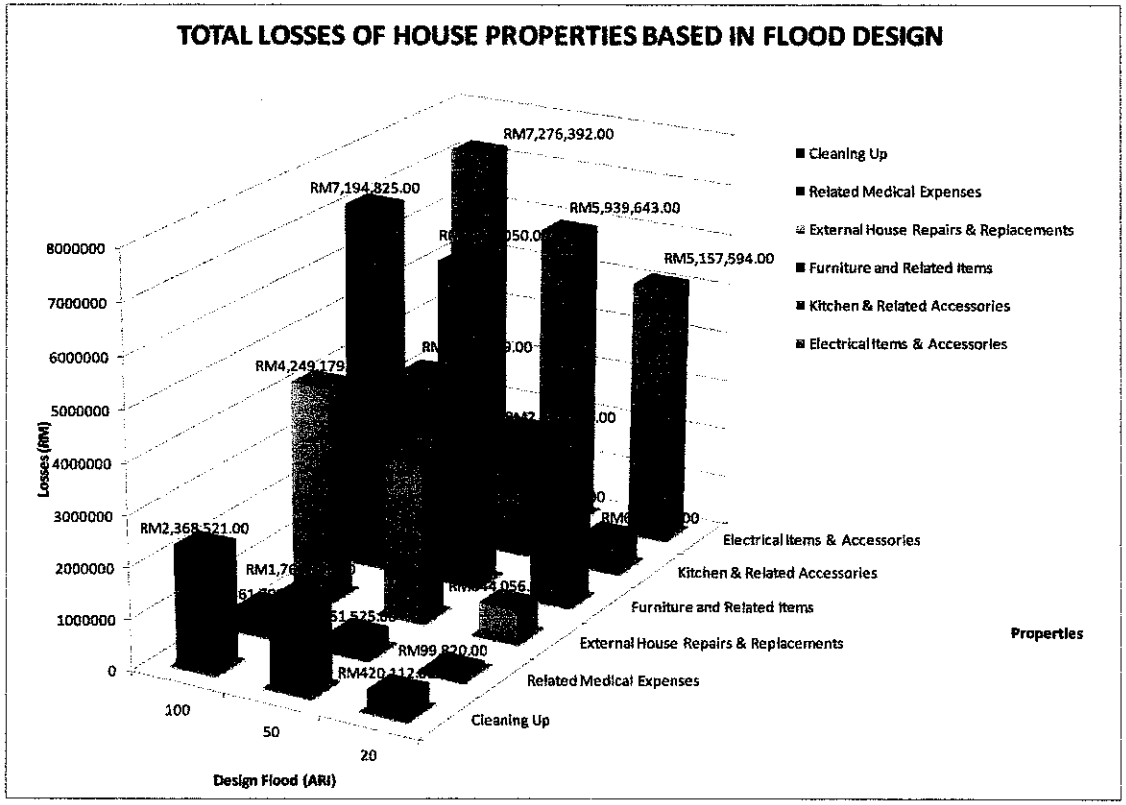


Figure 22: Total losses of house/building properties with respect to ARI

From the graphs, it is clear that there were three main items of losses contribute to the higher value of losses which was lead by Electrical Items and Accessories, followed by Furniture and Related Items and External House Repairs and Replacements. The main region of the contributor to the flood losses again was dominated by Taman Subang Jaya. It contributes RM 15,072,706.00 which is about 90% of total losses of house properties for 100 years ARI.

4.1.3 Vehicles

The potential damage of vehicle were determined by doing some assumptions which is, the flood will happen in the night time where the car and the motorcycle were parked at the house. As discussed in methodology section, the student just put the cars and motorcycle owned by the people lived in Kg. Melayu Subang while at Taman Subang Jaya, the student decide to make another assumption whereas 2-storey house will own luxury car and large motorcycle, single storey will own medium car and motorcycle and finally the shop will have no car.

As reported in *KTA Tenaga Sdn. Bhd. (2003) Flood Damage Assessment of 26 April 2001 Flooding Affecting The Klang Valley and the generalized procedures and guideline for assessment of flood damages – Draft Final Report*, the expertise of motor adjusters was used in assessing the damage. Based on their database of previous claims and flood depths, the motor adjusters were able to establish the extent of damage to these vehicles. So, the student could say that this data of losses for the vehicles (Table 8 of this report) is reliable.

Table 15 and 16 will show the value of losses of each region with respect to flood ARI. From the tables, the total losses for vehicles damages are RM4,898,500.76, RM9,327,250, and RM10,787,500for 20 ARI, 50 ARI and 100 ARI respectively.

Table 15: Vehicles affected and its losses (Kg. Melayu Subang)

ARI	Vehicles Affected (Based on the Houses)			Losses (RM)			Total Losses (RM)
	Both	Car Only	Motorcycle	Both	Car Only	Motorcycle	
20 Years	15	33	35	78750.00	16500.00	8750.00	104000.00
50 Years	80	78	72	420000.00	39000.00	18000.00	477000.00
100 Years	205	80	125	1076250.00	40000.00	31250.00	1147500.00

Table 16: Vehicles affected and its losses (Taman Subang Jaya)

ARI	Types of House		Value of Losses (RM)	Total Losses (RM)
	Single Storey	2-Storey	Luxury/Large	
20 Years	200	418	13,000.00	4794500.00
50 Years	430	621		8850250.00
100 Years	454	712		9640000.00

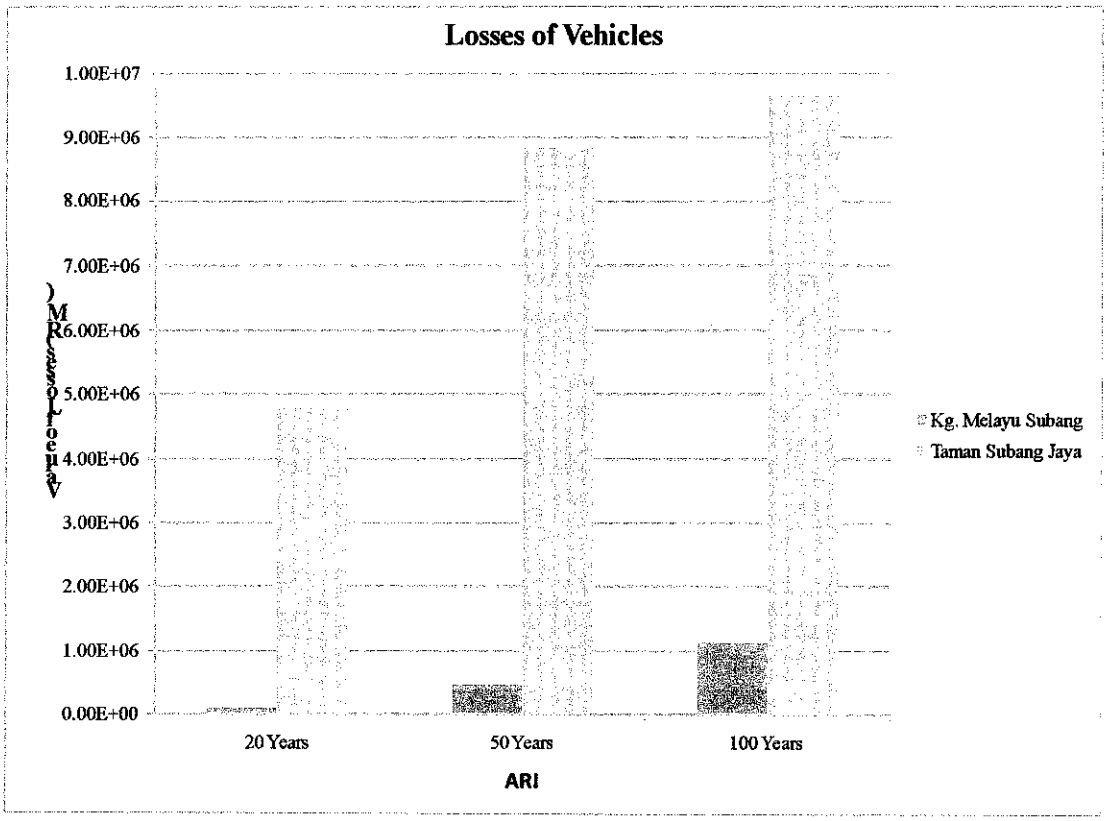


Figure 23: Total losses of vehicles with respect to ARI

4.1.4 Analysis to the flood depth

It is difficult to estimate the flood damages to the flood depth since there was no data to determine the level of water. The student was just provided with non-vector of flood map of 100 Year ARI. This is the only data that the student has in order to make an analysis to the flood depth and it is appreciated if the student could have the vector map of flood for each flood design. But it was the limitation that the student faced in this project.

Besides that, the student also faced difficulties in order to find the rate of damages given that there is only flood damage rate with American Standard (flood depth with feet). The rate of the damage could be seen in Table 8 of this report. However, the student has computed the rate value to SI unit as because the unit of flood depth determined from the hydraulic simulation software was in meter. The rates of the damage are 0 meter to 1 meter was RM3.72/m^2 and 1m meter to 2 meter was RM9.52/ m^2. Table 17 summarized the computed value of losses with reference to flood depth.

Table 17: Table of losses of affected area with respected to flood depth (100 years ARI)

Flood Depth	Total Area of Locations (m^2)		Average Losses Rate (RM/$m^{2)}$	Total Losses (RM)	
	Kg. Melayu Subang	Taman Subang Jaya		Kg. Melayu Subang	Taman Subang Jaya
0 - 1 m	537314.01	495069.48	3.72	1998808.12	1841658.45
1 - 2 m	153719.30	77710.01	9.52	1463407.72	739799.34
			Total	**3462215.84**	**2581457.79**

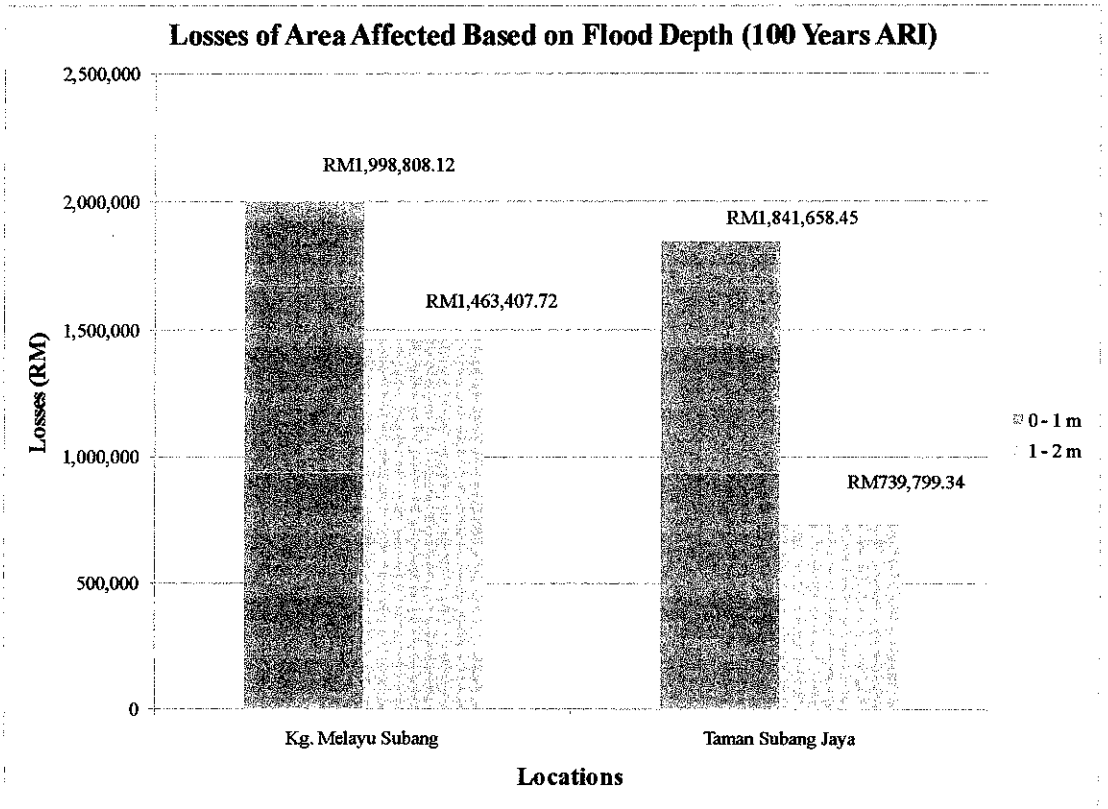


Figure 24: Losses of affected area based on flood depth

From the graph, it shown that 0 meter to 1 meter of flood depth was given greater damages. this is because of the flood depth was covered wider area while the depth 1 – 2 meter flood depth was happened at area which is close to river.

4.2 Analysis of the Total Losses

All the calculated losses were gathered to one table for the computation of total losses based on the flood design. Table 18, 19 and 20 summarized the total losses for the flood design 20 years, 50 years, 100 years ARI respectively.

Table 18: Total flood losses for 20 years ARI

Item	Properties	Location		Total
		Kg. Melayu Subang	Taman Subang Jaya	
1	Road	280500.76	178000.00	458500.76
2	Houses Properties	1793500.00	8481860.00	10275360.00
3	Vehicles	104000.00	4794500.00	4898500.00
	Total	**2178000.76**	**13454360.00**	**15632360.76**

Table 19: Total flood losses for 50 years ARI

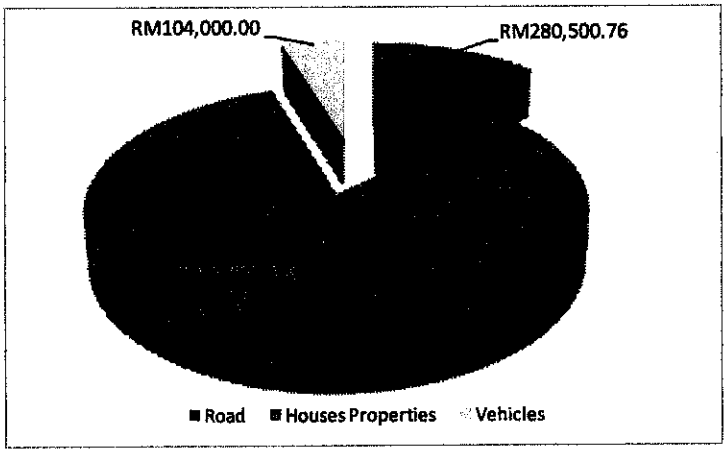
Item	Properties	Location		Total
		Kg. Melayu Subang	Taman Subang Jaya	
1	Road	558680.80	440000.00	998680.80
2	Houses Properties	2259810.00	13432336.00	15692146.00
3	Vehicles	477000.00	8850250.00	9327250.00
	Total	**3295490.80**	**22722586.00**	**26018076.80**

Table 20: Total flood losses for 100 years ARI

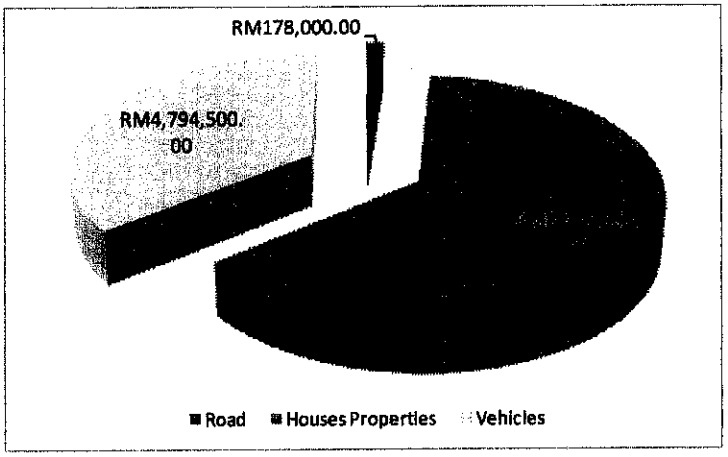
Item	Properties	Location		Total
		Kg. Melayu Subang	Taman Subang Jaya	
1	Road	886562.89	700000.00	1586562.89
2	Houses Properties	2675902.00	15072706.00	17748608.00
3	Vehicles	1147500.00	9640000.00	10787500.00
4	Flood Depth	3462215.84	2581457.79	6043673.63
	Total	**8172180.73**	**27994163.79**	**36166344.51**

Total flood damages will become greater because of the flood extent. From the GIS database, the student seen that 100 years ARI gave wider affected area. Figures of pie-chart in the next pages will show how the contribution of the properties items to the total flood damages. It was cleared that, house properties is the main contributor to the total flood damages, then followed by vehicles and road losses.

The total losses for 20 years, 50 years and 100 years of flood are RM 15,632,360.76, RM 26,018,076.80 and RM 36,166,344.51 respectively.



(a)



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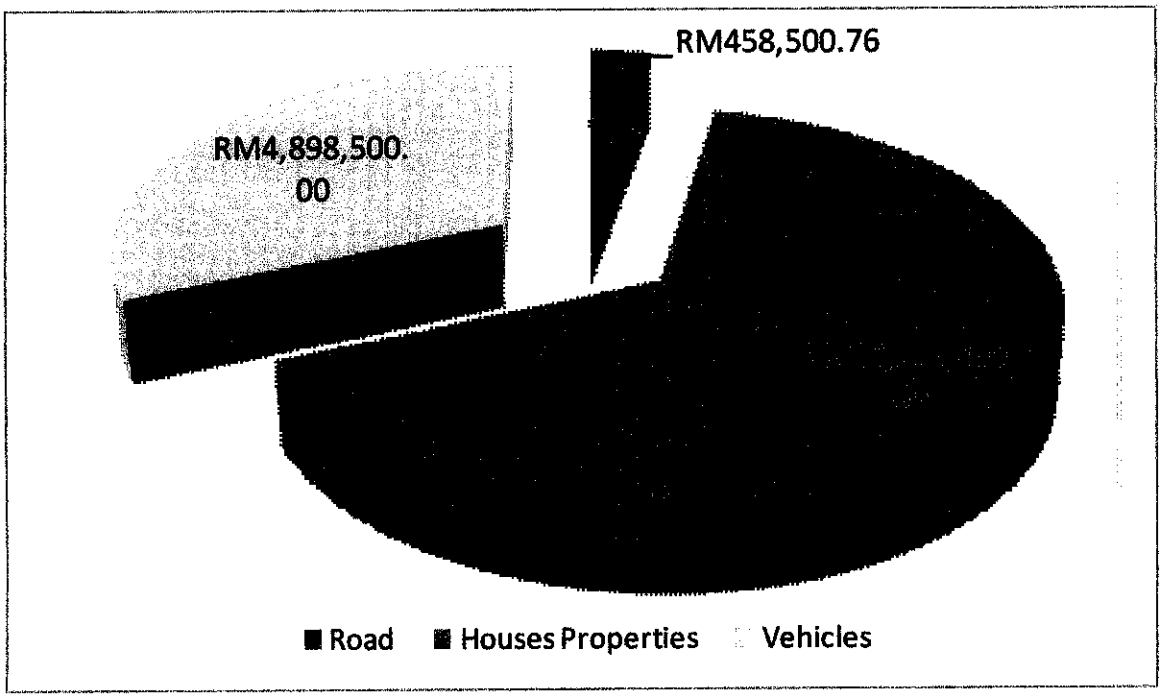
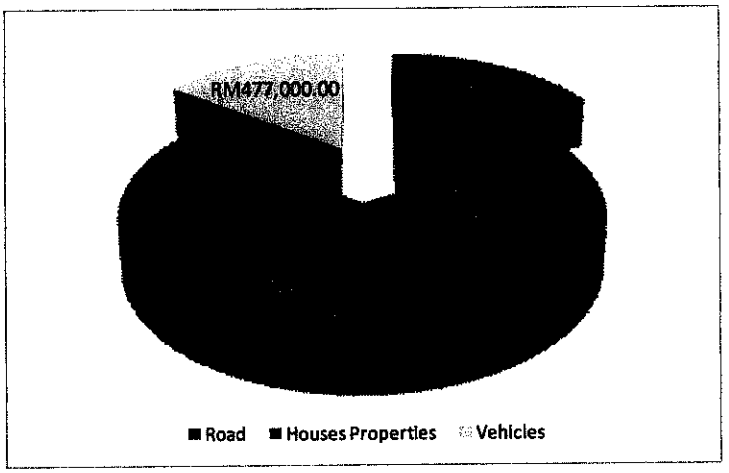


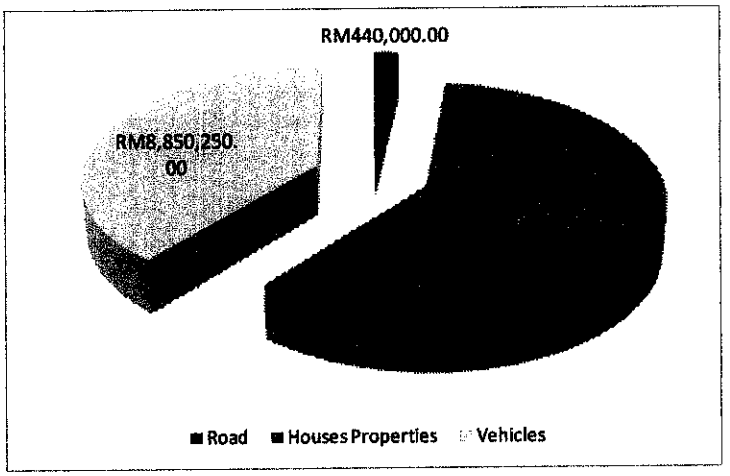
(c)

Figure 25: Losses of 20 years ARI flood

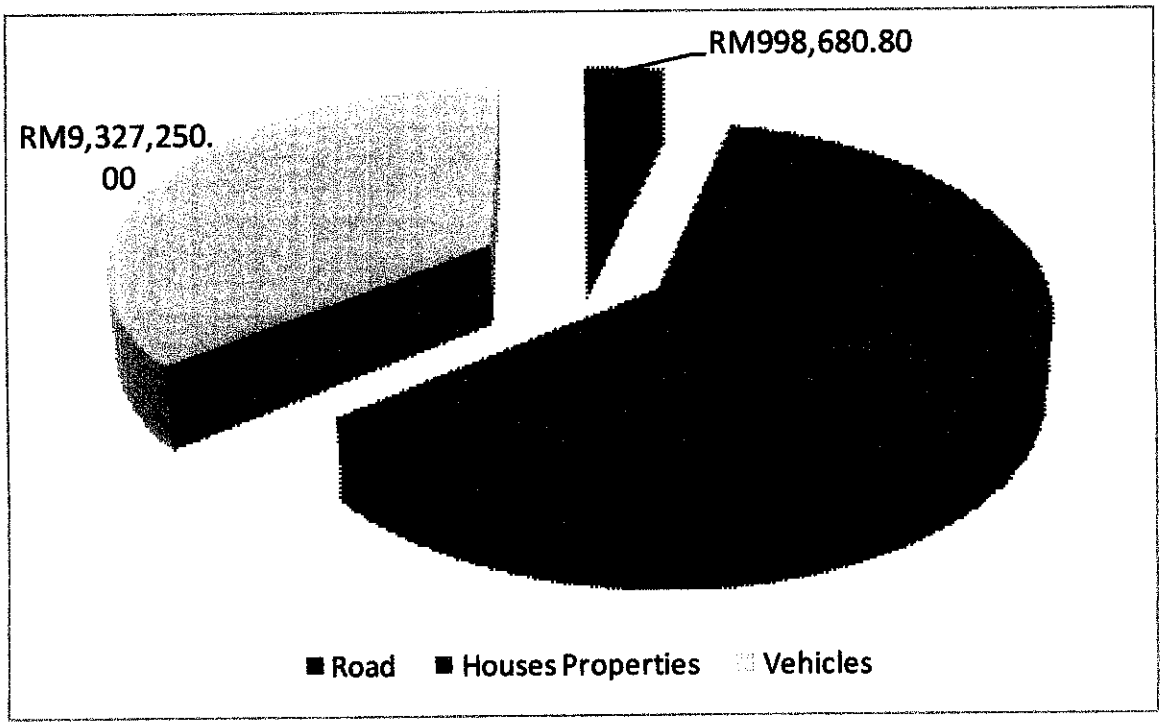
(a) Kg. Melayu Subang; (b) Taman Subang Jaya; (c) Total Losses



(a)



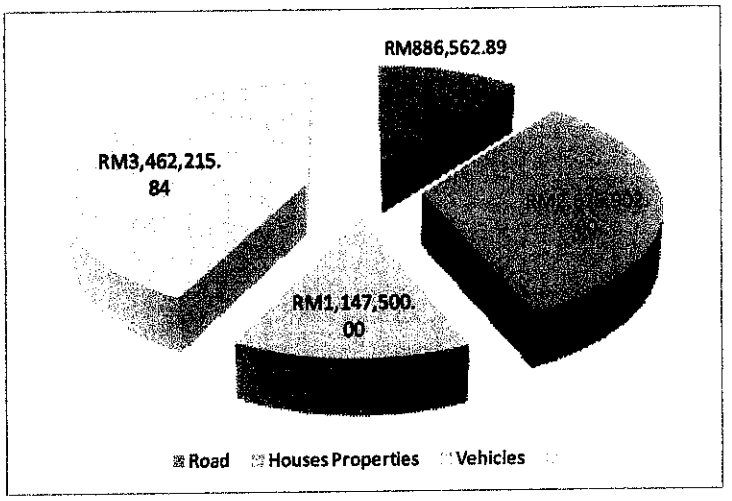
(b)



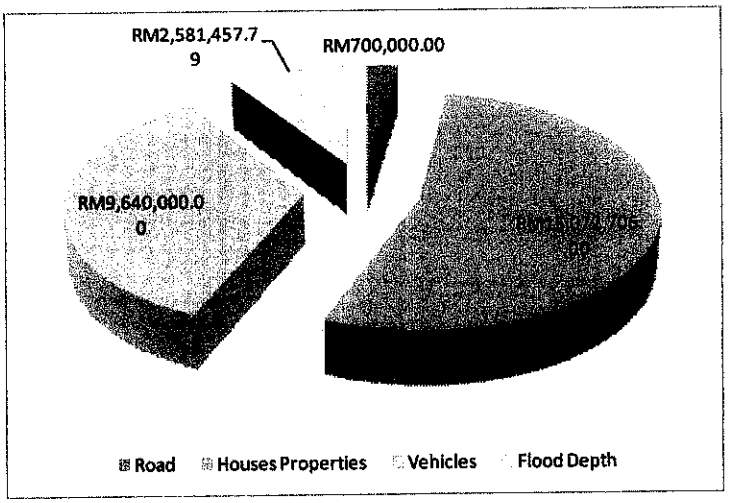
(c)

Figure 26: Losses of 50 years ARI flood

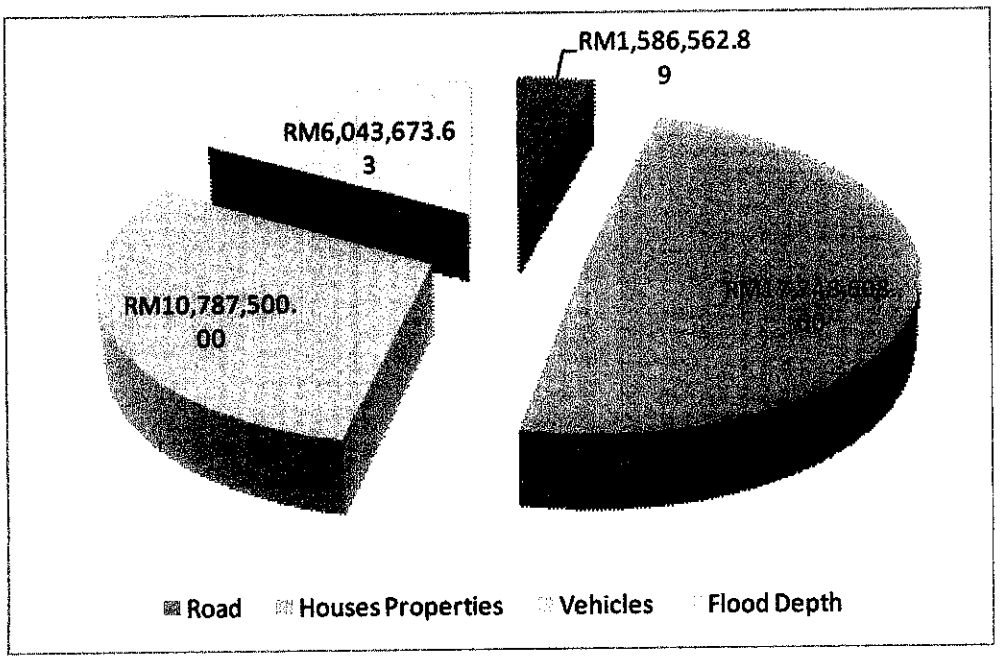
(a) Kg. Melayu Subang; (b) Taman Subang Jaya; (c) Total Losses



(a)



(b)



(c)

Figure 27: Losses of 100 years ARI flood

(a) Kg. Melayu Subang; (b) Taman Subang Jaya; (c) Total Losses

4.3 Result Comparison

This study is compared with available flood damage assessment for Kg. Melayu Subang. As noted in *Sg. Damansara Flood Impact Survey, 2007,* about 66 hectares of Kg. Melayu Subang were affected by flood on 26th February 2006 that included 200 houses suffered as well as some industrial properties located nearby. Table 21 shows the comparison of the total estimated potential direct losses in damages in affected areas for Kg. Melayu Subang with outcome of the study. It is clear that there is not much different with the losses of the houses properties at Kg. Melayu Subang.

Table 21: Losses Comparison of Houses for Kg. Melayu Subang

Item	ARI	Houses Affected	Total Losses of Houses (RM)	Remark
1	**8**	**200**	**1,700,000**	**26th Feb 06 - Flood**
2	20	250	1,793,500	Simulated flood design
3	50	430	2,259,810	
4	100	454	2,675,902	

This study can provide more details about damages since the flood impact survey was not estimated the losses of other properties such as road and infrastructures. GIS can provide more precise and time saving for estimating the flood damages as discussed in previous chapters.

A comparison for losses at Taman Subang Jaya cannot be made because it was not involved in flood on 26th February 2006. So, it doesn't have any parameter to justify the value of losses.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

A newly method of flood assessment was determined in this study. The study had been conducted in order to determine the flood damages/losses with respect to the flood design (ARI). This study has demonstrated that the flood damages for certain area and region can be achieved in a short time with the support of GIS tools meaning that no more flood assessment to be conducted by using survey method. However, the properties of the each house and other public properties should be updated at least every year since this method of flood assessment require that data.

There is only a data of flood losses for the Kg. Melayu Subang that taken from *Sg. Damansara Flood Impact Survey, 2007* for make a comparison as discussed in section 4.3. However, based on the flood event on 26th February 2006, the total losses for the whole of Sg. Damansara river catchment included Shah Alam, TTDI Jaya and many more is about RM 34,542,800. Based on the study conducted by Jurutera Perunding Zaaba Sdn. Bhd, the flood event was just 8 years of ARI. By referencing to the flood damage of 20 years ARI for Kg. Melayu Subang and Taman Subang Jaya (RM 15,632,360.76), the student could say that the losses that based on this study is reliable.

As the conclusion, the student was achieved the objectives of the study where he could develop a GIS database of the flood damage and also can predict the flood damages to the properties and could convert all the losses items to the monetary terms.

5.2 Recommendations

GIS give a very wide application in analyzing the flood damage whereas some studies and research on the flood extend and flood risk were conducted by integrating hydraulic and hydrology analysis in the GIS application. Malaysia is common with heavy rainfall for every year while there is now a climate change issue.

The result of this flood damages assessment impact study is very much dependent on the data of the properties for each building and house and also the accuracy of flood maps that generated by hydraulic and hydrology simulation software. The suggestion made that the data of properties should be updated and could be asked from Urban Planning Department of local authority.

In the future, further study can be examined since there are other values of losses that cannot be incorporated in this study due to the limitation of time and data. Other losses especially intangible losses should be taken into account. The values of losses that can be taken as consideration are:-

i. Imputed loss in income,
ii. Imputed loss in property value,
iii. Losses of commercial and industrial activities and properties,
iv. Losses of environment (tree and plants),
v. Time losses from traffic congestion' and
vi. Other properties such as bus stop, public phone, etc.

As recommendations to the department of Civil Engineering, the department can allocate new version of GIS software so that the extension of GIS software can be implemented for details analysis. Besides that, the department also can provide a software for hydraulic analysis and other GIS software such as InfoWorks for better research.

REFERENCES

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8. http://support.esri.com/index.cfm?fa=knowledgebase.techarticles.articleShow&d=27632 - HowTo: Convert selected CAD data to ArcGIS shapefile, coverage or geodatabase feature classes using geoprocessing

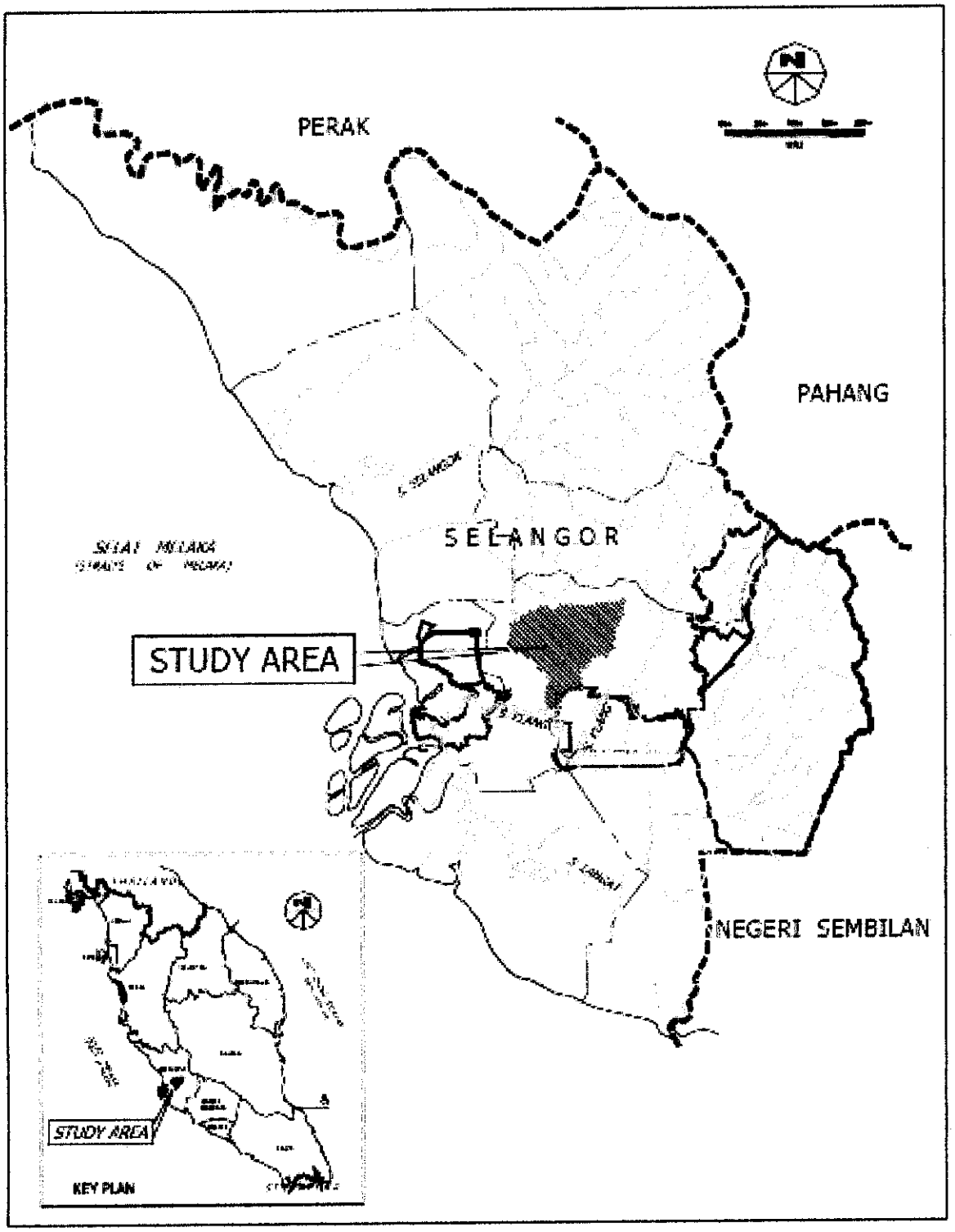
9. http://support.esri.com/index.cfm?fa=knowledgebase.techarticles.articleShow&d=24704 - Problem: Spatial reference, statistics, or pyramids are not persistent for rasters.

10. Jabatan Pengairan dan Saliran Malaysia. (2000), Manual Saliran Mesra Alam (MASMA)

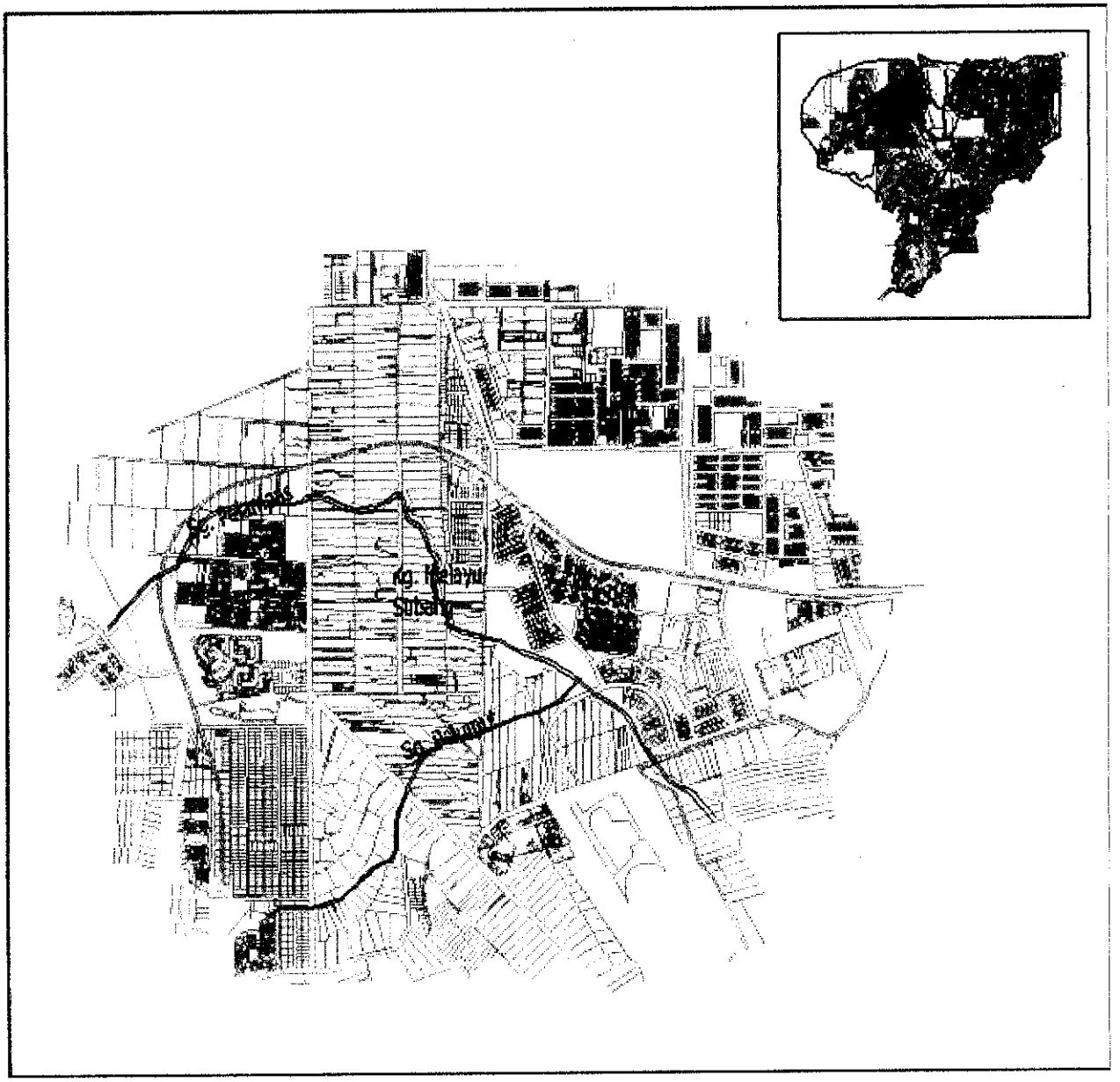
APPENDICES

List of Appendices

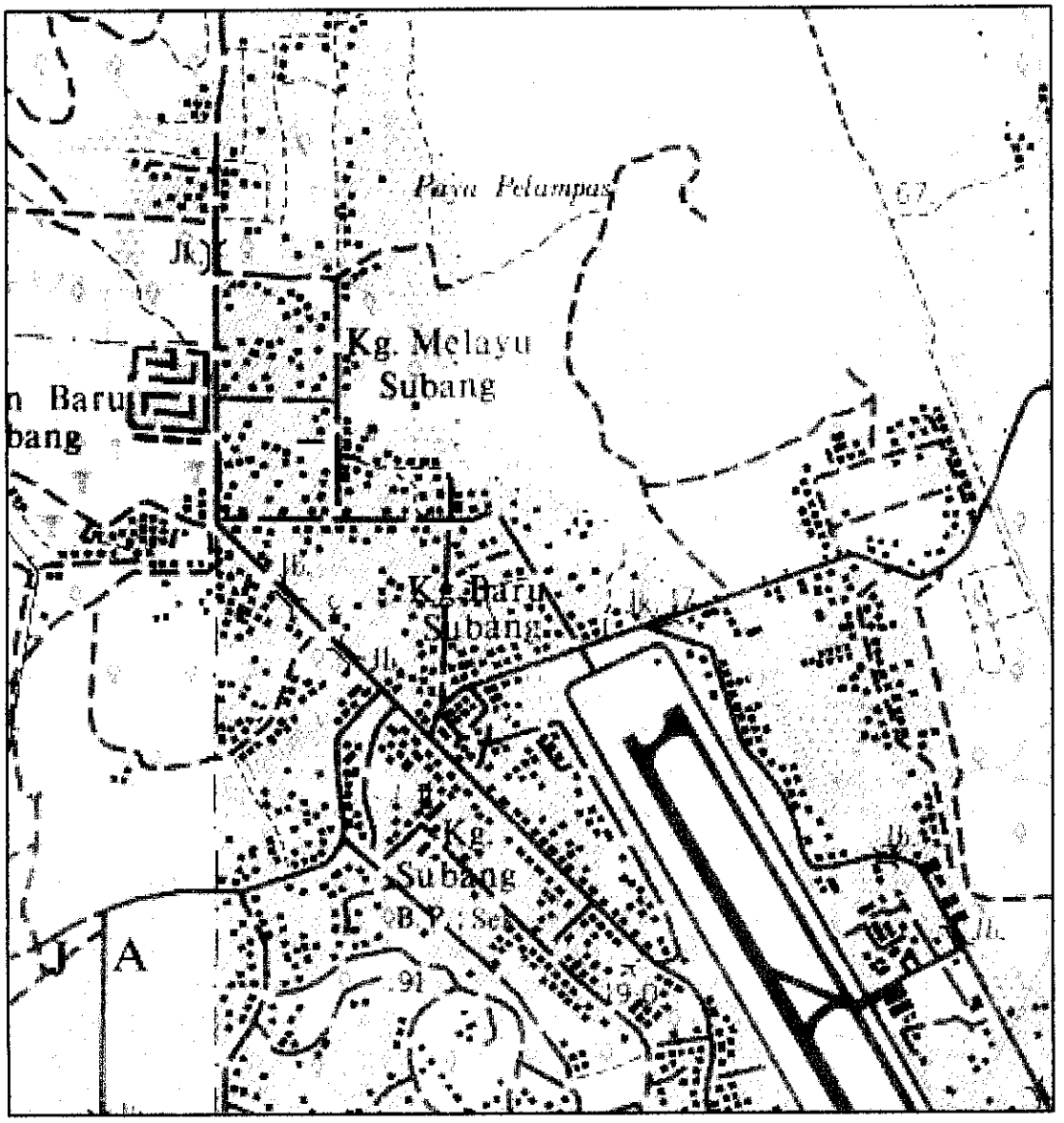
Study Area


PERAK
PAHANG
SELANGOR
STUDY AREA
NEGERI SEMBILAN
STUDY AREA
KEY PLAN

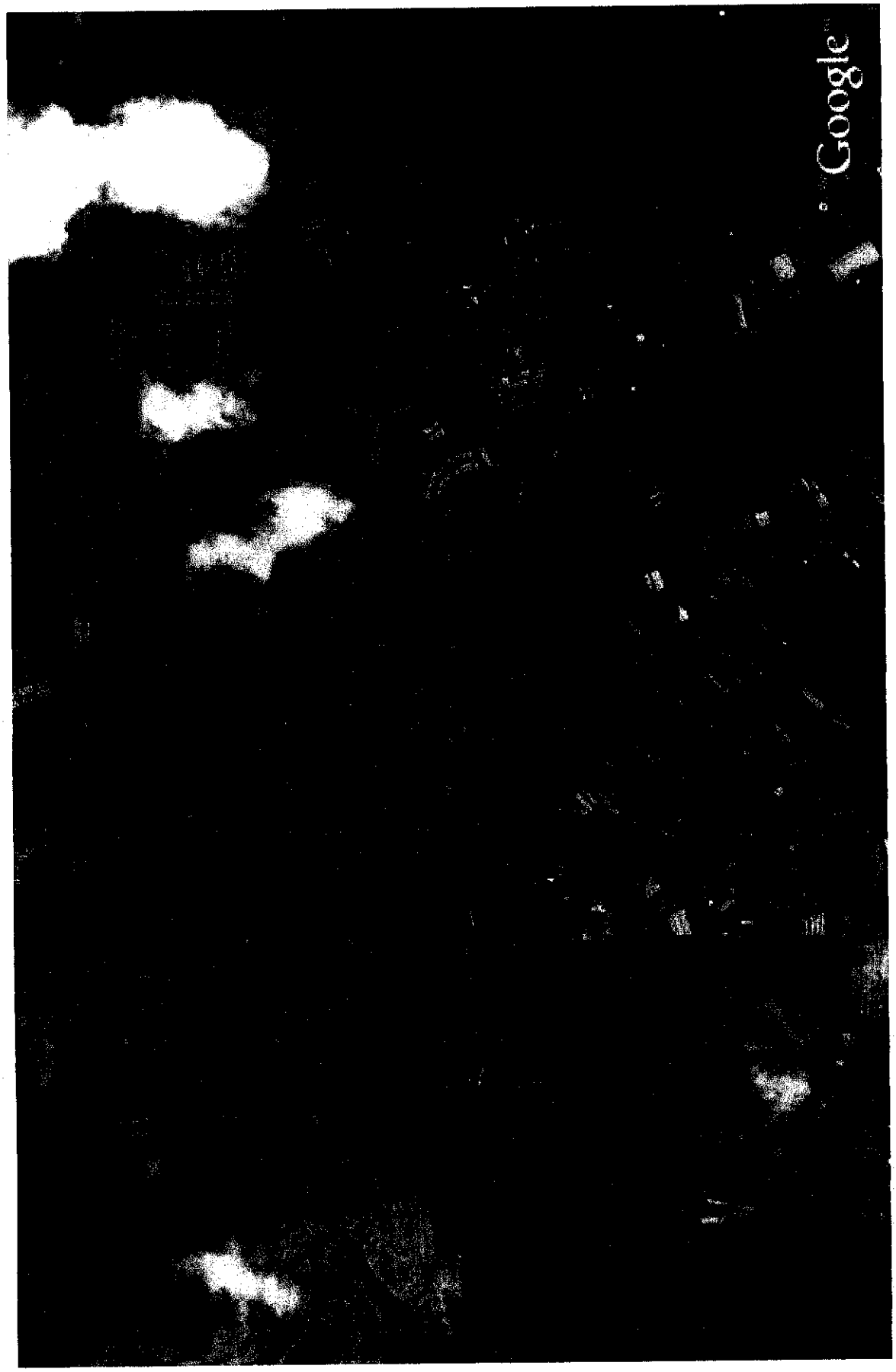
AutoCad Drawing of Study Area



Topographic Map of Study Area



Satellite Image of Study Area



Non-Vector Map of 100 Years ARI Flood

Flood Damages Survey Questionnaire Form
(KTA Tenaga Sdn. Bhd.)

FORM 1- RESIDENTIAL PROPERTY AND HOUSE-HOLD SURVEY

We, the consultant have been commissioned by Jabatan Pengairan & Saliran (JPS) to conduct an assessment of damages incurred as a result of flooding. As you would be aware, the said flooding may caused extensive damage to business premises, loss of trade due to flooding and associated clean up activities, equipment or employing new staff. These are the indirect impacts of flooding.

The following survey aims to obtain information from you on how the flooding has affected this business and its premises. In completing this survey we need you to consider the impact of floods, including extreme flood events. It is important to list both direct and indirect impacts of flooding in your response.

All responces to this questionnaire are entirely confidential and will not be published. However, the data contained will be consolidated within the Floodplain Management Plan to support possible works and measures to mitigate the impact of flooding.

SECTION A : BACKGROUND INFORMATION

Name : _____

Address : _____
_____
_____

Contact No. : _____

E-mail address : _____

1. Was your house affected by the flood on _____?(date of flood event)

☐ Yes ☐ No (If no, proceed to Section C)

2. Age of building : _____year

3. Building material

External Walls: ☐ Brick ☐ Cladding ☐ Timber ☐ Other: _____

Internal Walls : ☐ Brick ☐ Gypsum ☐ Timber ☐ Other: _____

4. Building form

Storeys : ☐ One ☐ Two ☐ Three or more

Bedrooms : ☐ One ☐ Two ☐ Three ☐ More

FORM 1- RESIDENTIAL PROPERTY AND HOUSE-HOLD SURVEY (continue)

SECTION B : TANGIBLE DAMAGES

5. Damages

Damages to the building

Area	Desription of damage	Estimated cost (RM)
Foundations		
External Walls		
Internal Walls		
Floors		
Doors / Windows		
Built-Ins		
Others		

Damages outside the building

	Damaged items	Estimated cost (RM)
Garage/workshop, including equipment stored inside		
Motor Vehicle		
Storage, including equipment stored inside		
Gardens		
Other		
Fences		

Damage to motor vehicles

If there was damage to a motor vehicle, who owns the vehicle?

☐ Private ☐ Company ☐ Government

What type of vehicle was it?

☐ Sedan/ Station Wagon ☐ Commercial ☐ Motor bike ☐ Other: _____

FORM 1- RESIDENTIAL PROPERTY AND HOUSE-HOLD SURVEY (continue)

Damage inside building

Damaged items	Comments	Estimated cost (RM)
Furniture		
Appliances		
Clothing		
School books		
Others		

Water level inside the premises

_____ ☐ m ☐ ft

FORM 1- RESIDENTIAL PROPERTY AND HOUSE-HOLD SURVEY (continue)

6. Clean Up Cost

Inside building _____ Days/Hours _____ Cost

Outside building _____ Days/Hours _____ Cost

7. Loss of Wages

_____

_____

8. Other Cost

Relocation _____

Medical _____

Others _____

Have you been compensated for flood damages?

☐ Yes (Details: _____ RM _____)

☐ No

SECTION C : INTANGIBLE DAMAGES

9. Would you say that you are:

☐ used to floods and are prepared for it

☐ used to floods but not prepared for it

☐ not used to floods but prepared for it

☐ not used to floods and not prepared for it

10. Are you worried when it rains?

☐ Very worried

☐ Worried

☐ Slightly only

☐ Not at all

FORM 1- RESIDENTIAL PROPERTY AND HOUSE-HOLD SURVEY (continue)

11. Are you in a continual state of preparedness, anticipating floods?

☐ Yes ☐ No

12. What actions do you take (short term)?

☐ Someone in the house all the time
☐ Take up employment that allows flexibility for leave to clean up floods
☐ Staying on upper floors
☐ Constructing blocks to stop flood waters coming into house
☐ Other defensive measures (details, if yes: _____)

13. What actions are you planning (long term)?

☐ Planning to move out of this community
☐ Lobby govt for more flood mitigation projects
☐ Others (Specify: _____)

14. Does your fire insurance coverage include flood damage?

☐ Yes ☐ No

15. If you could pay something so that your house does not flood, would you be willing to pay an amount every year?

☐ Yes (If yes, how much: RM_____/year)
☐ No (why not?_____)

16. Are you willing to move to another area that does not flood?

☐ Yes. How much more are you willing to pay for an equivalent house?

- ☐ 0%
- ☐ 10%
- ☐ 20%
- ☐ 30%
- ☐ 40%
- ☐ 50 % and more.

☐ No.

FORM 1- RESIDENTIAL PROPERTY AND HOUSE-HOLD SURVEY (continue)

17. Any other comments

_____

_____

_____

_____

_____

_____

Tenant or occupiers signature
Date:

Flood Damages Survey Questionnaire Form

(Jurutera Perunding Zaaba Sdn. Bhd.)

KAJISELIDIK KOS KEROSAKAN BANJIR SG DAMANSARA 26 FEB 2006

Assalamualaikum / salam sejahtera

erikutan banjir besar 26 Februari 2006, pihak Jabatan Pengairan dan Saliran (JPS) Malaysia sedang erusaha melaksanakan langkah-langkah intensif ke arah menyelesaikan masalah tersebut agar ia tidak erulang lagi.

alah satu maklumat yang diperlukan untuk membantu ke arah mencapai tujuan ini ialah kos kerosakan tau kerugian yang dialami oleh penduduk akibat banjir tersebut.

ntuk itu, kami amat menghargai kesudian kerjasama Tuan/Puan mengisi borang ini bagi memudahkan emerolehan maklumat tersebut.

egala kerjasama dan sokongan pihak Tuan/Puan kami dahului dengan ribuan terima kasih.

abatan Pengairan dan Saliran Malaysia
urutera Perunding Zaaba

KAJISELIDIK KOS KEROSAKAN BANJIR SG DAMANSARA 26 FEB 2006

KAJISELIDIK ISIRUMAH

Nama penemuduga	[redacted]	Tarikh kajiselidik	
Nama penyelia		Tarikh pemeriksaan	

A. Kawasan kajian

Nama ampung/Bandar	BATU TIGA	Kod kawasan	46600
lamat	3H, JALAN MESRA, TAMAN MESRA, BATU TIGA, SHAH ALAM, SELANGOR		

1. Jenis rumah		1 tingkat	2 tingkat	2 ½ tingkat
anda x di mana sesuai)	Banglo			
	Rumah berkembar			
	Teres		✓	
	Kampung			
	Kondominium/Apartment			
	Lain-lain (sila huraikan)			
Dimensi rumah *netrik / imperial)*	Keluasan tanah 20'x70'	(m per)		(ka per)
	Kawasan terbina	(m per)		(ka per)
	Tinggi lantai – tanah	(m)		(ka)

Bahan binaan *andakan x di mana sesuai)*	Bahan utama dinding	Bata	✓
		Kayu/papan	
		Campuran bata-papan	
		Lain (huraikan)	
	Lantai	Jubin marmar / seramik	✓
		Kayu / parquet	
		Simen	
		Lain (huraikan)	

B. Maklumat umum mengenai responden

Nama Responden			TT:
Status pemilikan	(1) Milik sendiri	(2) Sewa	(3) Lain (huraikan)

. Jumlah bulan / tahun menetap	12 tahun 2 bulan				
. Harga rumah semasa di pasaran	RM 185000.00				
. Anggaran harga rumah sebelum banjir	RM 250,000.00				
. Jumlah banjir dialami	(1) Sekali(*nyatakan tahun*)				
	(2) Dua kali (*nyatakan tahun*)				
	(3) Tiga kali (*nyatakan tahun*)				
	(4) Empat kali (*nyatakan tahun*)	1996	2003	2003	2006

0. Adakah anda mempunyai insurans banjir? *(bulatkan)*	(1) Ya	(2) Tidak
1. Jika ya, berapakah premium tahunan?	RM	
2. Adakah anda mempunyai insurans kebakaran? (*nyatakan tahun*)	(1) Ya	(2) Tidak
3. Jika ya, berapakah premium tahunan?	RM 248.00	
4. Semasa banjir 26/2/06, adakah anda memiliki insurans banjir?	(1) Ya	(2) Tidak
5. Jika ya, adakah premium tahunan meningkat?	(1) Ya	(2) Tidak
6. Adakah anda menerima pampasan insurans akibat kerosakan banjir?	(1) Ya	(2) Tidak
7. Jika ya, berapakah jumlah yang diterima?	RM	
8. Adakah anda menerima sebarang amaran banjir dari pihak berkuasa pada 26/2/2006?	(1) Ya	(2) Tidak
9. Jika ya, namakan pihak berkuasa tersebut.		
0. Kos anda membersihkan rumah akibat banjir 26/2/2006	RM 500	

C. Kedalaman dan jangkamasa banjir

1. Kedalaman maksima banjir di dalam rumah	1.5 (m)	(ka)
2. Jangkamasa banjir	24	jam

D. Anggaran kerugian / kerosakan

D1. Anggaran kerugian / kerosakan –Peribadi

3. Bilangan jumlah ahli rumah yang bekerja	2
4. Bilangan ahli rumah yang tidak dapat bekerja atau mengambil cuti akibat banjir	2

5. Anggaran jumlah hari atau jam tidak bekerja (*hari atau jam*)

	Pendapatan sebulan (RM)	Hari tidak bekerja	Jam tidak bekerja
(1) Ahli rumah 1	RM 730.00	BEBERAPA	
(2) Ahli rumah 2	RM 2000.00	7 HARI	
(3) Ahli rumah 3			
(4) Ahli rumah 4			
(5) Ahli rumah 5			
(6) Ahli rumah 6			
(7) Ahli rumah 7			
(8) Ahli rumah 8			

D2. Anggaran kerugian / kerosakan – Kos sakit dan lain-lain

. Jumlah ahli rumah yang sakit akibat banjir, jika ada	1	orang
. Jumlah kos rawatan	RM 250.00	
. Kematian disebabkan banjir, jika ada *(bulatkan yang sesuai)*	(1) Ya	(2) Tidak
. Hubungan s mati dengan anda dan umurnya Hubungan:	✓	
Umur:	✓	
. Kos kehilangan binatang peliharaan, jika ada	RM ✓	
. Kos rawatan binatang peliharaan, jika ada	RM ✓	

D3. Anggaran kerugian / kerosakan – Bangunan, tanah dan lain-lain

2. Tolong nyatakan anggaran kerosakan rumah dan persekitarannya termasuk lanskap	Mengganti baru (RM)	Membaiki (RM)
Taman/halaman, lanskap, perparitan	Rm 550.00	SEMUA ROSAK
Dinding, lantai, tingkap, pintu, cat	Rm 1500.00	
Elektrik. Telefon, sistem pembetungan	Rm 300.00	
Lain-lain (huraikan)		

D4. Anggaran kerugian / kerosakan – Perabut, kelemgkapan rumah dan lain-lain

13. Anggarkan kerosakan terhadap berikut:	Mengganti baru (RM)	Membaiki (RM)
Set sofa, kerusi, meja, rak buku	RM 600	Rm 200
Lekapan (fittings/dividers)		
Permaidani, hamparan, lantai kayu	Rm 800	
Kertas dinding (wallpaper)/Langsir/"blind" & lekapan berkaitan	Rm 200	
Katil, tilam dll	1	
Lain-lain		

D5. Anggaran kerugian / kerosakan – Dapur dan bilik air

14. Sila anggarkan kerosakan dapor	Mengganti baru (RM)	Membaiki (RM)
Kabinet, peralatan dapor (oven, pemasak nasi dll))	Rm 3000	
Peralatan memasak (periuk, kuali dsbnya) / Sudu garfu dll	Rm 800	
15. Sila anggarkan kerosakan bilik air		RM 100

D6. Anggaran kerugian / kerosakan – Milik peribadi dan peralatan elektrik

16. Sila anggarkan kerosakan milik peribadi dan peralatan elektrik	Mengganti baru (RM)	Membaiki (RM)
Pakaian, kasut dan lain-lain barangan peribadi	Rm 700	
17. Kerosakan peralatan elektrik		
TV, radio, pita rakaman, pemain DVD	Rm 5000	
Komputer, pencetak (printer), faks	✓	
Peti ais		Rm 200/=
Pembasuh baju		Rm 150/=
Pawa dingin		✓
Lain-lain (huraikan)		
(a)		
(b)		
(c)		

D7. Anggaran kerugian / kerosakan – Kenderaan

8. Anggaran kerosakan kenderaan

	Anggaran nilai semasa (RM)	Rosak sepenuhnya Mengganti baru (RM)	Rosak sebahagian Membaiki (RM)
) Kereta 1	65,000		RM 6760
?) Kereta 2			
) Kereta 3			
) Motosikal 1			
) Motosikal 2			
) Van 1			
) Van 2			
) Lori 1			
) Lori 2			
0) Basikal			
1) Lain-lain (huraikan)			
a)			
)			
c)			

D8. Anggaran kerugian / kerosakan – lain-lain

). Lain-lain kerugian / kerosakan	RM
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	