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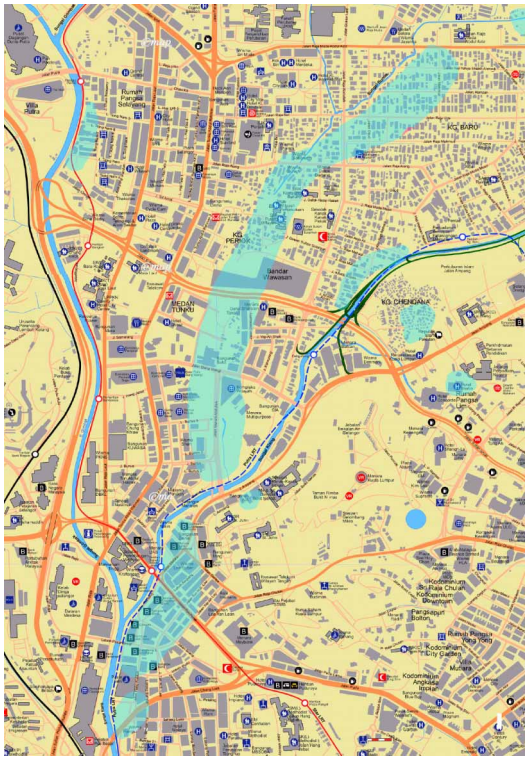
FLOOD DAMAGE ASSESSMENT OF 26 APRIL 2001 FLOODING AFFECTING THE KLANG VALLEY AND THE GENERALISED PROCEDURES AND GUIDE LINES FOR ASSESSMENT OF FLOOD DAMAGES



FINAL REPORT

Volume 2 - Guidelines and Procedures for the Assessment of Flood Damages in Malaysia

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'FLOOD DAMAGE ASSESSMENT OF 26 APRIL 2001 FLOODING AFFECTING THE KLANG VALLEY AND THE PREPARATION OF GENERALISED PROCEDURES AND GUIDELINES FOR ASSESSMENT OF FLOOD DAMAGES'

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VOLUME 2:

GUIDELINES AND PROCEDURES FOR THE ASSESSMENT OF FLOOD DAMAGES IN MALAYSIA

1. INTRODUCTION

1.1 Background

This guidelines and procedures for the assessment of flood damages is being developed as part of the deliverable for the study titled 'Flood Damage Assessment of 26 April 2001 Flooding Affecting the Klang Valley and The Generalized Procedures and Guidelines for Assessment of Flood Damages' commissioned by JPS Wilayah Persekutuan/RTB Lembah Sg. Klang.

In formulating this set of guidelines for use in Malaysia, a review of procedures and guidelines on flood damage assessment adopted in other countries was conducted. Previous flood damage assessment studies carried out in Malaysia were also reviewed and the relevant flood damage data were adopted for this guideline.

1.2 Guideline Objectives

The main objective of this guideline is to enable the relevant user in the country such as JPS and local authorities to conduct flood damage assessment according to the methods recommended. This guideline will also assist the relevant user in choosing the method of assessment which is most suitable for a particular situation and needs.

During all phases of damages studies, that there are two principles that it is important to remember:

- The collection of flood damage data must be an on-going activity, not restricted to one flood or a flood of a particular recurrence interval; and
- Damages estimations are required across the whole range of floods, from the common to the most extreme (PMF).

Unless these principles are borne in mind, then whatever value may be drawn from the initial study, the value will be lost over time.

1.3 Current Practices World-Wide

The majority of published information on damages collection and analysis comes from the United States, the United Kingdom, Japan, New Zealand and Australia. All literature examined indicates that most countries have adopted a unit loss approach, based on a property by property assessment of damages, be it actual or potential.

However, there appears to be some wide variance in the application of the data collected to the estimation process. For example, the UK approach is very structured and detailed for all classes of damage whereas the other countries such detail is only applied to urban situations.

This situation is best summarised in a Table taken from *Direct Flood Damage Modelling Towards Urban Flood Risk Management* by Dutta et al, as below:

Table 1.1 - Summary of existing flood loss estimation methodology

Damage Categories		Japan	Australia	UK	USA
Urban damage	Residential	Detail	Detail	Detail	Detail
	Non-Residential	Detail	Detail	Detail	Detail
Rural damage	Crop damage	Rough	Detail	Detail	Detail
	Farmland damage	Detail	Detail	Detail	Detail
	Fishery	None	None	Detail	None
Infra-structure	System damage	Rough	Rough	Detail	None
	Service loss	Rough	Rough	Detail	None
Business loss		Rough	Detail	Detail	Detail
Environmental damage		None	None	Detail	None

The collection of actual damages is approached consistently across nations and is as follows:

- Identify areas affected by flooding during the event (or events) being assessed;
- Record the depth of inundation or the level to which floodwaters rose; and
- Record, in detail, the extent of damage for all of the buildings 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.

Five common activities have been identified that will establish and maintain a "best practice" approach. These activities are:

- **Flood damage assessment teams enter the affected area very shortly after a flood has occurred.**

  While there must be some sensitivity to those affected by the flood, the data to be collected is best collected while flood marks are fresh, damaged possessions and property are clearly visible and there is no "loss of memory" amongst those affected.

- **Flood damage assessment teams should consist of professionals with broad knowledge of flood behavior and able to value the damaged possessions.**

- **The flood damage assessment must cover all possible sources of damage.** Direct damages will include residential, commercial, industrial properties together with infrastructure and motor vehicles. Indirect damages especially clean-up costs, travel disruptions and loss of income/wages must also be included in the data collection.

- **The assessment teams must be able to access information regarding any insurance information, "community service" or charitable payments.**

- **All data collected must be documented in a consistent form to a National Standard.**
  This standardisation is essential to the development of "Stage-Damage Curves", essential in the Potential Damages assessment process described below. It should be noted that this standardisation is not always complied with, leading to some disparity in the quality of flood damages estimation. Once the data is collected, a total actual damage for the particular flood can be calculated. The data should then be analysed to provide a stage/damage relationship - flood depth above floor or above ground equating to a specific damage value. This stage/damage relationship is very site specific and can only be applied to the location where the flood occurred. If the relationship is applied to another location or stage/damage relationships are imported from another country, the resulting damages estimates will be of limited value without additional work adjusting the valuations used in the initial damages calculations.

Internationally, the practice for determining "Potential" damages is very consistent, and is based on the collection of property data, the estimation or survey 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 methodologies either have been computerised into specific Programs, such as ANUFLOOD or FLDAMAGE (Australian) and into *FloodEcon* (US Corps of Engineers) or are analysed using spreadsheet (Microsoft Access or Excel) methodologies. While these methodologies provide a guide to an approach to Potential Damages**, they cannot be directly applied** as their built-in Stage/Damage relationships reflect their country of origin, thereby placing a significant bias in damage values.

The procedures adopted in all methods use information from a detailed site survey of all residential, commercial and industrial buildings located on land inundated by floodwaters up to a probable maximum flood (PMF). Typical survey forms for potential damages surveys are attached in the Appendix.

Flood damages surveys, either actual or potential, are 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 projects, they also provide a means of prioritising projects (through addressing those areas with the highest damages first, etc.) on both a National and State basis.

1.4 Review of Past Flood Assessment Studies in Malaysia

The Japan International Co-operation Agency (JICA), in the National Water Resources Study (NWRS) for Malaysia, had conducted a nation-wide flood damage estimation exercise in 1982. Due to the limited availability of data and flood damage records, the 'proxy method' was employed in estimating the flood damages. Flood maps were prepared principally by assuming the largest flood recorded in each river basin between 1963 and 1982. Topographic maps of 1 in 50,000 scale or larger were used as base maps to plot the flood boundaries.

Land-use maps were superimposed onto the flood maps and from the different land-use flooded, flood damages were estimated. Damage to agriculture crops were directly estimated from the type of land-use flooded after applying appropriate flood depth damage factors. Damage to properties were computed from the number of households affected, which were estimated from the urban and mix-horticulture land-use together with data on population density.

The estimated flood damage in the NWRS 1982 study by JICA, represents the potential damage the flood assaults the area under the 1980 development conditions. The average flood damage potential for Malaysia at that time was estimated to be RM100 million per annum (at 1980 price level).

In year 2000, KTA Tenaga Sdn. Bhd., under the National Register of River Basin study commissioned by JPS Malaysia, carried out the updating of the flood damages that was completed by JICA in the above-mentioned study. The same proxy method was employed in the estimation of damages due to the limited available data on flood damages. However, flood maps were based on more recent flood events for floods of

larger magnitude. The latest available land-use maps were used to determine the type of land-use inundated. In this study, which is now under Final Report stage, the annual average flood damage for the whole country was estimated to be RM 915 million (at 2000 price level).

The proxy method employed in the two studies above is a conservative approach in flood damage assessment suitable for a large scale type of assessment. The standard potential damages for properties, agriculture and infrastructure were assumed to be uniform throughout the country.

The damage values and damage factors for agriculture crops in the study were adopted for this guideline as they are the most recent updated values.

2. DEFINITIONS

2.1 Flooding

Given the concepts of flooding and flood damages that are being addressed in these Guidelines, it is essential that the terminology used is consistent and understood. The following definitions of flood characteristics and flood damages are referred to throughout the guidelines:

Average Annual Damage (AAD) depending on its size (or severity), each flood will cause a different amount of flood damage to a flood prone area. **AAD is the average damage per year that would occur in a nominated development situation from flooding over a very long period of time**. In many years there may be no flood damage, in some years there will be minor damage (caused by small, relatively frequent flood events) and, in a few years, there will be major flood damage (caused by large, rare flood events). Average annual damage provides a basis for comparing the economic effectiveness of different management measures against floods of all sizes, i.e. their ability to reduce the AAD.

Average Recurrence Interval (ARI) the **long-term average** number of years between the occurrence of a flood as big as or larger than the selected event, e.g. floods with a discharge as great as or greater than the 20 year ARI flood event will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence

	of a flood event. Another term that may be used for flood frequency is **Annual Exceedance Probability (AEP).** AEP the chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example if a peak flood discharge of 500 m^3/s has an AEP of 5%, it means that there is a 5% chance (i.e. a chance of one-in-20) of a peak flood discharge of 500 m^3/s or larger occurring in any one year (see Average Recurrence Interval).
Effective Warning Time	the time available after receiving advice of an impending flood and before the floodwaters overwhelm damage reduction activities. The effective warning time is typically used to move farm equipment, raise furniture and evacuate people.
Flash Flooding	flooding which is sudden and unexpected. It is often caused by sudden local heavy rainfall or rainfall in another area.
Flood	relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or overland runoff before entering a watercourse and/or coastal inundation resulting from super elevated sea levels and/or waves overtopping coastline defences.

Flood Awareness	an appreciation of the likely effects of flooding and a knowledge of the relevant flood warning, response and evacuation procedures. In communities with a high degree of flood awareness, the response to flood warnings is prompt and efficient. In communities with a low degree of flood awareness, flood warnings are liable to be ignored or misunderstood, and residents are often confused about what they should do, when to evacuate, what to take and where it should be taken.
Flood Damage	the tangible and intangible costs of flooding. Tangible costs can be quantified in monetary terms, e.g. damage to goods and possessions, loss of income or services during the flood aftermath, etc. Intangible damages represent the increased levels of physical, emotional and psychological illness in flood affected people attributed to a flooding episode and are less easy to quantify in monetary terms. (These terms are defined in Section 2.3)
Flood Hazard	potential risk to life and limb and potential damage to property resulting from flooding. The degree of hazard varies with circumstances across the full range of floods. **Existing Flood Hazard** is the hazard a community is exposed to as a result of its location on the floodplain. **Future Flood Hazard** is the hazard a community may be exposed to as a result of its placement

	on the floodplain. **Continuing Flood Hazard** the hazard a community is exposed to after floodplain management measures have been put in place.
Floodplain	area of land which is subject to inundation by floods up to the probable maximum flood event, i.e. flood prone land. **Flood Prone Land** is land susceptible to inundation by the probable maximum flood (PMF) event.
Floodplain Management Measures	the full range of techniques available to reduce flood damage and disruption, as canvassed in floodplain management studies.
Local Overland Flooding	inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.
Mainstream Flooding	inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
Minor, Moderate And Major Flooding	**minor flooding**: causes inconvenience such as closing of minor roads and the submergence of low level bridges. The lower limit of this class of flooding on the reference gauge is the initial flood level at which landholders and townspeople begin to be flooded.

	Moderate flooding: low-lying areas are inundated requiring removal of stock and/or evacuation of some houses. Main traffic bridges may be covered. **Major flooding**: appreciable urban areas are flooded and/or extensive rural areas are flooded. Properties, villages and towns can be isolated.
Probable Maximum Flood (PMF)	the largest flood that could conceivably occur at a particular location. Generally, it is not physically or economically possible to provide general protection against this event. **The PMF defines the extent of flood prone land, i.e. the floodplain**. The extent, nature and potential consequences of flooding associated with the PMF event should be addressed in a floodplain management study.
Probable Maximum Precipitation (PMP)	the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (World Meteorological Organisation, 1986). It is the primary input to the estimation of the **probable maximum flood**.

2.2 Flood Damages

2.2.1 Tangible and Intangible Damages

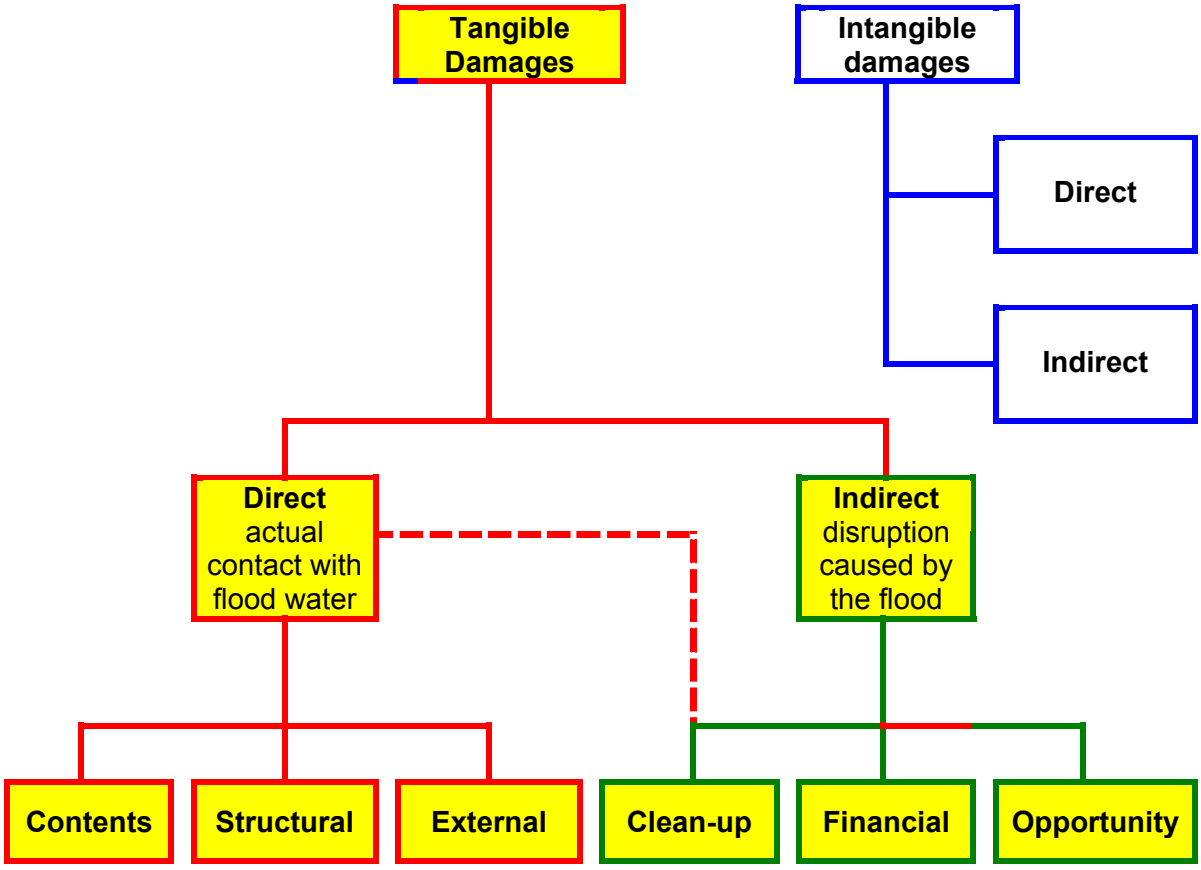
The most basic division of flood damages is into tangible and intangible damage categories. Figure 2.1 illustrates the various damage types commonly estimated/ assessed in flood studies and their inter-relationships.

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 infrastructure, 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 damages 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.

The emotional costs on flood victims can be quite severe and the strain may linger for several years after the event. Flood-aware communities can be expected to suffer less social and financial disruption than communities with a low level of flood awareness. This is, however, not always the case – an extreme or sudden flood event can have deleterious effects on the most aware of communities.

Figure 2.1 Types of Flood Damage



Both tangible and intangible damages can be divided into direct and indirect damages. Direct and indirect tangible damages can be clearly defined, as discussed above. In the case of intangible damages, however, the dividing line between direct and indirect damages is not clear-cut and is open to interpretation. While intangible damages are important, discussion on the division between direct and indirect intangible damages is not taken further in these Guidelines.

2.2.1.1 Direct Damages

Direct tangible damages are caused by floodwaters wetting goods and possessions, thereby either damaging them irreparably or reducing their value. Some items might be capable of repair; other items will be damaged beyond repair. In the first case, the direct damage is equal to the cost of repairs plus the loss in value of the repaired item. In the second case, the direct damage is equal to the pre-flood value of the item or its replacement cost. It may be that direct damages are not immediately apparent, as what may be thought to be repairable may have to be scrapped eventually, due to long-term damage.

The direct damage to a property (residential, commercial or industrial, urban or rural) is commonly divided into the categories of Contents, Structural and External damage. Contents damages generally refers to the impacts on items such as floor coverings, bedding, furniture, commercial stock, industrial output, equipment and machinery. Structural damage refers to damage to the structural fabric of buildings and includes damage to roads and infrastructure. External damage refers to all items external to buildings, including damage to parked motor vehicles.

Direct damages also include the loss of crops, the loss of value to damaged crops, infrastructure damage (roads, irrigation systems) and damage to machinery and equipment.

2.2.1.2 Indirect Damages

Indirect damages are the additional financial losses caused by the flood. These can include:

- The extra cost of food and accommodation for evacuees;
- Any loss of wages by employees;
- Any loss of investment in the affected areas where flood exposure may limit development or economic advancement;
- The loss of actual and/or prospective production or sales by flood-affected agricultural, commercial and industrial establishments; and
- Opportunity losses caused by the closure or limited operation of commercial, industrial or public facilities. These must be offset by increased economic activity in other localities.

This is not an exhaustive list of indirect damages – the full extent of these will only become apparent during the damage data collection exercise.

Indirect damage can be divided into general categories such as clean-up costs, financial costs and opportunity costs. Clean-up costs may also be considered a direct flood damage, particularly when those involved are employed by relevant authorities and that workforce would normally be employed in other activities. Financial costs usually refer to loss of wages, loss of production and loss of income inflicted on flood victims and businesses. Opportunity costs refer to the absence or reduced levels of service provided by public authorities and commercial/ industrial facilities. Opportunity costs are imposed on the community, including those with properties outside the floodplain.

Opportunity costs may also reflect loss of investment in an area and loss of confidence by clients that goods or services will be available as required. This economic impact on one area may be offset by possible increased activities in other areas.

2.2.2 Actual and Potential Damages

Flood damages can be divided into actual and potential damages. Actual damages are the damages caused by an actual flood and are calculated directly through valuations of property lost, the cost required to repair a property and the costs met in satisfying the indirect costs associated with a flood.

Potential damages are the maximum damages that could eventuate should a flood occur. In assessing potential damages, it is initially assumed that no actions are taken by the flood-affected population before or during the flood to reduce damage, such as lifting or shifting items to flood free locations, and moving motor vehicles.

The estimation of these damages is further discussed in Section 3.

2.2.3 Damage Reduction Factors

Damage Reduction Factors are used to convert potential damage estimates to likely actual damage estimates. Damage Reduction Factors are based on, amongst other factors, the length of the flood warning period and the flood awareness of the affected population. The longer the warning period, the greater the time available for evacuating goods and possessions; the more flood aware the population, the more effective these measures will be.

Stage-damage curves reflect average damages, however even for properties of the same type, there is typically a widespread variation in damage from property to property. Thus, when using stage-damage curves to assess damage in an unsurveyed property, the estimate is necessarily approximate. Further inaccuracies creep into damage estimates from uncertainties in flood, ground and floor levels. If the estimation procedures are soundly based, there should be no gross bias in the total damage estimate.

2.2.4 Average Annual Damage

To compare the benefit and effectiveness of proposed mitigation measures, it is necessary to first estimate the flood damage that would be caused by different sized

floods that might occur now, and second, estimate the reduced flood damage that would be caused by those floods after specific mitigation measures were implemented. For comprehensive cost/benefit analysis, this requires the estimation of the Average Annual Damage for the area concerned.

Over a long period, a flood prone community will be subject to a succession of floods. The table below indicates the probability of experiencing a flood of a certain magnitude over an expected lifetime of 70 years.

Table 2.1 - Probability of Experiencing a Given Size Flood One or More Times in 70 Years

Likelihood of Occurrence in any Year (AEP)	Percentage Probability of Experiencing	
	At least Once	At Least Twice
10% (1 chance in 10)	99.9%	99.3%
5%(1 chance in 20)	97.2%	86.4%
2%(1 chance in 50)	75.7%	40.8%
1%(1 chance in 100)	50.5%	15.6%
0.5% (1 chance in 200)	29.6%	4.9%

Average Annual Damage (AAD) is a convenient yardstick to compare the economic benefits of various proposed mitigation measures. AAD is equal to the total damage caused by all floods over a long period divided by the number of years in that period. (It is assumed that the development situation does not change over the period of analysis).

2.2.4.1 The Estimation of Average Annual Damage

The actual sequence of floods that will occur at a particular flood prone location is not generally a known factor. However, it is known that, **on average**, the 20 year Average Recurrence Interval (ARI) or Return Period event will occur once every twenty years, the 50 year ARI event will occur *on average* once every 50 years, etc. Further, by examining a range of floods, it is possible to estimate the potential and actual damages caused by floods of different severities.

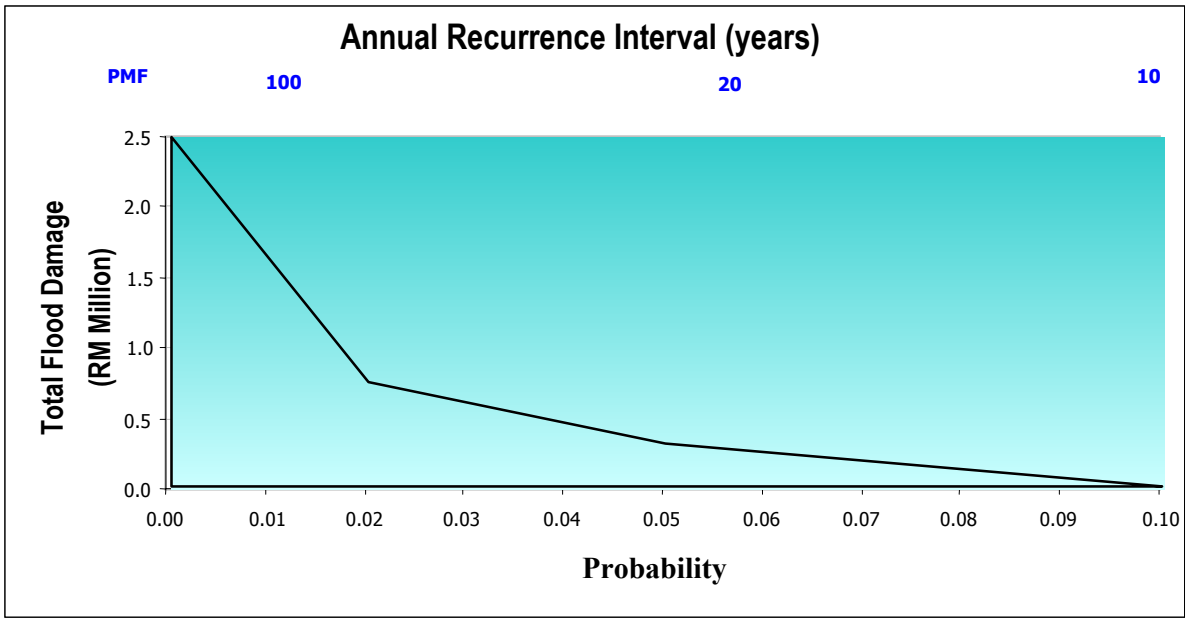


Figure 2.2 - Calculation of Average Annual Damage

In Figure 2.2 above, flood damage only commences at the 10 year ARI flood event and the more extreme the flood, i.e. the higher the ARI, the greater the damage. The AAD for the situation depicted in Figure 2.2 is equal to the area under the damage/probability of occurrence curve. The area under the 20 year ARI flood is RM5,000 (½ x RM200,000 x 0.05), i.e. floods up to the 20 year ARI event contribute RM5,000 to the AAD, which in Figure 2.2 is RM50,000 per year.

3. GUIDELINES AND PROCEDURES

3.1 Data and Information Needs

The data and information needs for the range of flood damage estimations, as well as the basic differences between the methods, are described in Table 3.1 below.

The main data and information needs are:

- Property data, including type of property and number of properties;
- Flood maps for either the particular event or for floods of various return periods;
- Flood data, including depth, velocity and times of inundation.

This data is essential for all damages studies and must be collected as soon as physically possible after a flood. Experience across many nations has shown that quick data collection is essential as:

- Data may be lost if people move away from affected areas;
- Flood marks may be lost with time so accurate estimates of depth are lost;
- Residents may be confused regarding which particular flood is being investigated, particularly if there have been a number of recent events; and
- There can be variations from flood to flood that must be identified and recorded for future, more detailed investigations.

It is not viable to wait for a long period after a flood to try to collect the essential data and there should be protocols in place, either within the relevant Agency or with the local authority, that will ensure the requisite data is collected immediately after the flood has occurred.

Table 3.1- Flood Damage Assessment Methods - Basic Differences and Data Requirements

ACTUAL DAMAGE ASSESSMENT	POTENTIAL DAMAGE ASSESSMENT	RAPID ASSESSMENT METHOD	DETAILED ASSESSMENT METHOD
1. To determine damages caused by an actual flood event 2. Requirements: - Flood Maps of the particular event. - Identify every property inundated. - Depth of inundation. - Conduct survey and record, in detail, the extent of damages for all damage categories (direct and indirect) 3. Total actual damages calculated from the data collected. 4. Stage/damage relationships can be developed for the types of development in the specific flood location.	1. To determine maximum damages that could eventuate should a flood occur. 2. Requirements: - Collection of property data. - Flood maps for floods of various return periods - Estimation/survey of ground and floor levels. - Identify a sample of representative properties from survey. - Estimate damages for 3 or 4 possible flood depths. - Stage/Damage curves for each type of property developed from previous studies 3. Assume no actions taken before or during floods to reduce damage. 4. Indirect damages are approximated as a percentage of total direct damages.	1. Quick, easy, desk-based method to provide a first level approximation of flood damages. 2. Requirements: - Flood Maps for a range of floods i.e defines the Study Area. - Potential damages for a range of properties in the Study Area. - Broad valuation of any major properties. - Standard rates for agriculture and infrastructure 3. Indirect damages are approximated as a percentage of total direct damages. 4. A preliminary estimate of AAD can be derived from a 4 point loss vs. probability curve.	1. Follows same procedure as an actual damages survey without having actual flood levels and actual flood damages. 2. Requirements: - Flood Maps for a range of floods from 'no damage flood' to PMF. - Detailed potential damages for properties. - Detailed valuation of major properties. - Stage/Damage curves for each type of property developed from previous studies - Detailed damages for agriculture and infrastructure. 3. Damages to include additional cost allowance for repairs and clean-up. 4. Total damages are plotted to produce damage/frequency curve, AAD can then be derived.

3.2 Determination of Actual Damages

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

Actual damage 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 to the contents of dwellings and work areas. Further, many items may have already been discarded during the clean-up process. These 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 pre-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 needs 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.

3.3 Determination of Potential Damages

Studies to determine potential flood damage are necessary for areas that have no recent records of damage in an actual flood or where major flooding has not occurred for a significant period. These estimates also cover floods greater than may have previously occurred. In a potential damage survey, a sample of representative properties is first identified and then damages to these properties are determined, either by questionnaire or through personal inspection.

In a potential damage 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 floor level). The damage estimates are made on the basis that no furniture and/or fittings are shifted should a flood occur. Detailed survey forms are required to record this data.

Actual and potential flood damage data can be presented as stage-damage curves for different property types. Such curves relate contents damage to depth of flooding above floor level. These curves are generally derived from numerous damage studies on similar areas throughout the region or nation. Stage-damage curves can be derived for residential, commercial, rural and public properties, however industrial properties have many inherent differences that may make stage-damage curves non-viable.

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 on 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.

3.4 Choice of Method - The Two-Tier Approach

Malaysia presents a broad range of situations for flood damage assessment. The major cities - Kuala Lumpur, Johor Bahru and Pulau Pinang - present the closest parallel to those areas where flood damage assessment methodology for urban areas was developed, whereas many other areas have very different flood regimes, flood reactions and types of property affected. The level of flood damages will vary across each State and Territory, and the need for detailed assessment, rather than a more general approach, must be established.

With such a wide range of possible applications, the issue to be addressed is "Will one method suit all applications?" 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:

- Rapid Assessment Method; and
- Detailed Assessment Method.

A discussion on when to adopt which method follows the discussion on the methods (below). Unless examination of the situation reveals a need for the Detailed Assessment Method, it is recommended that every flood affected urbanised area in Malaysia, (both Peninsular and East) should be subject to the Rapid Assessment Method, described below. When a quantitative assessment of the damages is available, the Detailed Assessment Method should be applied to those areas where the flood damages appear greatest or where there is the greatest need for mitigation works. In this way, the broad flood damages scenario can be established without the lengthy and expensive requirements of the Detailed Assessment Method.

With two methods (Rapid or Detailed Assessment Methods), or a combination of these methods available, how is the choice between methods made by practitioners. There is no simple "yes" or "no" scenario that can be set up to "automate" the response to this question; the answer is in the response to a series of questions.

The questions can be grouped into five broad but not mutually exclusive categories:

- Why is the damages study needed?
- What is the impact of flooding?

- Has a study been done before?
- How many properties are affected?
- What level of Flood Hazard do these properties face?

Why is the Damages Study Needed?

A damages study can have a number of reasons behind it:

- **Political** - there may be a need to advise a politician (e.g., State/Federal Minister or Local Mayor or Departmental Head) regarding the size of the flood problem and/or what cost may have been incurred;
- **Priority Determination** - the budget for flood studies and/or mitigation works may be limited and priorities need to be established between competing locations;
- **Obtaining funding** - funding may be sought to implement a study or work from either local sources or regional/world banking sources. These institutions will have certain requirements regarding cost/benefit or financial return and a justification will be needed for the lending authority; and
- **The Need to Know** - this may simply be the DID, State or Federal, wanting flood information on a town or groups of towns.

For all except the third point, application of the Rapid Assessment will usually suffice; funding authorities, and particularly regional or international funding authorities, will require a detailed assessment before any works are funded. A study to determine the data in more precise terms may only require a rapid assessment.

What is the impact of flooding?

Again, this question generates even more questions before a decision can be reached:

- Is flooding accepted as a part of normal life, as an occurrence that is simply part of the seasonal climate?
- Is flooding a rare occurrence (Kuala Lumpur) or is it becoming more common?
- Does it flood for a short or lengthy period with varying degrees of impact;
- Does flooding cause little disruption to life or does it cause major disruption to the study area?

Determining the response under this category requires some iteration with the previous category (Why is the damages study needed?) and the coming to a pragmatic decision. If flooding is a part of normal life, causes little disruption and the damages are required for information, then a Rapid Assessment Method is more than

adequate. However, if the flooding is not part of normal life, occurs frequently and there is considerable disruption, there is probably a demand for mitigation works and the Detailed Assessment Method will be essential for funding purposes.

How many properties are affected?

This is a simpler question to resolve, but does need knowledge of the flood extent. If only a small number of properties are affected by flooding, then the Rapid Assessment Method will provide the damages in a short time. If, however, there are a large number of properties involved, and the properties include industrial, commercial and residential properties, then it would be more appropriate to undertake an immediate Rapid Assessment to be followed by a Detailed Assessment when more data is gathered.

What level of Flood Hazard do these properties face?

This category is linked to nearly all others in the consideration of Methods. A quick assessment of risk requires knowledge of:

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

Much of the requisite knowledge for resolving this category would come from a range of flood studies and management studies in accordance with the recommended approach published in the "Klang River Basin Environmental Improvement & Flood Mitigation Project".

Has a study been done before?

If a study has been done, then the Rapid Assessment Method can be quickly applied or, if required, a Detailed Assessment can be carried out with limited additional work. If a study has not been done, then provided there can be some reasonable estimate of the flood extents, the Rapid assessment can be done but not a Detailed Assessment.

3.4.1.1 Illustrative Examples of Choice

To illustrate the approach to be adopted, two scenarios are discussed, a town in non-urbanised East Coast Peninsula Malaysia and the Klang Basin, the area being addressed in this study.

Example 1 - a town in non-urbanised East Coast Peninsula Malaysia. This hypothetical town has 500 residences of various types and is subject to regular monsoons flooding. The community is aware of this flooding and welcome it for the agricultural benefits it brings. There is unlikely to be any demand for flood mitigation works, or those that are required are generally limited in scope and cost. As such, there is little demand for detailed flood damage assessment and the Rapid Assessment Method would provide an estimate that is viable for the great majority of situations.

Example 2 - the Klang Basin. This is Malaysia's principle conurbation, with the cities of Kuala Lumpur, Shah Alam and others on the floodplain of the Klang River and its tributaries. There are thousands of potentially affected properties - agricultural, industrial, commercial and residential, let alone the public infrastructure and public services - on the flood prone areas. The flood hazard varies throughout the Basin, with community awareness being generally low. Flooding causes considerable disruption to community activities, resulting in high levels of political interest and involvement. Any flooding incident gives rise to political pressure to "do something" to stop the flooding however all mitigation works in such a built up area will be very costly and difficult to implement. In this case, a Rapid Assessment Method will only provide an approximation of the damages and benefits; the Detailed Assessment Method must be adopted for a case such as this.

3.5 Rapid Assessment Method

The "Rapid Assessment Method" (RAM) involves a limited amount of work to provide a first level approximation of the flood damages in a particular study area. RAM can be:

- Quick, once the practitioner has experience with the process;
- Easy, provided there is sufficient information to work through (see below for RAM requirements);
- Desk based, with only one inspection of the study area usually required; and
- A preliminary step in determining the need for the application of the Detailed Assessment.

It should be noted that RAM is not a suitable basis for any Benefit/Cost Analysis that may be required for External Funding of major projects. This will require application of the Detailed Assessment Method.

The Key Concepts of RAM can be described as:

- **Optimal ignorance** - knowing what facts are not worth knowing; and
- **Appropriate imprecision** - knowing that precise data are often unnecessary or impossible to obtain.

With these concepts in mind, RAM needs the following data to be successfully applied:

- Flood Maps (for a range of floods) – defines the "Study Area";
- Potential Damages for range of properties in Study Area;
- Broad valuation of any major properties; and
- Standard rates for agriculture and infrastructure.

3.5.1 Methodology

The application of RAM requires the following steps:

Define The Study Area

The region to be assessed can be large and complex (the Klang Basin) or a single town with small numbers of residential and commercial properties. As a broad criteria, areas where the effects from a given cause are felt should be combined to establish the study area. Once determined, existing topographical mapping or air photography can be used to determine the number of similar properties within the study area.

These maps/photos can also be used to determine number of large properties for individual assessment;

Estimate Damages for Each Flood Event

The main data required to use RAM are:

- Flood extent map;
- Simple count of the total number of each type of building; and
- A rapid survey of large non-residential buildings.

The potential damages can then be calculated by applying a standard potential damage to each property (see below for example) except for the large properties, which must be treated separately. These potential damages are then converted to an "actual" damage value through the application of a "damage reduction ratio" that reflects, among others, the experience of the community with flooding (experienced, ratio may be 0.5, inexperienced, ratio may be 0.9) and the effective flood warning time - the longer the warning period, the greater the time available for evacuating goods and possessions; the more flood aware the population, the more effective these measures will be.

Agricultural enterprises and all infrastructure, including roads, require special treatment. For example, damages to agricultural enterprises can vary according to:

- Type of enterprise;
- Time of year;
- Depth of flooding;
- Duration of flooding; and
- Velocity of flooding.

There is a need for significantly more investigation into agricultural damages, in all parts of the world. Some guidance may be gained from published sources, but it will be essential for Malaysian authorities to develop local valuations.

Infrastructure, which includes roads, railways, water treatment and sewerage infrastructure, must also be assessed. For roads, damages per kilometre of road inundated may be:

- RM 240,000 for primary sealed roads;
- RM 110,000 for secondary sealed roads;
- RM 85,000 for minor sealed roads; and
- RM 30,000 unsealed roads.

The above damage values are based on cost of road re-pavement of RM190,500 per ha as given in 'The Study on Integrated Urban Drainage Improvement for Melaka and Sungai Petani' by JICA (2000).

For railways, damages per kilometre of track may be RM2,000,000 however this value is very site specific and must be assessed more accurately in future studies.

Indirect damages are best approximated as a percentage of total direct damages. In the majority of cases, adopting 30% as the indirect damage will be adequate however this number may be varied when the characteristics of the study area are more closely examined. For example, where populations are low, 20% may be appropriate whereas a major city centre may require 45% as indirect damages.

Calculate AAD

The AAD for each Study Area is the single most important piece of data for determining relative problems and priorities between Study Areas.

Using RAM, a simple four-point loss-probability curve is sufficient to obtain a preliminary estimate of AAD. The points necessary are:

- The highest probability of the flood where damages are nil;
- Damages based on a mid range flood of known probability;
- Damages based on a high range flood of known probability (say 1% AEP, or 100 year ARI); and
- Damages based on an extreme flood of assumed probability (say 0.0001% AEP, or 10,000 year ARI).
- Using these points, a "curve" similar to that shown in Figure 2.2 can be developed and the AAD calculated as previously described.

3.5.2 Summary

A simple checklist of requirements to carry out RAM can be described as follows:

- Flood extent maps for a range of floods. Minimum of 3 ARIs e.g. 10 yrs, 100 yrs and PMF.
- The potential damages for a range of properties to be obtained from similar studies or survey
- Broad valuation of any major properties e.g. large commercial or industrial complexes.
- Standard rates for agriculture and infrastructure (given in this guideline)

- Determine the number of each type of properties inundated for the each range of flood from topographical maps or town maps
- Determine the same for roads and railway lines
- Determine the area of each type of crop land flooded from landuse maps or topographical maps, for the various range of floods.
- Calculate the AAD using the RAM spreadsheets.

3.6 Detailed Assessment Method

3.6.1 Data Requirements

A detailed flood damage assessment generally follows the same procedures as an actual damages study, without having the actual flood levels and actual flood damages. The following data is usually obtained:

- Addresses of buildings comprising street number and street name as per site visits and local authority records;
- Provision of a building description, i.e. flat, house, unit, shop, factory;
- Designation of building types between:
  - Residential
  - Commercial
  - Industrial
  - Public institution
  - Public utility
- A determination of the damage category within which each building falls as per site visits, i.e. low, medium or high;
- An estimate of building size;
- Identification of the type of material used in the construction of external walls and floors;
- Floor levels;
- Estimation of ground level at each building location, from topographic information;
- Identification of the possible cause of flood damage; and
- An identification chainage to locate the building at a point along the designated water course,

The value of damages to all property occupied by buildings can be computed for the following categories for particular flood events:

- Existing conditions; and
- Proposed design conditions with different flood mitigation options.

An additional cost allowance for repairs and clean-up of the local infrastructure is also included. Vacant land is considered to contribute negligible damages overall and is normally excluded from the study. For each category above, total damages resulting from all floods are plotted to produce a damage/frequency curve from which the Average Annual Potential Damage (AAD) is derived.

3.6.2 Data Presentation

A building database is established using a suitable computer-based data management program such as Excel or Access. The information held within the database is tied to individual blocks by street addresses enabling retrieval of specific data. Information in the Building database usually comprises the following:

- Floor level;
- Building type (residential, commercial, industrial, public institution, public utility);
- Building description or Business type (house, unit, etc or industrial, retail, etc);
- Material type (commercial and residential);
- Number of stories;
- Footprint of Building;
- Condition of Building and Garden (residential only);
- Value Code (residential only); and
- Estimates of building, contents and turnover (commercial only, not comprehensive).

The value of damages to buildings is evaluated by incorporating suitable relationships into the database. Commercial and industrial properties are assessed using actual damage data collected through surveys of commercial property owners. Damage curves are developed for low, medium and high levels of flooding.

Value Codes are used to indicate the estimated value of goods and material that may be damaged by a flood and are categorised based on the type of residence, its potential sale price and the likely level of fittings and furnishings therein.

3.6.3 Methodology

The procedure using a computer-based package to estimate direct flood damages has three major steps undertaken for each dwelling:

- Assign location, floor level, property type and value;
- Interpolate flood levels throughout the affected area for actual or design floods; and
- Estimate the potential flood damages.

The procedure is outlined in Figure 3.1 below.

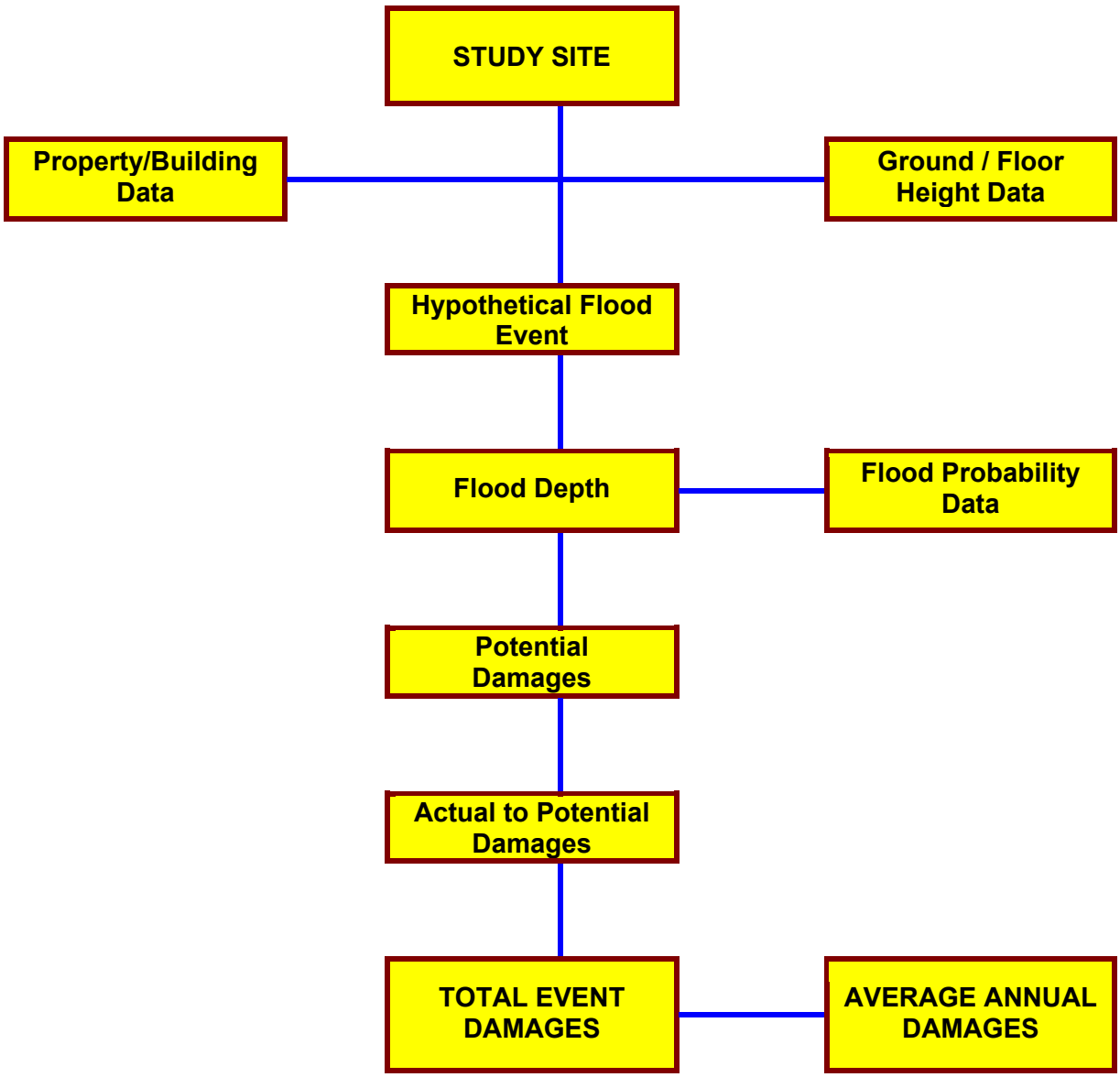
Property type and value information can be assessed as described above. Potential flood damage assessment requires flood level estimates at individual dwellings. An automated procedure of assigning design flood levels to dwellings can then be established for the data available. The procedure of assigning design flood levels to dwellings is based on interpolation of flood levels from the flood level data.

Individual property damage estimates are based on depth of flooding above floor level and generalised stage-damage estimates derived from previous damage studies. Potential damage estimates include damage to residential dwellings, commercial and industrial properties. Estimates of flood damage can be computed for a range of return periods, and AAD estimates prepared.

A detailed assessment needs

- Flood Maps for a range of floods from “no damage flood” to PMF;
- Detailed Potential Damages for properties in Study Area, based on inspection and valuation;
- Detailed valuation of any major properties; and
- Detailed damages for agriculture and infrastructure.

Figure 3.1 - Schematic of detailed Flood Damage Assessment Process



4. WORKED EXAMPLES

4.1 Rapid Assessment - Urban Area

A major town in Peninsular Malaysia has a flooding problem and based on flood maps of floods of various return periods, it is estimated that the properties are divided as below:

Property Type	Number In 5% AEP Flood	Number In 1% AEP Flood	Number in extreme Flood
Residential			
Kampung Houses	46	167	240
Bungalow	58	140	360
Terraces houses	25	300	350
Flat/Apartments	20	88	100
Commercial			
Small Commercial	20	70	120
Medium Commercial	10	25	30
Large Commercial Complexes	1	4	20

From the 'Flood Damage Assessment of 26 April 2001 Flooding affecting the Klang Valley' by KTAT (2003), the following potential damages values have been established for the various property types:

Property Type	Damages In RM
Residential	
Kampung Houses	9,225
Bungalow	11,360
Terraces houses	10,260
Flat/Apartments	6,600
Commercial	
Small	12,000
Medium	24,000
Large (Complexes)	160,000

Applying the Potential Damages to the number of properties, and then applying an 80% potential to actual ratio, and also indirect and intangible damages of 40%, the Calculations give:

Flood Event	Potential Direct Damages RM	Estimated Actual Damages RM	Infrastructure Damages RM	Indirect Damages RM	Total Damages RM
In 5% AEP Flood	2,111,730	1,689,384	750,000	975,754	3,415,138
In 1% AEP Flood	8,869,775	7,095,820	2,000,000	3,638,328	12,734,148
Extreme Flood	15,914,600	12,731,680	8,000,000	8,292,672	29,024,352

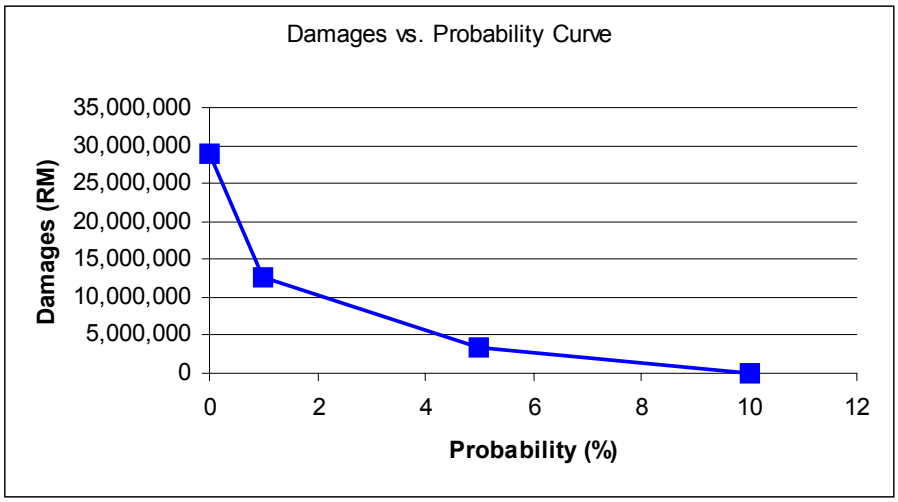
Calculating AAD, the estimated AAD using RAM for this town is RM616,948; this can be rounded to RM617,000 to reflect the innate inaccuracy of the process. A sample worksheet is attached that shows the full RAM calculation from the Excel Spreadsheet. The calculation spreadsheet is available in the floppy diskette attached to this guideline. It should be noted that once the spreadsheet is established and all formulae verified correct the actual calculation of AAD takes less than 5 minutes.

Sample AAD Worksheet for RAM.

Type of Property	Damage Unit Value (RM)	Number of Properties		
		In 5% AEP Flood	In 1% AEP Flood	Extreme Flood
Residential				
Kampung Houses	9,225	46	167	240
Bungalow	11,360	58	140	360
Terraces houses	10,260	25	300	350
Flat / Apartments	6,600	20	88	100
Commercial				
Small	12,000	20	70	120
Medium	24,000	10	25	30
Large (Complexes)	160,000	1	4	20

Flood Event	Potential Direct Damages	Estimated Actual Damages	Infrastructure Damages	Indirect & Intangible Damages	Total Damages
In 5% AEP Flood	2,111,730	1,689,384	750,000	975,754	**3,415,138**
In 1% AEP Flood	8,869,775	7,095,820	2,000,000	3,638,328	**12,734,148**
Extreme Flood	15,914,600	12,731,680	8,000,000	8,292,672	**29,024,352**
Notes:		*P/A = 0.8* *Flash =1.0 flood*	*Note: these are assumed values only*	*ID = Total D * 0.4*	**45,173,638**

Probability %	Probability	Damages	AAD
10	0.1	0	
5	0.05	3,415,138	85,378
1	0.01	12,734,148	322,986
0.001	0.00001	29,024,352	208,584
Total AAD			**616,948**



4.2 RAPID ASSESSMENT - RURAL AREA & CROPS

The majority of damage in rural areas occurs to crops rather than buildings, be they residential, commercial or industrial. The flood damages in rural areas are best estimated using the Rapid Assessment Method.

For crops, four factors affect the damage likely to be experienced from flooding:

- Type of crop;
- Stage of growth of crop;
- Depth of flooding; and
- Duration of flooding.

Flood damage factors and crop production values, taken from recent flood studies completed in the country, given in Appendix 1 can be used for calculation of damages.

For the following example of flood damage estimation using RAM, the northern state of Kedah is selected. The extreme flood event in this example has a flood duration of 6 days and a flood depth of 1.0m on average. Based on flood maps of various flood return periods, the estimated number of properties and area of crops inundated are tabulated below:

Type of Property & Crops	In 5% AEP Flood	In 1% AEP Flood	Extreme Flood
Property	(no.)	(no.)	(no.)
Residential	95	190	230
Commercial	5	20	30
Crops	(ha.)	(ha.)	(ha.)
Paddy	160	240	480
Rubber	15	110	110
Oil Palm	24	125	350
Coconuts	20	50	120
Other Tree Crops	20	20	50
Mix Horticulture	30	30	180

Table 4.1 'Computation of Crop Damages for Extreme Floods' shows the related flood damage factors. For extreme event, it was assumed that the flood occurred during the booting to heading period for paddy crops which result in heavier losses. The unit value for paddy production in Kedah is RM1,857 per hectare. Table A.2 'Crop Production Unit Values' in the Appendix gives the unit values for all states in the country. The unit damage values for residential and commercial properties are obtained from 'The Study on Integrated Urban Drainage Improvement for Melaka and Sungai Petani by JICA (2000).

The potential damage values for the various property types and crops are computed and shown in the following computation tables. For crops, only the damage for extreme flood is estimated. The damages for crops in the 5% and 1% AEP flood are assumed to be directly proportional to the area flooded in relation to the area flooded in the extreme flood. The actual damages are assumed to be 80% of the potential damages. Indirect and intangible damages are assumed to be 30% of the total direct damages. The AAD for this particular example for a rural area in Kedah using RAM, is computed to be RM125,390. The Excel spreadsheet for this worked example is also available in the floppy diskette attached to this guideline.

Table 4.1 – Computation of Crop Damages for Extreme Flood

State: Kedah **Flood Depth** **1.0m**

Type of Crops	Production Unit Value (RM/ha)	Planted Area Subject to Mortality (%)	Area Inundated (ha)	Flood Duration (days)	Damage Factor (%)	Total Damage (RM)
Paddy*	1,857	-	480	6	43	383,285
Rubber						
-Production loss per day	23.50	-	110	6	-	15,510
-Mortality	5,200	9	110	6	5	2,574
Oil Palm (mortality)	3,500	9	350	6	10	11,025
Coconuts (mortality)	6,200	9	120	6	10	6,696
Other Tree Crops (mortality)	6,400	10	50	6	25	8,000
Mix Horticulture	4,700	-	180	6	25	211,500

Notes : * Damage factor for production loss for paddy is also dependent on planting stage.

Table 4.2 – Computation of Damages

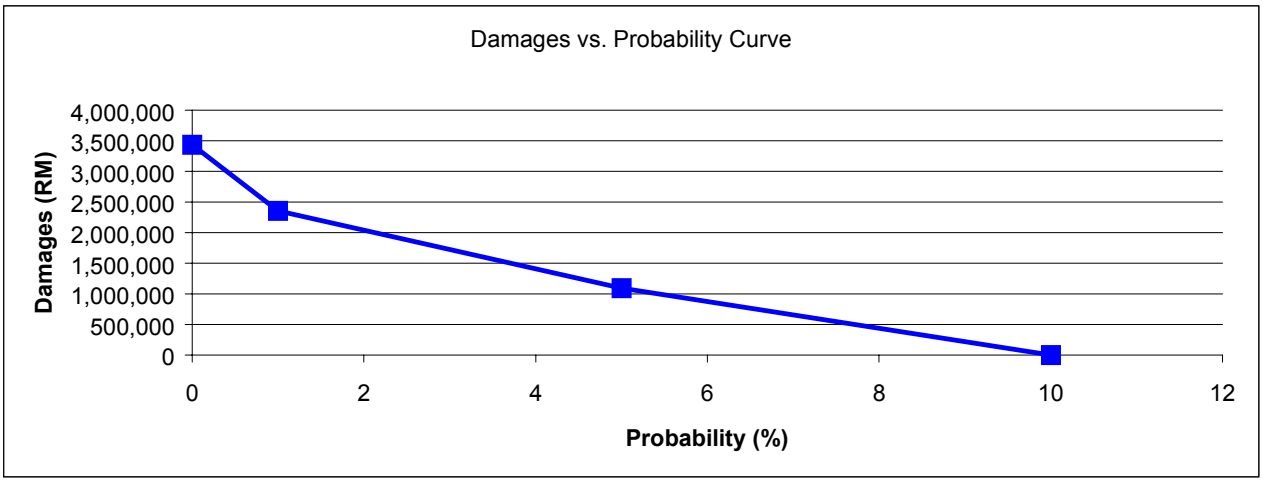
Type of Property & Crops	Damage Unit Value (RM)	In 5% AEP Flood		In 1% AEP Flood		Extreme Flood	
		Damage (RM)		Damage (RM)		Damage (RM)	
Property		**nos.**		**nos.**		**nos.**	
Residential	7,010	95	665,950	190	1,331,900	230	1,612,300
Commercial	18,385	5	91,925	20	367,700	30	551,550
			0		0		0
			0		0		0
Crops		**ha**		**Ha**		**ha**	
Paddy		160	127,762	240	191,642	480	383,285
Rubber		15	2,466	110	18,084	110	18,084
Oil Palm		24	756	125	3,938	350	11,025
Coconuts		20	1,116	50	2,790	120	6,696
Other Tree Crops		20	3,200	20	3,200	50	8,000
Mix Horticulture		30	35,250	30	35,250	180	211,500
TOTAL			928,425		1,954,504		2,802,440

Table 4.3 – Computation of Actual Damages

Flood Event	Potential Direct Damages	Estimated Actual Damages	Infrastructure Damages	Indirect & Intangible Damages	Total Damages
In 5% AEP Flood	928,425	742,740	100,000	252,822	1,095,562
In 1% AEP Flood	1,954,504	1,563,603	250,000	544,081	2,357,684
Extreme Flood	2,802,440	2,241,952	400,000	792,586	3,434,537
Notes:		*P/A = 0.8*	*Note: these are assumed values only*	*ID = Total D * 0.3*	6,887,783

Table 4.4 – Computation of AAD

Probability (%)	Probability	Damages (RM)	AAD (RM)
10	0.1	0	
5	0.05	1,095,562	27,389
1	0.01	2,357,684	69,065
0.001	0.00001	3,434,537	28,932
		Total AAD	**125,386**



4.3 DETAILED ASSESSMENT - URBAN AREA

The following example is based on work undertaken in Australia and applies strictly to Australian situations. As previously indicated, methodologies cannot be directly translated from country to country and there is a need to develop not only Damages Curves for Malaysia but also the formulae referred to below. This will ensure an accurate reflection of damages in the Malaysian context.

Damage evaluation to individual properties is based on a designation of building type corresponding to a Land Use number, i.e.:

Residential	-	Land Use 1
Commercial	-	Land Use 2
Industrial	-	Land Use 3
Public institution	-	Land Use 4
Public utility	-	Land Use 5

Each Land Use type, except for residential, is further categorised as either a low, medium or high damage category in an attempt to estimate more accurately the direct potential damage to individual properties.

In evaluating property damage for residential Land Use types the following equations are used:

For Depth of over floor flooding (H) < 1 m

$$D = D_2(0.06 + 1.42H - 0.61H^2)\ R\ (1 + ID) + D_{CLEAN} \quad (1)$$

For Depth of over floor flooding (H) > 1 m

$$D = D_2\ (0.75 + 0.12H)\ R\ (1 + ID) + D_{CLEAN} \quad (2)$$

Where D = Value of damage to property (RM)

D_2 = Assessed value of residential property damage at 2 m depth of flooding (H) or "size" (RM)

H = Depth of over floor flooding (m)

R = Reduction factor by virtue of a flood warning provision. 0.85 was adopted in this example.

ID = Indirect damage factor. 0.2 was adopted for this example.

D_{CLEAN} = Clean-up cost (RM)

Measures of "Size"

One measure of size is adopted for the evaluation of residential damages and another for the evaluation of the remaining Land Use category damages.

For properties other than residential, the floor plan area of the building is adopted as the size (A). For residential Land Use, an assessed value of residential property damage at a height of 2m above floor level was adopted as the size based on tables of values developed for previous studies, with adjustments to account for the different land values in different locations.

Based on extensive site survey, the median value property category was adopted as representative of the residential property within the flood zones. Thus the size (D2) of residential property became the summation of the internal, external and structural amounts of the medium value property category.

To make an allowance for the difference in comparable "size" between houses, flats and units, the following formulation was derived:

D_2 = X (Int + Ext) + (Y x Struct) (3)

D_2 = Annual assessed value of residential property at 2 m depth of flooding (H) or size (S) (RM)

Where

X = Total number of units/flats located on title block

Y = Total number of buildings which contain X

Int = Internal property value (RM)

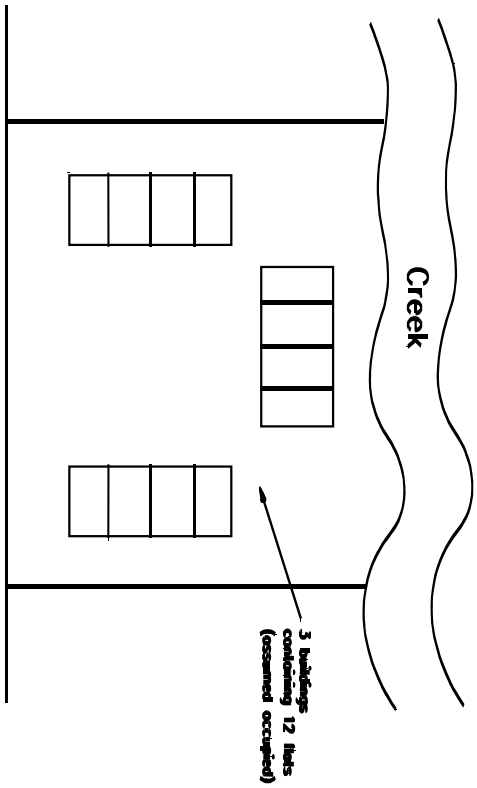
Ext = External property value (RM)

Struct = Structural property value (RM)

An example of the use of Equation 3 is the case illustrated in Figure 4.1 below where 12 units are assumed to have internal and external values of $16 000 and $1 750, respectively, and there are three buildings having a structural value of $10 000 each.

Thus D_2 = 12 (16 000 + 1 750) + 3 x 10 000 = $243 000

FIGURE 4.1 - Illustration of Building Count



Flood Level Interpolation

A hydraulic model of a floodplain only provides estimates of flood levels at specific cross sections along the river being modelled. Intermediate flood levels are therefore computed by interpolation, based on chainage.

Reduction Factor due to Flood Warning

The reduction factors or actual damage factors were determined from a review of previous studies. This factor is, as discussed above, the result of consideration of a number of factors, principally flood warning and the awareness of the community to measures to reduce flood damages. In some cases, where warning is very short, it is conservative to adopt a very low reduction factor to reflect the time it takes to mobilise the community to take suitable measures. In other cases, where there is a long warning time, the reduction factor could be as high as 90%.

Indirect Potential Damages

The indirect potential damages are usually expressed as a percentage of direct damages, again based on previous studies and accounting for conditions in the area in question. For residential properties, where clean-up costs were calculated as a

separate item, a factor of 20% may be allowed for the indirect potential costs. For commercial properties a factor of 25% or more is usually adopted. This factor includes the clean-up costs.

Potential clean-up costs

To calculate the potential clean-up costs for residential properties, a clean-up equation was adopted to suit Australian conditions:

$$D_{CLEAN} = \text{Daily rate} \times Z \times \ln\left(\frac{H}{0.023}\right) \quad (4)$$

Where D_{CLEAN} = Potential clean-up costs (RM)
Daily rate = Earnings per day of one worker ($/day)
H = Depth of over floor flooding (m)
Z = Factor accounting for sediment load and deposition

Special Conditions

Due to the inclusion of the natural logarithm function ln(A) in all equations used to evaluate damages, a value of "A"< 1 would result in negative values creating instances of negative damages for small depths of over floor flooding ranges. Considering D_{CLEAN}, if D_{CLEAN} is to be greater than zero, h must be greater than 0.023 m.

Accordingly, for depths of flooding between zero and (0.023 + 0.01) m (=0.033 m), D_{CLEAN} was estimated from Equation (4) as if the depth, H, was in fact 0.033 m:

D_{CLEAN} = 550 ln (0.033/0.023) = $198.56

Cautionary Note

The detailed assessment described above, as well as all other internationally applied methods, works on the basis of damage per unit-type of property (residential/commercial/industrial). This type of relationship is best illustrated in "Stage/Damage Curves" where the level of water above the ground or above the floor is equated to a level of damages in monetary terms.

As indicated previously, there are a range of detailed assessment methods that are based on increasingly complex computer-based models. These methods can range from the example given above, which can be performed on a suitable spreadsheet

(Microsoft Excel or Access) to GIS supported models such as ANUFLOOD or *FloodEcon*. **While these methodologies can be applied to Malaysian situations, they cannot be directly applied as their built-in Stage/Damage relationships reflect their country of origin, thereby placing a significant bias in damage values.**

As more detailed damages studies are undertaken, it is essential that the resulting data is centrally pooled, co-ordinated and collated so that an overall picture of damages and stage/damage relationships can be developed for Malaysia, or even within States in Malaysia.

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APPENDICES

APPENDIX 1

Table A.1 - Flood Damage Factors for Crops

Item	Flood Depth	Flood Duration	Damage Factor (%)		Remarks
			Booting to Heading Period	Heading to Ripening Period	
Paddy (Production loss)	Less than 0.5m	less than 2 days	30	3	
		3 to 4 days	37	8	
		5 to 6 days	40	11	
		more than 7 days	45	12	
	0.5 to 1.0m	less than 2 days	33	5	
		3 to 4 days	40	17	
		5 to 6 days	43	24	
		more than 7 days	49	25	
	More than 1m	less than 2 days	60	11	
		3 to 4 days	80	35	
		5 to 6 days	86	45	
		more than 7 days	96	48	
Rubber (Mortality of young tree)	More than 0.25m	less than 7 days	5		Assume 9% of total planted area to be subject to mortality
		8 to 14 days	15		
		15 to 21 days	60		
		more than 22 days	100		
Oil Palm /Coconuts Palm (Mortality of young tree)	More than 0.25m	less than 7 days	10		Assume 9% of total planted area to be subject to mortality
		8 to 14 days	20		
		15 to 21 days	70		
		more than 22 days	100		
Other Tree Crops (Mortality of young tree)	More than 0.25m	less than 4 days	10		Assume 10% of total planted area to be subject to mortality
		5 to 8 days	25		
		9 to 12 days	60		
		more than 13 days	70		
Mix Horticulture (Mortality)		less than 4 days	10		
		5 to 8 days	25		
		9 to 12 days	50		
		13 to 16 days	75		
		more than 17 days	100		

Source: 1. JICA 1982 Study: NWRS, Malaysia

2. JICA 1999 Study: Sg. Perak RBIS

Table A.2 – Crop Production Unit Values

Types of Crops			Unit	Value (RM)
1.	Mix Horticulture		ha	4,700
2.	Paddy	Perlis	ha	1,872
		Kedah		1,857
		Pinang		1,471
		Perak		1,500
		Selangor		1,911
		N. Sembialan		1,359
		Melaka		1,412
		Johor		1,197
		Pahang		967
		Terengganu		1,644
		Kelantan		1,519
		Sabah		1,409
		Sarawak		809
3.	Rubber	(Mortality)	ha	5,200
		Production loss	/ha/day	23.50
4.	Oil Palms	(Mortality)	ha	3,500
5.	Coconuts Palms	(Mortality)	ha	6,200
6.	Other Crops	(Mortality)	ha	6,400

Source: KTAT 2002 Study – National Register of River Basin Study, Part 2.

APPENDIX 1

- **Table A.1 : Flood Damage Factors for Crops**

- **Table A.2 : Crop Production Unit Values**

APPENDIX 2

POTENTIAL DAMAGES SURVEY FORMS

- **Form 1 : Standard Urban Flood Damage**
- **Form 2 : Standard Rural Flood Damage**

POTENTIAL DAMAGES SURVEY

FORM 1 : STANDARD URBAN FLOOD DAMAGE

Data Collected by : _____

Street/Road Name: _____ Date : _____

House No.	Unit No.	Property Code	Comments	Flood Level (m)	Floor Leveling			Storeys (Nos.)	Value (Code/RM)
					Ground Level (m)	Height to Floor (m)	Floor Level (m)		

Property Code: *Residential* - *A (Bungalow), B (Semi-Detached), C (Terrace), D (Flats/Apartment) E (Others – Detail)*

Non-Residential - *1 (Retail), 2 (Warehouse), 3 (Office), 4 (Industrial), 5 (Educational), 6 (Health Care)*

POTENTIAL DAMAGES SURVEY

FORM 2 : STANDARD RURAL FLOOD DAMAGE

Identification	Crop Losses			Stock Losses			Plant/Equipment Losses			Residential Losses	
	Type	Area Flooded (ha)	Area Not Flooded (ha)	Type	Drowned (Nos.)	Evacuated (Nos.)	Fences (m)	Roads (m)	Other	Flood Depth Above Floor Level (m)	Property Evacuated (Yes/No)
Name:											
Address:											
Property Name:											
River/Stream:											
Name:											
Address:											
Property Name:											
River/Stream:											

APPENDIX 3

POTENTIAL DAMAGES SURVEY QUESTIONNAIRE

Potential Damages Survey
Survey for Commercial or Industrial Premises

PROPERTY REFERENCE NUMBER: _____

Date:	FOR OFFICE USE ONLY
Surveyor:	Ground Level (m):
Height to Floor (m):	Floor Level (GL plus height):

Introduction

As you would be aware, some parts of _____ can be affected by flooding from Sungai _____. In the past, floods have had a significant impact on businesses, causing damage to business premises, loss of trade and costs associated with clean up activities. These are direct impacts of flooding. As a result of these losses, businesses are sometimes forced to put off renovations, delay purchase of new 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 responses to this questionnaire are entirely confidential and will not be published. However, the data contained will be consolidated to support possible works and measures to mitigate the impacts of flooding. We would appreciate it if you could complete the attached survey and return it in the postage paid envelope by _____.

If you have any questions about this survey or the Floodplain Management Study or Plan, please feel free to call _____.

Item 1 - Business Details

*a) Business Name:*_____
*b) Business Type:*_____
*c) Street Address:*_____
*d) Length of time in business:*_____

d) Type of Buildings:
(Eg: storage shed/warehouse, workshop, garage, cellar, shop, office, residence)

	Type	General contents of building	Number of storeys	Floor size (m^2)
Main building				
Additional buildings				
Additional buildings				

e) Building Material (concrete, timber, brick, fibro, plasterboard, steel, carpet, lino, tiles, other):

	Floor	Floor covering	Internal walls	Internal frame
Main building				
Additional building				
Additional building				

f) Do you provide exclusive car parking facilities for staff or customers?

☐ No ☐ Staff only ☐ Customers only ☐ Staff & customers Total No. spaces _____

g) If you answered yes to f) what type of car parking do you provide?

☐ Above ground ☐ Basement *If basement, how many levels?*_____

h) Do you see your car parking needs changing? If so how and in what time frame?
_____
_____

Item 2 - Flood History

a) Has the property ever been affected by flooding?(tick appropriate box)

☐ No	Go to item 3
☐ Yes	Please indicate details below

Year of flood	Estimated flood height (m):		Comments
	Above floor level	Above ground level	

b) Please indicate the damage that was caused to merchandise or stock; fittings, fixtures or equipment; foundations or walls.

Damaged Items	Description of item	Was the item raised? How high (m)?	Was the item damaged and repairable (R) or destroyed (D)?	Repair or replacement cost
Stock				
Fittings (eg doors, shelves, cupboards)				
Fixtures (eg floor coverings, painting)				
Wiring and cabling (eg telecom)				
Equipment (eg machinery,furniture)				
Electrical Equipment (eg photocopiers, computers)				
Foundations (eg settlement or slabs lifting)				
Internal walls (eg collapse or warping of walls)				
Other				

Comments or additional information _____
_____
_____

c) Have you ever received customer complaints about flood related incidents?

☐ No ☐ Yes

If yes, please comment:_____
_____
_____

*d) How much business was lost as a result of past flood events? (*Including the actual flood and time cleaning up) Year of flood: _____

During the flood

Business closure time (days):	
Estimated turnover loss per day ($):	
If business remained open, did you suffer reduced turnover?	
If yes, what was the estimated percentage reduction in daily turnover?	
For how long was turnover reduced (days)?	

After the flood

Clean-up time (days):	
Was the business closed during clean up?	
If business remained open, did you suffer reduced turnover?	
If yes, what was the estimated percentage reduction in daily turnover?	
For how long was turnover reduced (days)?	

Comments or additional information:_____
_____
_____

Item 3 - Potential loss of goods

a) *In the event of a flood (if never experienced flooding) or in a larger flood than previously experienced, please identify your potential loss in each of the following categories (ie. Total amount of goods, fixtures and equipment subject to inundation)- consider 0.01m, 0.5m and 1m depths:*

Item that could be damaged by flooding	Description of item	Height of item above floor level (m)	Is the item raiseable? Y/N	Would the item be damaged and repairable (R) or need replacing (D)?	Repair or replacement cost
Stock					
Fittings (eg doors, shelves, cupboards)					
Fixtures (eg floor coverings, painting)					
Wiring and cabling					
Equipment (eg machinery, motors, furniture)					
Electrical Equipment (eg: computers)					

Note: Previous available information will be used to estimate damages for structures, internal walls and clean up.

b) Could all raiseable items be moved out of rising floodwaters if you had prior notification? (approximately 30mins maximum)

☐ Yes ☐ No

Comments or additional information:
_____
_____

_____
_____

Item 4 – Future Business Improvements
a) Do you have any plans for improvements to your property or to purchase new equipment? If so please provide details below, including costs:

_____
_____
_____
_____
_____
_____

b) Does the possible impact of flooding deter you from carrying out the works listed above? Please give reasons.

_____
_____
_____
_____
_____
_____

Item 5 - Do you have other comments from this survey?
(Eg loss of clients, especially permanently; loss of client confidence; other affects from flooding)

_____
_____
_____
_____
_____
_____

Thank you for your assistance
Please return in the enclosed pre-paid envelope.

If you have any questions please contact:

APPENDIX 4

ACTUAL DAMAGES SURVEY QUESTIONNAIRE

ACTUAL DAMAGES SURVEY

Flood Damage Questionnaire

Introduction

The recent storm event and associated flooding created significant and widespread damage and disruption.

It is essential to collect as much data as possible on the storm event and associated flooding.

Your assistance is sought and will be appreciated.

Three (3) questionnaires are attached. The first questionnaire covers **Flood Data** while the second and third cover **Residential Flood Damage** and **Commercial/Industrial Flood Damage**.

We are asking your help by:

1) Completing Questionnaire 1 on Flood Data.

2) Completing and attaching Questionnaire 2 if your property is a *Residence* or Completing and attaching Questionnaire 3 if your property is *Commercial or Industrial.*

3) Posting the completed questionnaires in the postage paid envelope.

The data collected from the Flood Data Questionnaire will be used to complete our understanding of the recent flood. Information on damage and other data provided by the Residential Damage and Commercial Damage questionnaires will be collated and combined into group information such as flood depth compared to flood damage.

The data provided on your questionnaires is **Confidential** and will only be used by the authorities and their consultants in assessment of the flood and its consequences. The data will not be released to any other parties or bodies without your permission.

We are very aware of the significant damage, disruption and personal hardship that the recent storm event and associated flooding has caused. Your assistance in provision of the completed questionnaires will greatly help in developing ways to deal with similar events in the future.

QUESTIONNAIRE 1. STORM EVENT AND ASSOCIATED FLOOD DATA

Would you please: - Tick ☐ box where requested.
- Complete other sections

1. Please provide your address, details as below.

Address: ……..……..……

……..…...…..……...……

……..……..……Postcode …….

Name or Name of Business/Organisation (Optional): ……...…….….

……..……

2. How long have you been at this address (or owned this property)?

……. Years

3. What is the type of property development?

☐ Residential

☐ Commercial Please indicate type:

……..……..

☐ Industrial Please indicate type:

……..……..

☐ Other Please specify:

……..……..

4. Regarding this property, are you?

☐ Owner residing or conducting business at property
☐ Tenant
☐ Owner not residing nor conducting business at property
☐ Body Corporate
☐ Other Please specify: ……..……..

5. Have you previously experienced any flooding or drainage problems at this address?

☐ No ☐ Yes

QUESTIONNAIRE 1. STORM EVENT AND ASSOCIATED FLOOD DATA (Cont.)

6. What parts of your property were flooded and to what depth? (you may tick more than one box)

☐ Grounds (m) ☐ Garage/Shed (m) ☐ Building (m)

7. Would you please draw a sketch map of your property (in the space below).

Can you indicate your property compared to the surrounding properties, your street, where floodwater came from and went to. If possible, please indicate flood depths and any other details you think are relevant.

SKETCH OF PROPERTY AND WHERE FLOOD OR STORMWATER FLOWED OR REACHED.

QUESTIONNAIRE 1. STORM EVENT AND ASSOCIATED FLOOD DATA (Cont.)

8. Do you have any suggestions for resolving the flooding or drainage problems in your area?

……...……...……

……...……...……

9. Do you have any photographs, video or other information about flooding in your area which you would be prepared to make available?

☐ No ☐ Yes

10. Do you have any information which would help us identify water levels at particular times through the recent flood?

☐ No ☐ Yes

11. If you have relevant information (you have answered yes in Question 9 and 10) or if you have other information which you think would be relevant, please provide your telephone number below so that we may contact you.

Phone: …… (Ask for)

Best time to call is: ……

12. Please post this questionnaire with your Damage Questionnaire.
(Note: no stamp required for the attached reply paid envelope)

If you would like this questionnaire to be collected, please contact:

Telephone: **Fax:**

E-mail:

Thank you for your assistance.

QUESTIONNAIRE 2. HOUSE DAMAGE SURVEY

1. Age of Building …….. (Years)

2. Building Materials

External Walls ☐ Brick ☐ Cladding ☐ Timber ☐ Other (Please specify) ……..

Internal Walls ☐ Brick ☐ Gypsum ☐ Timber ☐ Other (Please specify) ……..

3. Building Form

Storeys ☐ One ☐ Two ☐ Three or More
Bedrooms ☐ One ☐ Two ☐ Three ☐ More

4. Damages

Damage to the building

Area	Description of Damage	Estimated cost
Foundations		
External Walls		
Internal Walls		
Floors		
Doors/Windows		
Built-Ins		
Other		

Damage outside the building

	Damaged items	Estimated cost
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 ……

QUESTIONNAIRE 2. HOUSE DAMAGE SURVEY (Cont.)

Damage inside the building

Room	Damaged items	Comments	Estimated Cost
Kitchen	Appliances		
	Furniture		
	Food		
	Floor Coverings		
Dining	Appliances		
	Furniture		
	Floor Coverings		
Lounge/Living	Appliances		
	Furniture		
	Floor Coverings		
Bedrooms	Appliances		
	Bed-Base & Linen		
	Clothing		
	Floor Coverings		
	Furniture		
Bath/Toilets	Appliances		
	Floor Coverings		
	Other		
Laundry	Appliances		
	Floor Coverings		
	Other		
Other			

5. Clean Up Costs

Inside the building _____ Days/Hours _____ Cost
Outside the building _____ Days/Hours _____ Cost

6. Loss of Wages _____ Days/Hours _____ Cost

7. Other Costs

……...……...……
……...……

8. Any other comments

……...……

QUESTIONNAIRE 3. COMMERCIAL/INDUSTRIAL DAMAGE SURVEY

1. Type of Business

……

2. Age of Building …..… Years **3. Number of Storey** …..….

4. Building Material

Foundation ……..……...

Walls ……..……...

Floor ……..……...

Floor Covering ……..……...

5. Floor Area ……..……...

6. Depth of Flooding above Floor Level (m) ……..

7. Damages sustained

Damage to the building

Area	Description of damage	Estimated cost
Foundations		
External Walls		
Internal Walls		
Floors		
Doors/Windows		
Other		

Damage to fittings

Damaged items	Estimated cost

QUESTIONNAIRE 3. COMMERCIAL/INDUSTRIAL DAMAGE SURVEY (Cont.)

Damage to stock

Damaged items	Estimated cost

Damage outside the building

	Damaged items	Estimated cost
Stores		
Vehicles		
Other		

8. Clean Up Costs

Time (man hours) : ……...

Salaries and Wages : ……...

Materials : ……...

9. Lost Trading

Disruption Time : ……..…… days ……... hours

10. Estimated Lost Sales

……..……

……..……

11. Any other comments

……..……