THUNDERSTO[illegible] MAGES IN

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ABSTRACT

Geographical position of Malaysia which is located at a position near the equatorial line affects the climate and weather of this country. One of the specific features of countries near the equator is thunderstorm occurrence that often occur in particular during inter monsoon. Damage to buildings due to the thunderstorm is frequently reported in the newspapers of the country. Even so there are no specific and scientific studies be carried out to identify the most recent thunderstorm right become a threat and can cause disaster. Therefore, this study was conducted to assess the strength of thunderstorm and associate it with the damage reported. Software "Geographical Information System" is used to map the strength of thunderstorm recorded for a period of time July 2013 to June 2014. The study found there is a strong relationship for damages as well as the strength of the thunderstorm which R^2 for the relationship between the two variables are equal to 0.85. From these results, it shows that the thunderstorm was a threat to the country. In this regard, further studies related to thunderstorm and also building strength to resist from the storm is critically important.

ABSTRAK

Kedudukan geografi Malaysia yang terletak di kedudukan yang berdekatan dengan garisan khatulistiwa memberi kesan kepada iklim dan cuaca di negara ini. Salah satu ciri-ciri khusus negara berhampiran khatulistiwa adalah kejadian ribut petir yang sering berlaku terutamanya semasa antara monsun. Kerosakan pada bangunan akibat ribut petir sering dilaporkan dalam akhbar-akhbar di negara ini. Namun begitu, tidak ada kajian khusus dan saintifik dijalankan untuk mengenal pasti ribut petir yang baru-baru ini benar menjadi ancaman dan boleh menyebabkan bencana. Oleh itu, kajian ini dijalankan untuk menilai kekuatan ribut petir dan hubungannya dengan kerosakan yang dilaporkan. Perisian "Sistem Maklumat Geografi" digunakan untuk memetakan kekuatan ribut petir yang dicatatkan dalam tempoh masa dari Julai 2013 hingga Jun 2014. Kajian mendapati terdapat hubungan yang kuat antara kerosakan dan juga kekuatan ribut petir yang mana R^2 bagi hubugan antara kedua-dua pemboleh ubah adalah bersaman dengan 0.85. Daripada keputusan ini, ia menunjukkan bahawa ribut petir adalah satu ancaman kepada negara. Oleh itu, kajian lanjut yang berkaitan dengan ribut petir dan juga membina kekuatan struktur bangunan untuk menentang kerosakan berpunca daripada ribut adalah amat penting

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

GIS	Geographical Information System
GF	Gust Factor

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

In Malaysia, the risk of people exposure to thunderstorm is increasing over the last 5 years. It is proved by the event of serious thunderstorm that happened over Peninsular Malaysia. The understanding on thunderstorm behavior is very significant. However, in Malaysia there is lack of expertise and not to mention the awareness among the Malaysian.

Nowadays, many thunderstorm events occur over Peninsular Malaysia that causes high level of damage. This includes rural and urban area. (Utusan News, 2013) reported that on 1st April 2014, five houses and a car wash wreaked havoc in Jalan Awang, Kampung Batu 23, Lenga, Muar, Johor and the most terrible in that year. The 5.30pm thunderstorm resulted the roof blown off and the loss about RM 20,000. However there is no injury reported. In other case, on 7th Mei 2014, (Utusan News, 2014) reported that a 4 years old boy dead after a house collapsed after get hit by tree in thunderstorm in Perumahan Awam, Taman Tasik Kamunting, Taiping, Perak. Meanwhile on the same date, (Utusan News, 2014) reported that 5 unit of houses undergo huge damage in Pinang Tunggal, Kepala Batas, Pulau Pinang causes roof blown away.

The rapidly increase in numbers of damage due to wind-related disaster events over the last few years in Malaysia has created the awareness among the Malaysian society. In order to enhance the resistance of the building structure to withstand wind storms, further understanding on characteristic of wind - structure interaction is needed. Malaysia is

located near the equator. In general, the wind climate is dominated by the two monsoon seasons and the inter-monsoon thunderstorms.

The north-eastern monsoon blows from December to March, usually accompanied by heavy rains. Around June to September, wind blows in the south-western monsoon which is slightly tranquil. Thunderstorms frequently occur during the inter-monsoon periods. Although thunderstorms are localized phenomena, they often produce significant strong and gusty surface winds. These winds from thunderstorms are relatively stronger and more turbulent than those of monsoon winds. (Choi, 1999) Unlike in cyclone prone region, the thunderstorms in Malaysia occurs in micro scale (Yusof, 2005). Despite, their small size and short duration of thunderstorm which is about 15 to 30 minutes, many damages have been reported in Newspapers. From the previous study, roof was the most damaging components due to wind storm (Tamura et al. 2005).

1.2 PROBLEM STATEMENT

The significant of this study is to identify the effect of thunderstorm event and damage phenomena. Throughout the years there might be certain locations in Peninsular Malaysia that have a higher percentage of thunderstorm event but the different is the frequency of it in different areas.

1.3 OBJECTIVES OF STUDY

Thunderstorm is a natural disaster as no one ever knows when it will be happened. We as human are only can predict or take safety precaution to make ourselves ready for the damages that carried by thunderstorm. In order to investigate thunderstorm behaviour, we must first know the characteristics of thunderstorm. So, the objectives of this research are as follows:

1. To study the gust factor characteristic of thunderstorm.
2. To study the relationship between thunderstorm gust factor and building damages.

1.4 SCOPE OF STUDY

The scopes of this study are as follows:

1. Analyse the characteristic of thunderstorm especially gust factor from July 2013 until June 2014.
2. Analyse the damage phenomena in Peninsular Malaysia.
3. The area of study is limited to Peninsular Malaysia only.
4. Microsoft Excel to produce charts.
5. ArcGIS software to locate and map the thunderstorm events.

1.5 STUDY AREA

The study area is limited to Peninsular Malaysia only (Figure 1.1). The east of Malaysia which is Sabah and Sarawak are not included in this study.

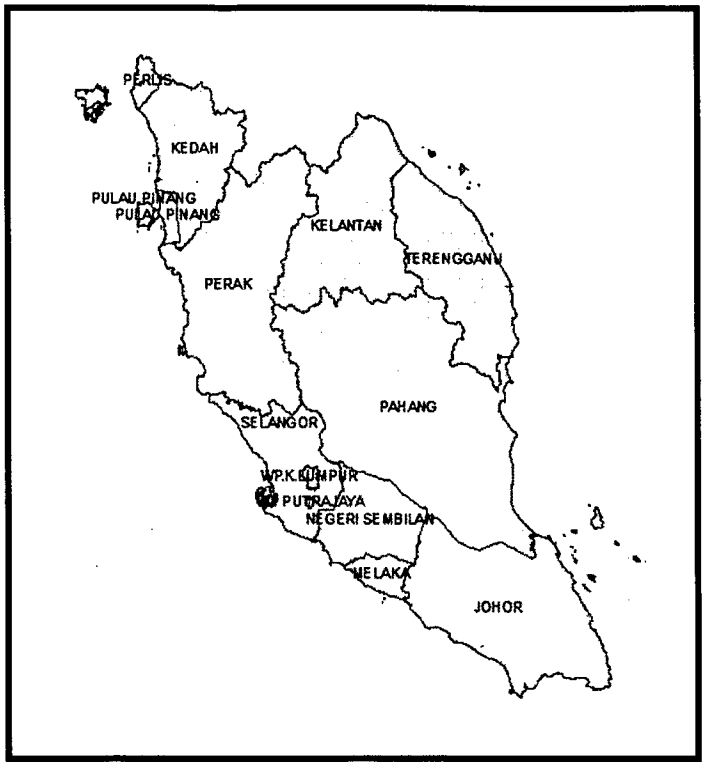

Figure 1.1: Area of Study

1.6 SIGNIFICANT OF STUDY

This study is to investigate the effects of thunderstorm behaviour to building damages. Some characteristic of thunderstorm are being investigated. By conducting this study, the pattern and speed of wind in Malaysia that developed thunderstorm can be determined so that the wind hazard can be reduced and minimize the damages on properties. For example, a place with a history of repetitions in terms of wind related disaster, the structure of building in the area should be design vary with the sustainability to withstand it's high wind speed.

1.7 THESIS STRUCTURE

This thesis is divided into five chapters:

1. Introduction : This chapter includes overview of problem statement, objective and scopes of the study, significance of the study and study area.
2. Literature review : This chapter is the previous study material related to objectives.
3. Methodology : The flow of the thesis production.
4. Result & Discussion : Discuss the result obtained based on case study
5. Conclusion : Conclusion of the discussion based on thesis result and provides the future suggestion.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Thunderstorm is the perceptible natural movement of the air, especially in the form of a current of air blowing from a particular direction. Wind engineering analyses effects of wind in the natural and the built environment and studies the possible damage, inconvenience or benefits which may result from wind. Wind engineering is best defined as the rational treatment of interactions between wind in the atmospheric boundary layer and man and his works on the surface of Earth (Dr Jack E. Cermak). Wind engineering is roughly subdivided into the following sub-fields, structural wind engineering, environmental wind engineering and wind energy, although the wind energy field is somewhat a stand-alone field of its own.

The severity and increased frequency of wind related disaster events over the last few years in Malaysia has shifted the attention from several researchers towards investigating its patterns and causes. The gust factor characteristic where the damage occurred is highly considered as one of the main reasons why these incidents happened in the first place. High wind gust will increase the wind speed thus increases the risk and damage of thunderstorm hazard disaster. Thus, a study can be carried out to investigate the relationship between the thunderstorm gust factor and damage phenomena.

2.2 MALAYSIA

Malaysia a country located in Southeast Asia. There are two distinct parts to this country being Peninsular Malaysia to the west and East Malaysia to the east. Peninsular Malaysia is located south of Thailand, north of Singapore and east of the Indonesian island of Sumatra. East Malaysia is located on the island of Borneo and shares borders with Brunei and Indonesia. The total land area of Malaysia is 329,847 square kilometres, the 67th largest country in the world in terms of area. Peninsular Malaysia makes up 132,090 square kilometres or 39.7% of the country's land area, while East Malaysia covers 198,847 square kilometres or 60.3%.

Peninsular Malaysia is divided to eleven states and 1 federal territory, Pahang is the biggest state (Figure 2.1) and Perlis is the smallest state. The climate of Malaysia is driven by its equatorial position, extensive coastlines on tropical seas and monsoonal winds. Because Malaysia is situated between one and six degrees North latitude (Figure 2.2), Malaysia has an equatorial climate with uniformly high temperatures, high humidity, relatively light winds, and abundant rainfall throughout the year. The average rainfall is 250 centimetres (98 in) a year and the average temperature is 27 °C (80.6 °F). The climates of the Peninsula and the East differ, as the climate on the peninsula is directly affected by wind from the mainland, as opposed to the more maritime weather of the East.

The main causes of climatic variation within Malaysia are differences in altitude and the exposure of the coastal lowlands to the alternating southwest and northeast monsoon winds. Malaysia faces two monsoon winds seasons, the Southwest Monsoon from late May to September, and the Northeast Monsoon from November to March. The Northeast Monsoon brings in more rainfall compared to the Southwest Monsoon, originating in China and the north Pacific. The southwest monsoon originates from the deserts of Australia. March and October form transitions between the two monsoons.

Figure 2.1 : Map of Peninsular Malaysia

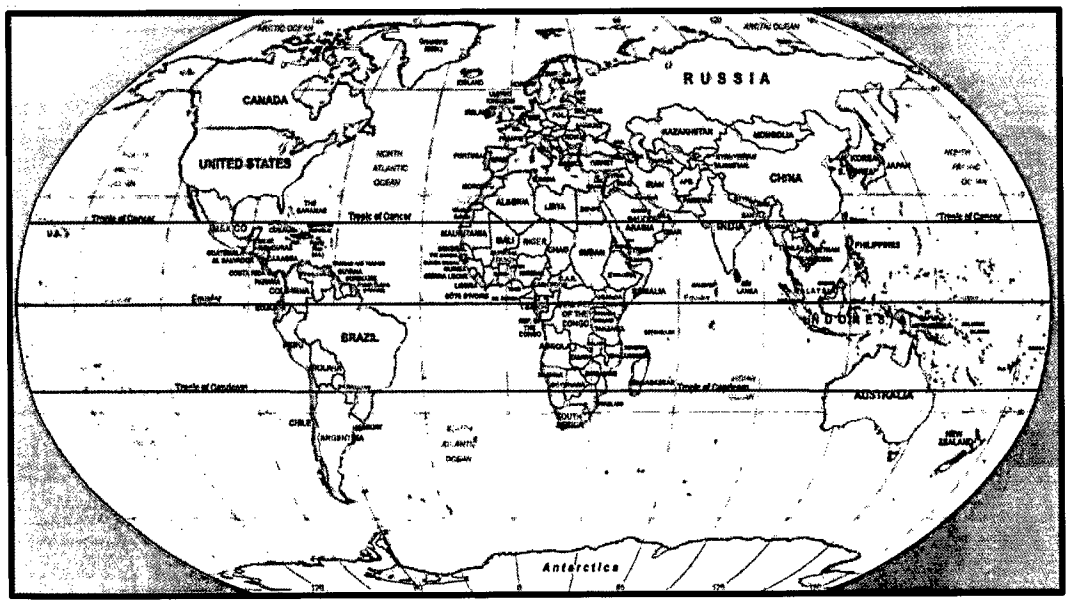

Figure 2.2 : Malaysia in Equatorial Belt

2.3 WINDS IN MALAYSIA

Malaysia is a country situated in South East Asia. There are two distinct parts to this country being Peninsular Malaysia to the west and East Malaysia. The characteristic features of the climate of Malaysia are uniform temperature, high humidity and over rainfall. Winds are generally light. Situated in the equatorial doldrums area, it is extremely rare to have a full day with completely clear sky even during periods of severe drought. On the other hand, it is also rare to have a stretch of a few days with completely no sunshine except during the northeast monsoon seasons (Malaysian Meteorological Department).

2.3.1 WIND FLOW IN MALAYSIA

Though the wind over the country is generally light and variable, there are, however, some uniform periodic changes in the wind flow patterns. Based on these changes, four seasons can be distinguished, namely, the southwest monsoon, northeast monsoon and two shorter periods of inter-monsoon seasons.

The southwest monsoon season is usually established in the latter half of May or early June and ends in September. The prevailing wind flow is generally south westerly and light, below 15 knots. The northeast monsoon season usually commences in early November and ends in March. During this season, steady easterly or north easterly winds of 10 to 20 knots prevail. The winds over the east coast states of Peninsular Malaysia may reach 30 knots or more during periods of strong surges of cold air from the north (cold surges). During the two inter monsoon seasons, the winds are generally light and variable. During these seasons, the equatorial trough lies over Malaysia.

2.4 WIND HAZARD RISK ASESSEMNT

Windstorm Hazard is the risk that a property will sustain losses due to strong winds. Windstorm insurance, or storm insurance policy or endorsement, generally covers losses resulting from excessive wind and/or hail. Most homeowner's insurance policies exclude coverage for losses arising from windstorms, and if coverage is desired, a separate windstorm insurance policy or endorsement must be purchased. (Investopedia). "Risk assessment is all about risk management. The only reason you do an assessment is because somebody has to make a risk-management decision" (Smith, 2005). Risk is something that everyone deals with every day and influences almost every aspect of decision-making. Although risk has different meanings and definitions among different professions and stakeholders, it can generally be quantified by three terms: probability, hazard (loss or other measurements), and time exposure. An example of risk from health sciences is the probability of getting cancer by smoking a pack of cigarettes per day (hazard) over lifetime (70 years on average). In the financial market, risk is defined as the probability of losing a certain amount of money (loss) over a period.

An evaluation of the possible role of disaster insurance in reducing natural disaster impacts must include an analysis of risk information requirements needed in the development and operations of the insurance programme and how these needs could be of the characteristics of insured physical elements such as buildings and other properties that are exposed to large scale geophysical events such as storms, flood or earthquakes, and the vulnerability of these elements at risk to damage or loss when an event of given severity occurs (Friedman, 1984).

There were three stages to thunderstorm hazard assessment. Firstly, the wind data description provides information about the location of weather stations, the service periods of these stations and the maximum historical wind gust recorded at each site. Secondly, the section on local thunderstorm effects estimates the local effect of gust factor for the structure height concerned, the shielding effect provided by upwind structures.

These effects were numerically estimated using remote sensing techniques, digital elevation data and by using formulas given in the wind loading design standard. The last stage was the estimation of likely severe wind speeds within a given time period. These wind speeds are commonly called return period wind speeds or return levels. The wind speed estimation for various return periods includes a sensitivity analysis. The final adopted return period wind speeds were a combination of statistical analysis, expert judgement and the satisfaction of internal consistency (Xun, 2006).

2.5 WIND GUST

The gust factor (GF) is defined as the ratio of the peak wind speed averaged over a short period to the mean wind speed averaged over a relatively long reference period. It is a simple statistic but is dependent on numerous inputs, including the roughness length, distance from an upstream terrain change, stability, height, and potentially the presence of convection. Based on wind measurement at Cardington, England, Dusrt (1960) derived a statistical relationship between maximum wind speeds averaged over various periods and the corresponding hourly mean wind speeds, for sites with open terrain exposure and flat topography (Paulsen et al, 2005).

2.6 GEOGRAPHICAL INFORMATION SYSTEM

The field of Geographical Information System (GIS) is concerned with the description, explanation and prediction of patterns and processes at geographic scales.
GIS is a science, a technology, a discipline and an applied problem solving methodology (Longley, 2005).

GIS consist of several components, computer system and software, spatial data, data management and analysis procedure and people. All these components are combining together to ensure the success of GIS. Many disciplines can be interpreted by GIS. The term Geographic information science has been adopted to refer to science behind the system. GIS draws on disciplines as diverse as landscape architecture, computer science, public policy, surveying, statistic, remote sensing and many more (Heywood et al.,2006).

2.6.1 GIS FOR EMERGENCY

Before any emergency strikes, we need to know our weakness. GIS software gives you the tools to detect the risk and gives idea of action need to be done. Analysis and mapping using GIS helps in future planning. GIS software is capable to analyse hazard and predict the potential damages that will occur. When hazard is identified and mapped, people can plan their future planning. More strategic plan can be obtain by using GIS. It is hard to develop comprehensive plans to prepare for all type of disaster using GIS. By providing in depth data management, optimizing situational awareness and supporting emergency personnel, GIS technology builds and enhances emergency preparedness.

2.6.2 DATA MANAGEMENT

A great deal of information must be gathered and maintained in advance of an event in order to achieve comprehensive and preparedness. Situational awareness by linking people, processes and information together using geography, GIS is quickly establish full situational awareness.

2.6.3 GIS SUPPLIES

Decision making can be made by analysing the operating picture. Resource

management for rapid deployment of emergency personnel, supplies, and equipment also can be made.

2.7 SUMMARY

Based on literature review, previous study states that wind are potential to damages of manmade and natural structure. Even though Malaysia is located on the equator of the earth, but the possibility of wind hazard damage is same as other country which has the high wind speed this is due to our four seasons known as southwest monsoon, northeast monsoon and two inter monsoon. As the result of these phenomena, many wind hazard damage are identified. On top of that, beneficial software as GIS will be used to analyse these phenomena.

By using GIS, time can be saved, prediction can be made and can save lots of data. The advantages of GIS is so many, it may encourage cooperation and communication among the organizations involved in environmental management, protection, planning and disaster. The collection of data may seem easy but it requires skills and knowledge to collect data used.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter is intending to fulfil the objectives of this study. There are 4 study primarily phases of this chapter. This including 1) Data collecting which is thunderstorm hazard related disasters in Peninsular Malaysia from July 2013 until June 2014 for each state in Peninsular Malaysia wind speed and wind gust of the nearest weather station to disaster location during incident and so on II) Pre-processing database to be converted in GIS and Microsoft Excel. III) Processing: establish data (Damage Ratio, Maximum Wind Speed, Mean Wind Speed, and Maximum Gust Speed). IV) Output: Speed Characteristic, Average Damage Ratio, Mean Gust Factor, Wind Hazard Disaster Map, Relationship between Gust Factors against Proportion of Damage Linear Graph.

The research methodology has been summarized in the flow chart below.

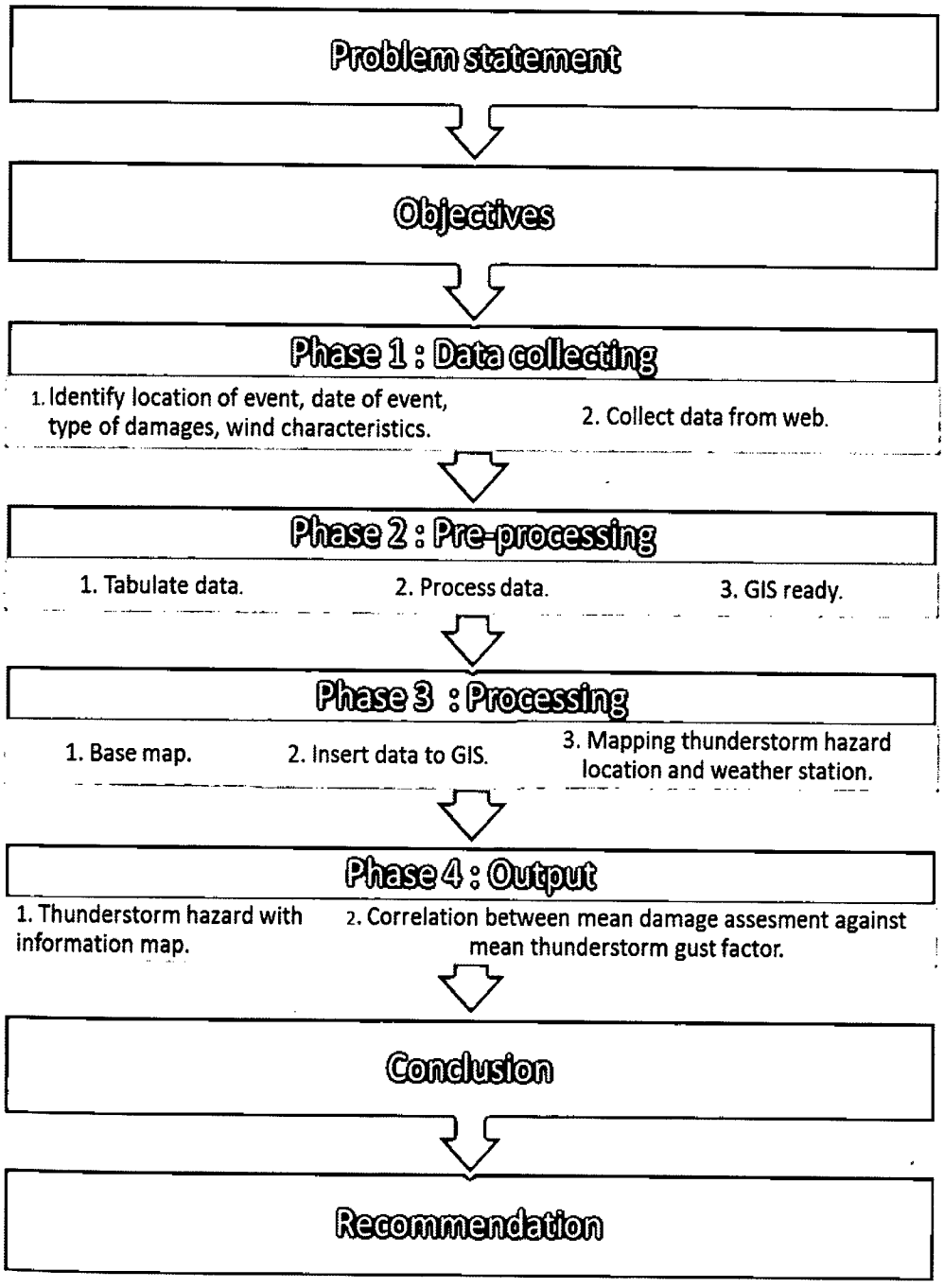

Figure 3.1 : Research Methodology Flow Chart

3.2 DATA COLLECTION

Data Collection is the process of gathering and measuring information on variables of interest, in an established systematic fashion that enables one to answer stated research questions, test hypotheses, and evaluate outcomes.

In this phase, the data are mainly collected through reliable sources from the internet. Among the sources used are archives from national newspapers (New Straits Times, Harian Metro, Kosmo, Berita Harian etc.), www.wunderground .com, Google map and so on so forth.

3.2.1 WIND HAZARD DISASTER DATA

Firstly, past wind hazard disasters from newspaper reports were collected based on the year of occurrence. The data taken down are time, date, locations, building type, damage type and losses and were recorded in Microsoft Word for future references as shown in the appendix. A total of 38 cases were recorded from July 2013 to June 2014.

3.2.2 DETERMINE WIND SPEED AND WIND GUST

Wind Speed is a fundamental atmospheric rate and is caused by air moving from high pressure to low pressure. Wind Gust is brief increase in speed of the wind.

A website called www.wunderground.com was used to get the records of the wind speed and wind gust at disaster locations during the occurrence of damage. An example of an incident occurred in Alor Setar on the 15th of November 2013 is shown below.