A STUDY ON HOSPITAL DISASTER PREPAREDNESS: A CASE STUDY OF SELECTED HOSPITALS BASED ON THE 2014 FLOOD IN KELANTAN, MALAYSIA

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by

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TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

Page

LIST OF ABBREVIATIONS

CGSS	Centre for Global Sustainability Studies
CRED	Centre for Research on the Epidemology of Disasters
DID	Department of Irrigation and Drainage (DID)
DRM-SD	Disaster Risk Management for Sustainable Development
DRR	Disaster Risk Reduction
GIRN	Government Integrated Radio
HFA	Hyogo Framework for Actions
HKK	Hospital Kuala Krai
HRPZ	Hospital Raja Perempuan Zainab
HUSM	Hospital Universiti Sains Malaysia
ICU	Intensive Care Unit
IPS	Institut Pengajian Siswazah
IRFC	International Red Cross and Red Crescent Societies
MECC	Medical Emergency Coordination Centre
NADMA	National Disaster Management Agency
NDRMRC	National Disaster Management Relief Committee
NOAA	National Oceanic and Atmospheric
NICU	Neotanal Intensive Care Unit
NSC	National Security Council
PAHO	Pan American Health Organization
PICU	Pediatric Intensive Care Unit
SDG	Sustainable Development Goals
SFDRR	Sendai Framework for Disaster Risk Reduction
TNB	Tenaga Nasional Berhad
UNISDR	United Nations International Strategy for Disaster Reduction
UNDP	United Nations Development Programme
USM	Universiti Sains Malaysia
VHF	Very High Frequency
WHO	World Health Organization

LIST OF APPENDICES

KAJIAN TERHADAP PENILAIAN TAHAP KESIAPSIAGAAN BENCANA HOSPITAL: KAJIAN KES BAGI HOSPITAL TERPILIH BERDASARKAN BANJIR 2014 DI KELANTAN, MALAYSIA

ABSTRAK

Banjir merupakan salah satu daripada bencana alam yang sering berlaku di kebanyakkan tempat dalam dunia. Pada Disember 2014, pantai timur Semenanjung Malaysia telah dilanda banjir besar yang direkodkan dalam sejarah khususnya negeri Kelantan. Banjir 2014 telah menjejaskan beberapa hospital di Kelantan yang menyebabkan hospital tidak dapat memberikan perkhidmatan kepada pesakit. Hal ini telah membawa kepada kesedaran kesiapsiagaan pengurusan bencana hospital penting untuk dipantau dan ditangani dengan teliti. Kajian ini membentangkan sebuah kajian kes yang menyiasat tahap kesediaan bencana hospital hospital terpilih yang terjejas oleh banjir 2014 di Kelantan. Kajian ini juga menggunakan kaedah kualitatif dan temu ramah dengan ahli jawatankuasa bencana hospital dijalankan. Hasil kajian menunjukkan bahawa hospital sememangnya mempunyai pelan tindakan bencana untuk digunakan sebagai panduan lengkap dengan elemen-elemen pencegahan, kesediaan, tindak balas dan pemulihan. Namun begitu, hospital tidak menyedari bahawa elemen-elemen dalam pelan tindakan itu merupakan sebuah model kesiapsiagaan bencana yang perlu diselaraskan sebagai latihan kepada semua kakitangan hospital. Kajian ini mencadangkan hospital untuk mengunakan pelan tindakan bencana hospital yang sedia ada dengan mengadaptasikan Model Pengurusan Risiko Bencana oleh Pusat Kajian Kelestarian Global, Universiti Sains Malaysia yang merupakan rangka kerja lengkap bagi model kesediaan bencana.

A STUDY ON HOSPITAL DISASTER PREPAREDNESS: A CASE STUDY OF SELECTED HOSPITALS BASED ON THE 2014 FLOOD IN KELANTAN, MALAYSIA

ABSTRACT

Floods are one of the common natural disasters occurred in most part of the world. In December 2014, the east coast of Peninsular Malaysia was hit by the massive flood ever recorded in history especially Kelantan. The 2014 flood was affected by several hospitals in Kelantan that left hospitals unable to provide services to patients. This has led to the realization of hospital disaster preparedness and management was important to be closely monitored and addressed. This research presents a case study that investigates the hospital disaster preparedness level of selected hospitals affected by the 2014 flood in Kelantan. This research used a qualitative study and guided interviews with hospital disaster committee members were carried out. The results show that the hospital has a disaster action plan to use as a complete guide to the elements of prevention, preparedness, response, and recovery. However, the hospital was not aware that the action plan is a disaster preparedness model that needs to be streamlined for all hospital staff to practice. This research suggested for hospitals to adopt an existing hospital disaster action plan using Disaster Risk Management-Sustainable Development by Centre for Global Sustainability Study, Universiti Sains Malaysia which is a complete framework for disaster preparedness model.

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Natural disasters take place around the world and they can be very devastating for human lives and the environment. The unpredictable global climate is listed as a major factor in today's disasters. Guerdan (2009) in his study stated that natural disasters such as floods, landslides, tsunamis, earthquakes, hurricanes, tornadoes and man-made disasters and epidemics are very frequent nowadays. A natural disaster can happen in any part of the world from poor countries, developing countries to developed countries. Besides, The United Nations International Strategy for Disaster Reduction (UNISDR, 2017) defines disaster as:

> *"a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources".*

There are some different types of hazards classified. Examples of these are meteorological events such as storms, earthquakes, bio-hazards including disease outbreaks, as well as man-made disasters caused by industrial accidents. Natural disasters have affected on average 60,000 people people globally died from natural disasters each year. This represents 0.1% of global deaths in natural disaster (Ritchie & Roser, 2019).

Disasters also bring about long-term emotional and mental stress to those involved, including the victims' families, the responders, the rescue team as well as other civilians (Ben-Ezra et al., 2013; Norris, Friedman, & Watson, 2002; Oldham, 2013). The year 2015 was a remarkable year for droughts as it was the hottest year on

record since pre-industrial times reported by the (Guha-sapir, Hoyois, Wallemacq, & Below, 2016). This phenomenon occurred when the greenhouse gas level reached record highs and had experienced a very strong El Nino. This phenomenon ended that year but its impact had lasted until early 2016 as some 24 million people struggled with this drought and food insecurity in the Horn of Africa and across southern Africa (Mead, 2016).

There were 317 natural disasters reported worldwide in 2014 by UNISDR, affecting 94 countries and most common disasters globally are floods, earthquakes, storms, heatwaves, and droughts. The 2015 World Disasters Report of the International Federation of Red Cross and Red Crescent Societies (IFRCS, 2016) highlights UNISDR's estimate that natural disasters has costed around USD 66 billion. UNISDR brings new perspectives on the importance of disaster preparedness to the world. At the same time, the countries most affected by these disasters appear to become more observant and sensitive to disaster preparedness (Mahjom, Ismail, & Abd Hadi, 2019) Malaysia is geographically located outside the Pacific Rim of Fire and is relatively not immune from natural disasters and adverse weather. Some of the environmental disasters that happened in Malaysia and caused damage to properties and human lives are the Highland Tower Disaster (1993), Tsunami (2004), Hulu Langat Landslide (2013), and Cameron Highlands mud flood (2013). These events have also reconfirmed the limited understanding of hazard management, reinforcing the need for research.

The World Conference on Disaster Reduction was held in January 2005 in Kobe, Hyogo due to natural disasters such as the great tsunami in the Indian Ocean in 2004 and the Bam earthquake in 2003. This conference introduced a Framework for Action 2005-2015, called the Hyogo Framework (Djalali, 2012). This framework

stresses ‘Hospital Safe from Disaster' as an objective of integrated disaster risk reduction planning in the health sector. The aim of this Hyogo Framework for Action is to make the world safe by initiating the disaster risk reduction.

Various types of disasters have occurred due to natural phenomena or human neglect that have resulted in great loss of lives and property. This phenomenon which includes personal injuries, fires, explosions, chemical spills, toxic gas releases, vandalism, natural disasters such as typhoon and floods, and man-made disasters such as riots and terrorist activities will continue in every industry if safety at the workplace is neglected. Emergency and disaster preparedness helps in reducing the rate of loss due to dangerous incidents in Malaysia.

The National Security Council (NSC) Directive No. 20: Policy and Mechanism of Disaster Management and Relief Committee is one of the guides for handling disaster management in Malaysia (Bahari, Hassan, & Ahmad, 2011). This shows that Malaysia has disaster management agencies to deal with disasters when they occur. According to the Disaster Management and Relief Committee at the Federal, State and District Level respectively, these disaster agencies would be integrated and coordinated in the event of a disaster.

At the end of 2014, Malaysia was hit by a huge flood that affected many states including Kelantan, Terengganu, Pahang, Perak, Perlis and Sabah, which had worsened after seeing more than 200,000 victims being evacuated to temporary shelters (Mansor, 2019). Besides, the 2014 flood in Kelantan is one of the most spectacular natural disasters as the heavy rainfall had resulted in the worst flood in three decades in Malaysia. The amount of rain at that time was large and could cover up to three months of rainfall. Malaysia has realized that there are many things that must be done to avoid life-threatening incidents and huge losses in the future. The

2014 flood has made the public to be aware of the importance of disaster preparedness in all areas, especially in hospitals as they play an important role in disaster preparedness.

In December 2014, floods have caused a huge amount of financial and property losses including the hospitals and clinics amounting to RM 281 million(The Star Online, 2015). The massive flood of 2014 affected several hospitals in Kelantan that resulted in the hospitals to be unable to provide services to the patients. The floods had a significant impact on the four hospitals affected by it. These are Hospital Tanah Merah, Hospital Kuala Krai, Hospital Raja Perempuan Zainab II, and Hospital Gua Musang. The operation and medical services of all these hospitals were nearly paralyzed due to the loss of electricity.

In another case, Oakwood Hospital-Dearborn, United States which is a hospital with 632-bed capacity sustained heavy damage to its emergency department kitchen, radiation oncology, radiology, inpatient pharmacy, and medical supply storage since it was flooded with stormwater. Fortunately, this hospital had carried out a pre-hazard vulnerability assessment to rate potential hazards for flood (Dan Hounsell, 2015). This assessment had helped the hospital when it was affected by the disaster. For example, they managed to relocate patients from the emergency department to the second floor very quickly (Dan Hounsell, 2015).

Datuk Dr. Noor Hisham Abdullah, Health General Director, firmly stated that the three hospitals could not operate because they had lost electricity as Tenaga Nasional Berhad (TNB) had cut off electricity supply in some parts of Kelantan for safety reasons (A.Shazwan, 2014). An anesthetist had to give a baby intubation treatment in the dark to save his life after the power plant at Hospital Kuala Krai ran out of fuel. The hospital operated by using a generator after the electric supply was cut

off (Mohamed, 2014). Furthermore, assistance was sent by the authorities through helicopters as the road was flooding. The assistance from the helicopters arrived earlier in the evening but Hospital Kuala Krai could only employ the use of boats as the helicopters were unable to land due to a lack of space.

Hospital Kuala Krai was reported to experience electrical power failure for five days and this situation has certainly affected some critical care units in the hospital such as NICU, PICU and the operation room where electricity is required to enable machines that use oxygen and water pressure to function. Besides, the hospital staff was also absent from duty because some of them became flood victims when their home sank in the water.

Dr. Nik Mohd Faizal Zainal Abidin, Director of Hospital Kuala Krai, explained that although the flood affected the hospital's operation, the management agreed to provide protection and the hospital staff ensured the welfare of the flood victims. Hospital Kuala Krai became the center of relief for flood victims to seek shelter as their homes were flooded. Besides, the hospital had to always ensure the availability of the supply of food and dry clothes for everyday use. Most hospitals do not have sufficient capacity and capability to deal with extraordinary disasters. Therefore, it is crucial for hospitals to realize that there are rooms for improvement in hospital preparedness. Additionally, hospitals can learn from what hospitals in other countries have practiced and their experience in dealing with disasters.

Situations and circumstances that occurred during the 2014 floods have proven that hospital preparedness should be strengthened. As Malaysia is located in the north of the equator, floods are a recurring disaster in Malaysia as they are affected by wind and geographical factors. Besides, Malaysia has a distinctive pattern of rainfall, allowing the rain period throughout the year to be easily predicted. They usually occur

from October to December throughout the year. Furthermore, the maximum rainfall during the period of October to December can generally cause either controlled or uncontrolled flooding. Hence, the situation in the 2014 flood will occur again if hospital preparedness is not strengthened. Consequently, Malaysia needs to allocate the high cost of recovery during and after the flood. Even worse, it also involves the lives of the people. Being concerned about hospital preparedness will ensure that hospitals are more equipped and their staff more knowledgeable about what to do to cope with flood disasters. World Health Organization (2018) reported that a hospital's facility and services should remain accessible and to be functional at maximum capacity in the same infrastructure during and immediately following the impact of a natural hazard.

The purposes of this study are to investigate the level of hospital disaster preparedness during the massive 2014 floods and to examine whether the present level of disaster preparedness of hospitals in Malaysia would be sufficient for any major disaster in the future. This study provided the hospitals the opportunity to identify the facilities and issues that require the most intervention so that they can be better prepared to address major disasters in the future. The results from this study can be used as a measurement tool for hospitals to assess their preparedness level to cope with disasters in the future since hospital preparedness for disasters is important for the development of the country.

1.2 PROBLEM STATEMENT

In October 2016, a fire broke out at the Intensive Care Unit (ICU) of Sultanah Aminah Hospital, Johor which resulted in the death of six patients (New Straits Time, 2016). Many patients were moved to the other ward of a different building after the fire broke out on the upper floor of the building. The incident prompted the

government to formulate policies for hospitals over the age of 50 across Malaysia to change the wiring system of the buildings to prevent further fires in the future. It is important for hospitals all around the world to be well prepared to manage disasters.

Hospitals play a major role in providing services and continuing their operations during disaster occurrences (Mulyasari *et al*., 2013). At the end of December 2014, Malaysia was hit by a major flood that affected a few states on the east coast especially Kelantan. During the flood, several hospitals in Kelantan were affected.Hakim (2015) mentioned in his seminar that some of the hospitals that were seriously affected in 2014 were Hospital Kuala Krai, Hospital Raja Perempuan Zainab, Hospital Tanah Merah, and Hospital Gua Musang. This situation has triggered questions about the level of hospital disaster preparedness when the disaster occurred.

Various researchers used quantitative methods to measure functional capacity and rainfall analysis for the 2014 floods in Kelantan but did not focus on hospital readiness to face disasters. Moreover, another study done by Ingrassia et al., (2016) revealed that a safe hospital has the ability to cope with disasters and catastrophes built on preparedness elements. These elements include buildings, equipment, facilities and medical support staffs. The term preparedness elements is also one of the sections in the Disaster Risk Management Cycle for Sustainable Development (DRM-SD). DRM-SD outlines pre-disaster and post-disaster activities as a step to deal with any possible disaster towards a sustainable development. According to Said *et al.* (2015), their studies showed that DRM-SD cycle elements of prevention, preparedness, response, recovery, and governance are the pillars for risk reduction and sustainable hospital management.

In addition, researchers have studied the guidelines used by hospitals during disasters. Studies on disaster preparedness of hospitals are significant in terms of the

safety and health of workers in hospitals to create a safe working environment in times of disaster. In addition, a better understanding of hospital disaster preparedness knowledge of all the hospital staff members can be improved to provide a better condition as a 'Safe Hospital'. This research aimed to fill in the gaps by looking into disaster management in hospitals in an event of a disaster.

1.3 RESEARCH QUESTIONS.

Research questions serve as a framework to what were sought in the study and the questions raised were significant with the research objectives. The researchers have made an in-depth study of the perspective of the respondents using qualitative case study form in relation to the following:

1. What are the guideline for hospital disaster preparedness during the flood in 2014?
2. What was the level of hospital disaster preparedness during the flood in 2014?
3. What are the factors that influence the level of hospital disaster preparedness in Kelantan?

1.3 RESEARCH OBJECTIVES

Since disasters are a global problem includes in health sectors, many studies from multiple disciplines have been done to seek the most practical and effective solution at all levels.

The research objectives of this study are as follows:

1. To find out whether the hospitals in Kelantan have a guideline or disaster action plan for their hospitals during 2014 flood in Kelantan.
2. To examine the present level of hospital disaster preparedness in Kelantan

3. To explore the factors that affect hospital disaster preparedness in selected hospitals in Kelantan.

1.5 PILOT STUDY

According to De Vos *et al.* (2005), in order to understand scientific research on a specific problem, the researcher should have a thorough background knowledge about it. Leedy and Ormrod (2001) added that a pilot study is one way in which the prospective researcher can orientate himself/herself to the project in mind. Besides, Leedy and Ormrod (2001) stated that one of the most common errors in doing research is that no piloting or pre-testing is done.

Moreover, De Vos *et al.* (2005) quoted a definition of pilot study from the New Dictionary of Social Work (1995) as the process whereby the research design for a prospective survey is tested. They again quoted Huysamen (1993) that the purpose of a pilot study is to investigate the feasibility of the planned project and to bring the possible deficiencies in the measurement procedure to the fore.

For the purpose of this study, the pilot was done by arranging a formal interview with disaster committee members of Penang General Hospital. This was conducted to learn as much as possible about their experiences in the area in terms of hazards, accidents that occurred in the past and how those accidents were handled. This pilot study assisted in the identification of most suitable volunteers to assist with data collection and appropriate officials to interview on issues relating to the selected research topic. The pilot study assisted in ensuring that errors on questionnaires were identified before they were disseminated to members of the community.

1.6 SIGNIFICANCE OF THE STUDY

Various studies have been conducted to investigate the effects of the 2014 floods in Kelantan on the state's economy and drainage system in Kelantan. However, no specific studies have been conducted on the scope of this study. This study is important to assess the level of hospital preparedness in the event of any disaster. The findings of this study are important not only for hospitals in Kelantan but also for other medical facilities in the country, in general, facing similar challenges with recommendations that would provide possible approaches to minimize the effects of natural and man-made disasters. From the findings of this study regarding the level of knowledge, attitudes and practices, the hospitals can provide further education on disaster preparedness and management.

Practically, the findings of this study will help to monitor the level of hospital disaster preparedness among members of the disaster committee at each selected hospital. Therefore, results gathered from this research provide a model of hospital disaster preparedness that had been used unknowingly by the hospital in their disaster action plan. In addition, the importance of this study is also to identify factors contributing to the level of disaster preparedness in hospitals. Therefore, hospitals can improve the level of disaster preparedness in a better way to keep them safe in the event of a disaster.

1.7 SCOPE OF STUDY

The scope of this study encompasses several areas in Kelantan involved in the 2014 flood disaster. Therefore, the scope of the authors' study describes the disaster action plan in the flood management prepared by the hospitals in managing the 2014 floods. Specifically, this research focuses on the level of disaster preparedness of hospitals in Kelantan based on their performance in the 2014 flood. In addition, the disaster management frameworks discussed in this study were used to provide this mechanism a regulatory guide for effective disaster management. The frameworks were Hyogo Framework for Action (HFA) and Sendai Framework for Disaster Risk Reduction. Other than that, Disaster Risk Management and Sustainable Development Framework adopted by the Centre for Global Sustainability Studies, Universiti Sains Malaysia was also used to streamline the hospital disaster preparedness (Koshy, Rahim, Khelgat-Doost, & Jegatesen, 2013) .

The scope of this research focuses on selected hospitals in Kelantan. This is because the floods of 2014 had caused hospitals in some areas to be unable to provide treatment to patients as flood had entered the hospitals' buildings. Therefore, interviews with the disaster committee members were conducted to learn more about hospital disaster preparedness in the 2014 flood in Kelantan

1.8 RESEARCH FLOW CHART

The research process was carried out based on Figure 1.1 below. This chapter has been separated into three sections; section one– conceptualization of research; section two- presentation of results and data analysis; and section three- discussion and conclusions.

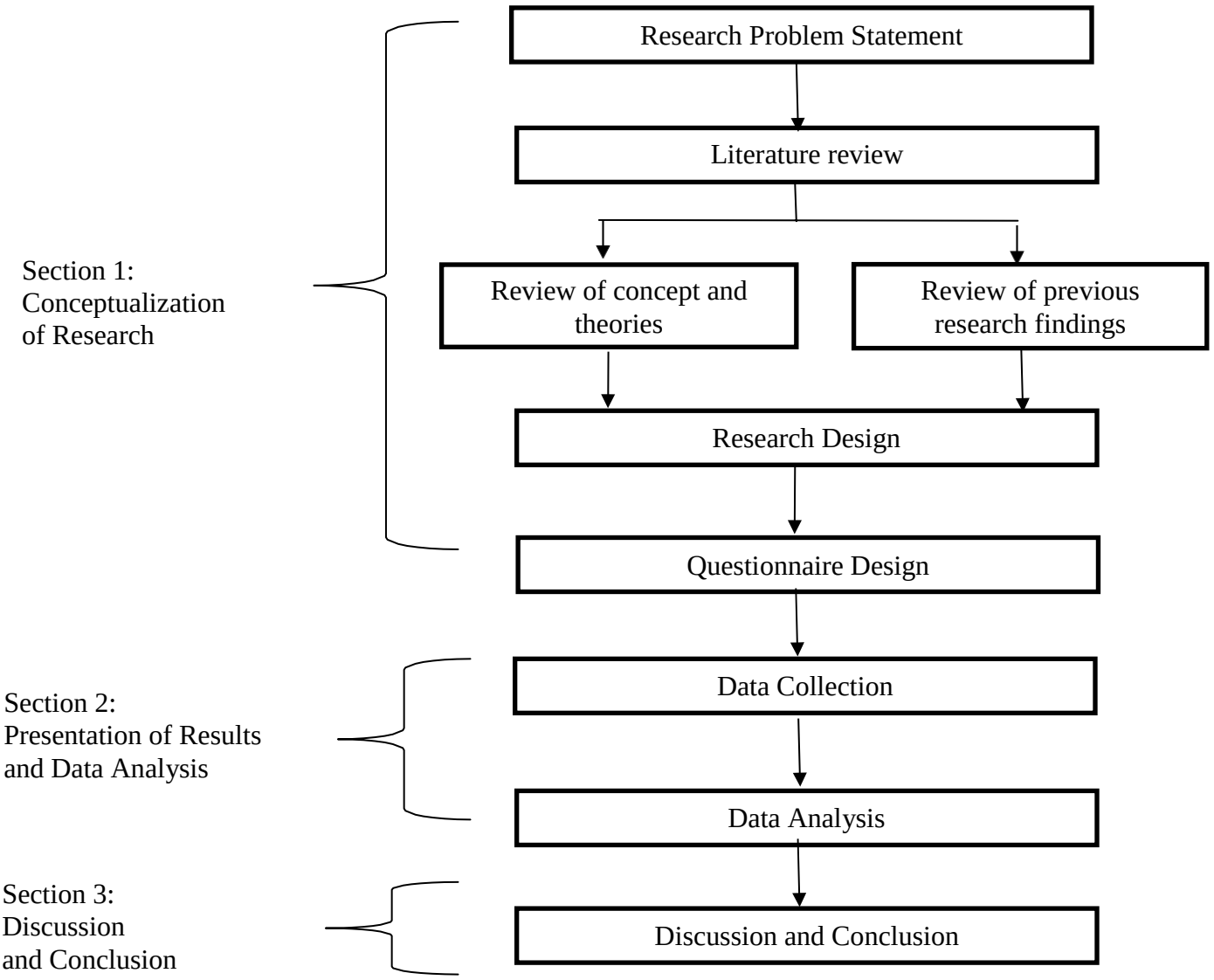

Figure 1.1 Research Flow Chart

1.9 ORGANIZATION OF THESIS

In this paper, there are five chapters: introduction to research and background, research study, research case study, research methodology, research findings and analysis, and finally research conclusion. The first chapter discusses the introduction to this study which includes the research background, problem statement, research questions, research objectives, and pilot study. Other areas of discussion are the significance of study, scope of the study, research flow chart and the organization of thesis. The final section summarizes the chapter.

Chapter two examines the literatures of the definition of disaster, Malaysian disaster risk management, and hospital disaster preparedness. It examines the factors that influence the level of hospital disaster preparedness in Malaysia. In particular, it discusses the importance of hospitals for disaster preparedness in Malaysia. The case study in chapter two also gives a detailed overview of the research area. This chapter presents the detailed information about this research and case study based on the 2014 flood in Kelantan.

Chapter three is all about research methodology used to carry out this research from the beginning until the end. This chapter is comprised of discussion on all variables involved in this research study- independent variables, intervening variable, and a dependent variable, research design used, sampling frame, sampling size, sampling technique and populations of the study, plan for data analysis, measurement of variables and explanation of how the data were analyzed.

In chapter four , after the data from interviews had been transcribed and gathered, the findings were analyzed to obtain the answers for the questions

and objectives of this research. The analysis of data was done by using ATLAS.ti version 8. This ATLAS.ti has many functions and can help researchers analyze data for the purpose of reporting the interpretation of data. All transcripts in this study were coded using ATLAS.ti version 8. This software provided systematic segment selection from transcripts or excerpts to represent concepts or ideas summarized as codes. The discussion is also included in this section, together with the data analyzed.

Chapter five comprises two sections which provide a summary of research findings as a whole through conclusions, answering all the research objectives, and propose recommendations based on findings from this research. The recommendations given were separated into two parts which are proposed opportunities that can be seized out of the problems identified in this study and the future research that can be undertaken.

CHAPTER 2

LITERATURE REVIEW

2. 1 INTRODUCTION

This chapter comprises four sections; introduction of the chapter, the literature review, case study and the conclusion of the chapter. Discussion on each part of the literature review was divided and written based on the thematic structure. Since disaster management was the main subject leading to this research study, the organization of the literature review has been focused on facts of disaster management, literature review on past researches concerning disasters, 2014 Kelantan's flood, disaster management, and hospital disaster preparedness. More discussions on previous related studies are discussed further in this chapter.

2.2 DEFINITION OF DISASTER

Disaster can be defined as a crisis that surpasses the capacity of the people to manage and deal with it for at least a while. According to Md Akhir, Azman, Hassan & Akhir (2017), disasters are physical events that result in damage to infrastructure and property, environmental and plant damage and loss of life and physical injury. Disasters are events that disrupt the functioning of community or society. They cause human, material, and economy or larger environment damages which in turn damage the ability of the community or society. Turner and Pidgeon (1978) in their studies pointed out that deaths in a large-scale incident as much as a function of population density has been declared as a disaster. Studies by Alexender (1993); Mileti (1999); Quarantelli (1998) have been done in the natural environment field particularly of disaster, crisis and emergency studies. Findings have shown that the effects of natural disasters have increased due to environmental degradation. Therefore, disasters are

beyond human control and cannot be accurately predicted when they would occur. It has a devastating effect on properties and lives.

According to The United Nations' International Strategy for Disaster Reduction (UNISDR), disaster is a serious disruption to community functioning, material loss, economic loss, and environmental impact beyond people's ability (UNISDR, 2009). The definition of disaster has been succinctly described by the Centre for Research on the Epidemiology of Disasters (CRED) as:

> *"a situation or event (which) overwhelms local capacity, necessitation a request to a national or international level for external assistance; an unforeseen and often sudden event that causes great damage, destruction and human suffering"*

The Malaysia National Security Council (NSC) defines disaster as an event that interferes with the country's activities and affairs, including loss of life, damage to property, economic loss and environmental destruction beyond the ability of the community to address and require extensive resource mobilization. In addition, Veenema (2006) highlighted that disasters were defined as ecological disorders, or conditions of anxiety, severity, and magnitude that result in death, injury, illness, or damage to the property that cannot be effectively managed by use of routine procedures or resources and result in the need for outside assistance. Veenema (2016) also added that disasters are the convergence of hazards with vulnerabilities. Therefore, an increase in physical, social, economic or environmental vulnerability can lead to increased frequency of disasters.

2.2.1 Types of disasters

Different types of disasters are distinguished by their nature and the extent of their effects. Hence, disaster has been classified into natural disasters

and man-made disasters. These disaster types have been summarized by Turner and Pidgeon (1978),Directive National Security Council (2018), CRED (2003) and WHO (2003). Mohd Khalid & Dol (2015) stated that both natural and man-made disasters have become an important issue that affects daily life. Evidences from previous studies show that disasters can cause the most fatalities to the community in the world. Many hydrological disasters which are geological disasters such as earthquakes, volcanic eruptions, and landslides have been witnessed by the world (Shaluf & Ahmadun, 2006). Figure 2.1 shows the natural disaster subgroup classification as reviewed by the CRED:

Figure 2.1: Natural disaster subgroup classification (Guha-sapir et al., 2016)

Various types of disasters have occurred due to natural phenomena or human negligence that have resulted in loss of lives and properties. These phenomena including personal injuries, fires, explosions, chemical spills, toxic gas releases, vandalism, natural disasters such as typhoon and floods, and man-made disasters such as riots and terrorist activities will continue in every industry if safety at the workplace is neglected. Emergency and disaster preparedness will help reduce the rate of loss due to dangerous incidents in Malaysia.

i. Natural disaster.

UNISDR (2017) stated that natural disaster is “a serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability, and capacity, leading to one or more of the following: human, material, economic and environmental losses, and impacts”. It is caused by a variety of natural events, including hurricanes, tornadoes, heavy rains, snowstorms, and wildfires (McKnight & Linnenluecke, 2019).

Table 2.1 shows categories, types and subtypes of the natural disasters that are a danger of concentrating on weaknesses as physical, socio-economic or environmental improvements can mean increased frequency of disasters.

<table>
<tr><th rowspan="2">Biological</th><th rowspan="2">Geophysical</th><th colspan="2">Hydrometeorological</th></tr>
<tr><th>Hydrological</th><th>Meteorological</th></tr>
<tr><td rowspan="2">Epidemic
Viral infectious disease
Bacterial infectious disease
Parasitic infectious disease
Fungal infectious disease
Prion infectious disease
Insect infestation
Animal stampede</td><td rowspan="2">Earthquake
Volcano
Mass movement (dry)
Rock
Landslide
Avalanche
Subsidence</td><td rowspan="2">Flood
General flood
Storm surge/coastal flood
Mass movement (wet)
Rock fall
Landslide
Avalanche
Subsidence</td><td>Storm
Typical cyclone
Estra-tropical cyclone
Local storm</td></tr>
<tr><td>Climatological
Extreme temperature
Heat wave
Cold wave
Extreme winter condition
Drought/wildfire
Forest
Land fire</td></tr>
</table>

Table 2.1: Natural Disaster Categories, Types and Subtypes (Source: UCL, “EM- DAT: The OFDA/CRED International Disaster Database”)

ii. Man-made disaster

Man-made disasters are difficult to predict but they are preventable. Turner and Pidgeon (1978) in their study on man-made disasters discovered that this type of disaster is the element of human intention or negligence that leads to human losses and environmental damages yet man has a direct hand in their occurrence. The examples of man-made disasters are economic collapse, terrorist attacks, power outages, chemical threats, biological threats, nuclear accidents, wars, and explosions. Therefore, there is a strong "business case" to pay more

attention to man-made dangers and integrating it into a risky approach to disaster risk management. Figure 2.2 shows the number of man-made and technological disasters per continent from 2005 until 2016.

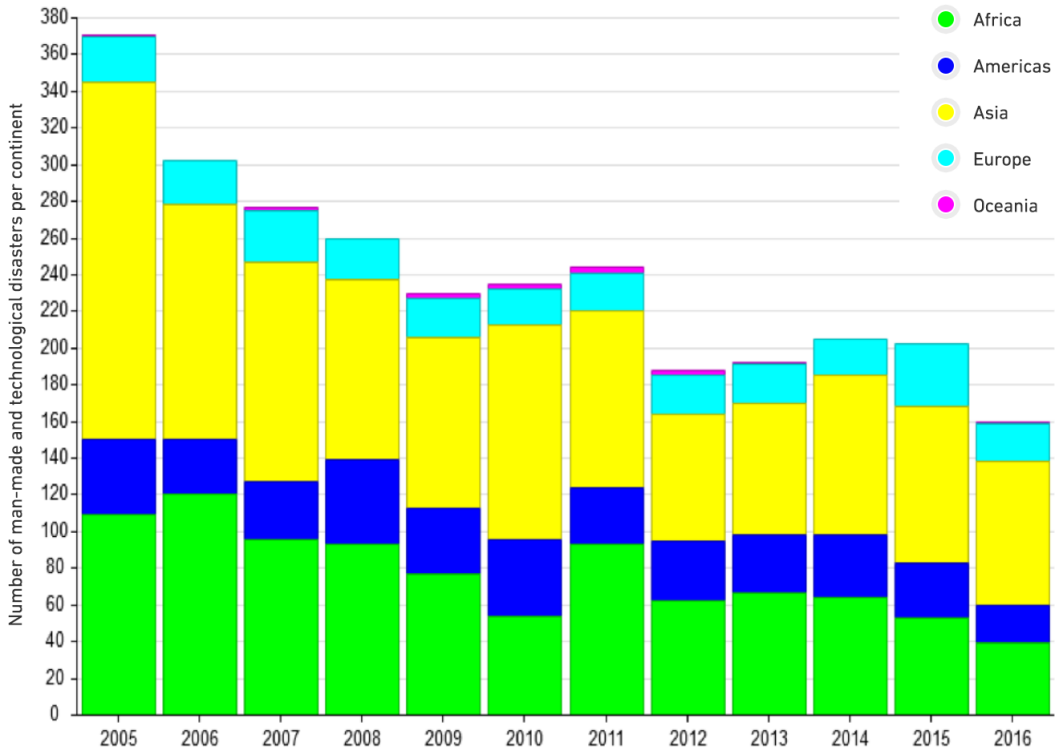

Figure 2.2: Number of man-made and technological disasters per continent (Source: EM DAT: the OFDA/CRED (International Disaster Database) www.emdat.be)

2.3 DISASTER IN MALAYSIA

Malaysia is free from natural disasters such as volcanic eruptions, earthquakes, hurricanes, tsunamis, typhoons, and tornadoes because it is located in a geologically stable region just outside the 'Pacific Ring of Fire'. It also lies too far south from major typhoon paths (Chan, 2012). The most severe hazard experienced in Malaysia is flood. Floods are the most devastating natural disasters that occur in Malaysia. Like the other hazards, floods can cause fatalities from drowning and damages to properties such as houses, buildings, cars, plantations, and others.

In Malaysia, past research showed that floods are the most common disaster affecting areas that are particularly low since the 1920s. Past research suggested that almost 9% of the amount of disasters are caused by the expansion of the area while almost 22% of the total population is directly affected by the floods (Salleh et al., 2013; Othman et al., 2014; Aliagha et al., 2015; Khalid & Shafiai, 2015; Tan et al., 2015). Figure 2.3 below shows the pattern of rainfall in Malaysia and the two monsoons which are the South West and North East Monsoon.

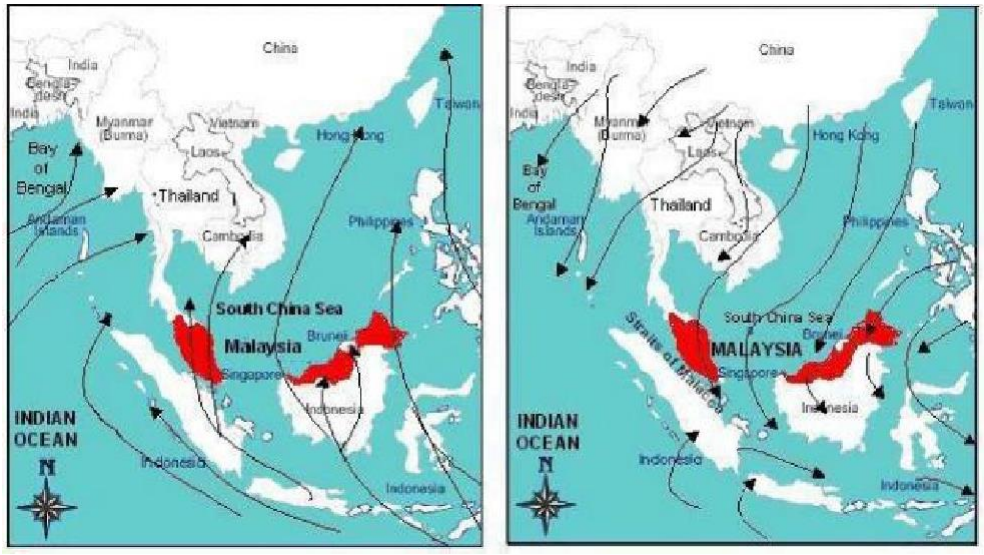

Figure 2.3: Southwest and Northeast Monsoons (Source: Diya, Gasim, Toriman, & Abdullah, 2014)

Although Malaysia is geographically located outside of the 'Pacific Ring of Fire' and relatively free from any damage caused by natural disasters such as earthquakes, typhoons and volcanic eruptions, nevertheless the country is exposed to the monsoon floods, landslides and severe haze. Malaysia is often hit by floods, droughts, landslides, haze, tsunamis and human-made disasters. The country is also annually hit by man-made disasters such as fires, mass casualty accidents, and the collapse of structures and buildings which result in damage to the environment and

property and loss of life (Shaluf & Ahmadun, 2006; Wan Hussin, Zakaria, & Ahmad, 2016)

Wan Hussin, Zakaria, & Ahmad (2016) in their study mentioned that the primary factor of floods in Malaysia is the incidence of heavy monsoon or continuous rainfall, resulting in a large concentration of overflow which is worsened by rapid development in the river catchment area and deteriorated river capacity. Usually, floods will occur in the states of the East Coast of Malaysia such as Kelantan, Terengganu and Pahang because of monsoon (Azmi, Hashim & Zamhury 2012).

2.3.1 2014 Flood in Kelantan

Floods are a common occurrence in Malaysia but the flood from December 2014 to January 2015 is considered the most devastating one in Malaysia in recent decades. This flood resulted in more than 100,000 victims to evacuate their homes. Previous study by Komoo (2015) identified that the 2014 flood caused RM2.85 billion in losses and the number of victims affected by the disaster surpassed 500,000 from the previous year. In addition, the National Security Council (NSC) of Malaysia stated that the 2014 flood in Kelantan is the worst one recorded in the history of the state (Azlee, 2015).

The massive flood that hits the entire region in Kelantan in December 2014 was characterized by the former Prime Minister Dato' Seri Najib Razak as a major catastrophe (Bernama, 2014c). Based on the results of the study conducted by "Jawatankuasa Khas Forensik Bencana Banjir 2014", the 2014 major flood was the worst flood recorded in the history of Malaysia since 200 years ago. The massive 2014 flood was described as a small tsunami based on the destruction suffered by the residents of Kuala Krai and Gua Musang (Fitri, 2014). This is because most residential areas in Kuala Krai and Gua Musang

were hit by the floods. 2014 floods resulted in losses of around RM2.85 billion and recorded the highest number of affected victims compared to the previous year of 500,000 people (Komoo, 2015).

According to Isahak (2015) in his study, it was found that the 2014 flood in Kelantan is the worst flood ever recorded in the history of Malaysia for the last 200 years as mentioned by the 2014 Flood Forensic Special Committee. Similarly, Ismail & Haghroosta (2018) in their study pointed out that the 2014 floods in Kelantan are the biggest flood in Malaysia this century. The 2014 flood had caused severe damage in some areas, especially the Kuala Krai area. Besides, the last 2014 flood was described as a small tsunami based on the devastation experienced by the residents of Kuala Krai and Gua Musang. The main cause of the flood was due to heavy rainfall which caused the river to overflow to high cliffs. Therefore, as a developed country, the effectiveness of flood disaster management should be emphasized in this regard to reduce disaster risk in the long run.

In December 2014, Kelantan was hit by the worst flood ever recorded. Alias, Mohamad, Chin, & Yusop (2016) in their study stated that the most recent extreme flood event occurring at the north-east coast was the flood called by locals as the Kelantan Flood 2014. Kelantan is located in the East-coast of the peninsular Malaysia exposing it to high rainfalls during the north-east monsoon season. Kelantan was hit by the worst flood ever where flood levels reached between 5 to 10 meters. Buildings were inundated up to the 3rd and 4th floor. Many people could not evacuate from their house and they took shelter in evacuation centers such as schools which were left helpless due to lack of supplies and necessities. Heavy rains began on the 17th of December

and continuously ran for three days from 21st to 23rd of December 2014 in Kelantan. This was a record-setting rainfall of 1295mm, equivalent to the amount of rain water usually seen in a span of 64 days.

There were several reasons contributing to the December 2014 flood in Kelantan. Liberto & Pugh (2018) claimed that the rain recorded prior to the flood was extremely high and prolonged. Factors influencing the heavy rainfalls in December 2014 were assessed based on reports by National Oceanic and Atmospheric (NOAA), the Tokyo Climate Centre (Kobayashi et. al, 2015) and Malaysian Meteorological Department (Fakaruddin et al., 2018)). The 2014 flood was due to heavy rainfall on the east coast from 15th to 29th December 2014. The rain that contributed to the floods occurred in two phases. Alias et al. (2016) in their study found that the first phase ran from 15th to 19th December 2014 with daily rainfall reaching from 100 mm up to 300 mm while the second phase started from 20th to 24th December 2014 reaching up to 500 mm. Besides, (Baharuddin et al., 2015) in their study mentioned that the violent rain on 17th December 2014 had caused the flash flood and forced around 3,390 people in Kuala Krai to flee their homes.

The 2014 flood is the largest recorded flood in history of Kelantan and it was a significant event of the year (Eliza, Mohamad, Yoke, & Yusop, 2016). Similarly, (Tuan Kamauzaman, 2014) stated that the 2014 flood in Kelantan is the worst in a decade due to continuous rainfall for more than 12 hours, swelling the number of flood victims in relief centers around the country by nearly 20,000. The results show that the water levels of Galas, Sungai Lebir and Sungai Kelantan had risen dramatically above the water level. The highest recorded level of Sungai Galas was 46.47m (flood stage: 38m), the highest

recorded level of Sungai Lebir was 42.17 m (flood stage: 35m) and the highest recorded level of Sungai Kelantan was 34.17m (flood stage: 25m). The highest level of Sungai Golok was 10.84m (flood stage: 23.5m), which was over the dangerous point (eBanjir Negeri Kelantan, 2015)

River	Location	Normal level (m)	Warning level (m)	Danger level (m)	Water level on December 2014	
					Date and time	Water level (m)
Galas	Dabong	28.00	35.00	38.00	24/12/14 16:00	46.47
Lebir	Tualang	23.00	31.00	35.00	27/12/14 04:00	44.51
Kelantan	Tangga Krai	17.00	22.50	25.00	25/12/14 15:00	34.17
Kelantan	Guillemar Bridge	10.00	14.00	16.00	26/12/14 00:00	22.74
Kelantan	Tambatan DiRaja	1.00	4.00	5.00	27/12/14 07:00	6.96
Golok	Jenob	19.00	22.50	23.50	11/1/14 21:00	25.44
Golok	Rantau Panjang	5.00	8.00	9.00	18/12/14 11:00	10.84
Semerak	Pasir Putih	0.40	2.30	3.00	18/12/14 07:00	2.67

Table 2.2: The Highest Recorded Water Level At The Main River.
(Source: eBanjir Negeri Kelantan, 2015)

Ziegler et al. (2012) have stated that major flood events occurred due to climate change that increased rainfall distribution and river flow. This has led to sea level rise. The sea level rise can be seen in Table 2.2 for the Kelantan River for 1967 and 2004 which shows the highest record of floods in 1967. The record of Kelantan River water level at Tangga Krai was the highest reading of 2014 at 34.71 meters compared with 1967 at 33.61 meters from the danger level.