EARTHQUAKE AND FLOOD MITIGATION ON DAM FAILURE OF DOWNSTREAM COMMUNITY OF VAJIRALONGKORN DAM, THONGPHAPHUM DISTRICT, KANCHANABURI PROVINCE

KAMONCHAT KOEDMANKHONG

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Thesis
entitled

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Kamonchat Koedmankhong

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EARTHQUAKE AND FLOOD MITIGATION ON DAM FAILURE OF DOWNSTREAM COMMUNITY OF VAJIRALONGKORN DAM, THONGPHAPHUM DISTRICT, KANCHANABURI PROVINCE

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ABSTRACT

The objectives of this research were to study the operational situation of relevant agencies in the mitigation management of earthquake and flood on dam failure of downstream community of Vajiralongkorn Dam, to investigate people's knowledge, understanding, participation attitude towards the problems and problem solving from earthquake and flood and to find mitigation guidance for future disasters. In the process of this study, questionnaire (n=366), in-depth interviews (n=20) and non-participant observation were analyzed. The results showed that people in the area have a little knowledge to help themselves and they do not thoroughly obtain information about disaster; thus people need help from the agencies the whole time (before, during, after disaster). At present related government organizations in the area such as Disaster Prevention and mitigation Provincial Office Kanchanaburi Thongphaphum Brance, Subdistrict (DDPM), Subdistrict Administrative Organization (SAO), and Electricity Generating Authority of Thailand (EGAT) have more attention about earthquake management than in the past. A campaign should be done to increase understanding and public awareness about dam mitigation so that the people will become more involved and eventually get their participation. So the participation of people in the area is the important factor which leads to success in the disaster risk management.

KEY WORDS: EARTHQUAKE/FLOOD/MITIGATION/DAM FAILURE/ DOWNSTREAM COMMUNITY

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การจัดการรับมือจากแผ่นดินไหวและน้ำท่วมจากเขื่อนพิบัติของชุมชนท้ายเขื่อนวชิราลงกรณ อำเภอทองผาภูมิ จังหวัดกาญจนบุรี

EARTHQUAKE AND FLOOD MITIGATION ON DAM FAILURE OF DOWNSTREAM COMMUNITY OF VAJIRALONGKORN DAM, THONGPHAPHUM DISTRICT, KANCHANABURI PROVINCE

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บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาสถานการณ์การดำเนินงานของหน่วยงานที่เกี่ยวข้องในการจัดการรับมือแผ่นดินไหวและน้ำท่วมจากเขื่อนพิบัติของชุมชนท้ายเขื่อนวชิราลงกรณ ตรวจสอบความรู้ความเข้าใจ ทัศนคติการมีส่วนร่วมของประชาชนที่มีต่อปัญหาและการแก้ปัญหาในการจัดการแผ่นดินไหวและน้ำท่วมจากเขื่อนพิบัติ และการหาแนวทางสำหรับการจัดการรับมือกับพิบัติในอนาคต วิธีการศึกษาโดยใช้แบบสอบถาม (n = 366) การสัมภาษณ์เชิงลึก (n = 20) และการสังเกตแบบไม่มีส่วนร่วม ผลการศึกษาพบว่าประชาชนในพื้นที่ยังขาดความรู้ในการที่จะช่วยเหลือตัวเองและยังไม่ได้รับข้อมูลข่าวสารเกี่ยวกับภัยพิบัติอย่างทั่วถึง ประชาชนมีความกังวลเกี่ยวกับความปลอดภัยของเขื่อนวชิราลงกรณ และต้องการความช่วยเหลือจากหน่วยงานที่เกี่ยวข้องในช่วงเวลาทั้งก่อน ระหว่าง และหลังเกิดภัยพิบัติ ปัจจุบันหน่วยงานที่เกี่ยวข้องในพื้นที่เช่น สำนักป้องกันและบรรเทาสาธารณภัย องค์การบริหารส่วนท้องถิ่น และการไฟฟ้าฝ่ายผลิตให้ความสำคัญกับการจัดการภัยพิบัติเพิ่มมากขึ้น ควรมีการรณรงค์เพื่อเพิ่มความเข้าใจและความตระหนักของประชาชนเกี่ยวกับการเตรียมความพร้อมรับมือกับภัยพิบัติเพื่อให้ประชาชนมีส่วนร่วมมากขึ้น เนื่องจากการมีส่วนร่วมของประชาชนในพื้นที่เป็นปัจจัยที่สำคัญที่จะนำไปสู่ความสำเร็จในการบริหารความเสี่ยงจากเกิดภัยพิบัติ

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CHAPTER I
INTRODUCTION

1.1 Significance of the Problem

At present, earthquakes frequently occur in many regions of the world, as well as occasionally they affect the houses were damaged and people were injured and killed. Earthquake is a natural phenomenon caused by a sudden movement of the crust, and most often at the edges of the plate. If the edges of the crust move over or near any particular country, it will be high to earthquakes occurrence. For Thailand located in Low Seismic Risk Zone to Intermediate Seismic Risk Zone (Department of Disaster Prevention and Mitigation, 2010).

Kanchanaburi has the 2 large dams including Srinakarin dam based on Sri Sawat fault and Vajiralongkorn dam located on Three Pagoda fault. Those 2 faults isolate from Sagaing Fault in Myanmar move and are likely to cause earthquakes. Earthquakes of small - medium size from 3.0 to 5.9 on the Richter scale occurred in the past then it must be in a condition to be monitored. So Kanchanaburi province is a sound disaster caused by the earthquake. Sometimes, when an earthquake occurs in an area which can affect the structure of the human need to much load, such as dams where water is stored above the dam are numerous. If an earthquake in the area, or the area below the dam could cause damage to life and property number (Department of Disaster Prevention and Mitigation, 2010).

Vajiralongkorn dam is a part project of the Mae Klong River Basin Development Plan, and has been developed by the Electricity Generating Authority of Thailand (EGAT) to produce electricity to increase benefit to the public. A characteristic of Vajiralongkorn dam is the first Concrete Face Rock fill Dam (CFRD) that pave surface with concrete located on the Khwae Noi River and also located on the Three Pagoda fault. So, people who live along the fault and at the downstream area are at risk to be affected by the earthquake disaster which caused flood disaster behind the dam. For this reason they have to understand about disaster management, and

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should participate in commenting on problems and solutions in community disaster management. The participation of people in the area is the important factor leads to successful in the disaster risk management, because the community is the first side that face the consequences of the disaster and nobody know or pay attention in resources and people in the community, including their needs and requirements as well as that community. Therefore, in order to prevent and prepare disasters. Would be educated and people would be given knowledge continuously, Moreover, people, especially who live in vulnerable areas along the pass downstream of Three Pagodas fault is award of the involvement in disaster management by asking for opinions on the forthcoming disaster (Department of Disaster Prevention and Mitigation, 2010).

Currently, the Electricity Generating Authority (EGAT) which is the main agency works together with to study on the impact and put in measures to support the disaster in each level. But the most important thing of natural disaster management area is coordination knowledge providence and right understanding of people in the area for an effective proceeding of all related agencies. Although the earthquake that happened in the past, have never affected the structure of the dam including people who live at the downstream of Vajiralongkorn dam, but it still cannot conclude that the disaster will not happen in the future. Therefore, raising awareness of this issue is necessary and can reduce the risk of disasters because people in risk areas will have right practical approach to response if the disasters happen in the future. And area community network establishment should be given importantly for timely warning in both agencies to community, and between each community. Because the important factor in reducing the risk of disasters for a community is a powerful alarm. The risks in each community in risky area are not equal. If the faraway community receives news in time from agencies or community networks, they will have time to evacuate and it can decrease damage (Supanich N., 2006).

Researcher has thought that a disaster is interested topic to study on the management and preparation of the community. Therefore, the researcher wants to study by collect documents, research activities related to disaster due to the earthquake and flood from the dam, and local and abroad case studies. Include studying about the operations by the organizations involved in managing the earthquake response and flood from the dam disaster, together with the study of people's understanding in

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disaster management. In process of the study, questionnaire which is used with people in risk areas is the quantitative study and qualitative study by using in-depth interviews with leaders of community and related agencies. In order to, understand the problems and solutions in disaster management of downstream communities of Vajiralongkorn dam, and to prepare for an earthquake disaster and flood from the dam disaster.

1.2 Objectives of the study

1.2.1 To study the operational situation of relevant agencies in the mitigation management of earthquake and flood on dam failure.

1.2.2 To investigate people's knowledge and understanding, participation attitude towards the problem, and problem solving of earthquake and flood mitigation on dam failure of downstream community of Vajiralongkorn dam, Thongphaphum district, Kanchanaburi province.

1.2.3 To find mitigation guidance for future disasters of the relevant agencies and communities in downstream community of Vajiralongkorn dam.

1.3 Scope of the study

In order to know the opinions on the problems and solutions of the people in the downstream community of Vajiralongkorn dam, which is the risk area from earthquakes and flood from the dam, the study area around Khwae Noi River was defined from the risk map of Vajiralongkorn dam. The study area covers all the risk areas at of 7626 households in 12 villages at Thongphaphum district that is the first area receives water from the dam if an earthquake disaster and flood happen. The questionnaire was created to collect quantitative data by asking people in the area, and collect qualitative data using In-depth interviews with the relevant agencies and community leaders. Structure of the questions cover the content issues and focus on the community participation to get diverse opinions and guide for the same

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understanding and efficiency in future disaster management of relevant agencies and communities in downstream community of Vajiralongkorn dam.

1.4 Definition of Terms

Earthquake is a natural phenomenon that parts of plate tectonics move immediately and cause the motion of land.

Flood is threated from water that usually happens by long-continued rain such as overflow water, cataract, and sometimes can affect landslide. Flood may occur from many reasons like tropical storm, active monsoon and monsoon trough, vary weather and tidal bore. In this research, flood means threat from water caused by earthquake and dam failure which are the other reasons of deluge.

Disaster is threated that caused by nature or human activities extremely effect on people's life including damage of property, society, economy and environment more than mitigation management ability of community.

Mitigation is measures and activities in both construction and not construction that early decide in order to decrease or control negative effect of disaster (Supanich N., 2006).

Dam failure is dam damage that can happen in many types with various causes bring out flood and related to the violence of damage on dam and the volume of water stored in reservoir.

Downstream community is defined as individuals and organization live in downstream area of Vajiralongkorn dam, Thongphaphum district, Kanchanaburi province.

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1.5 Conceptual framework

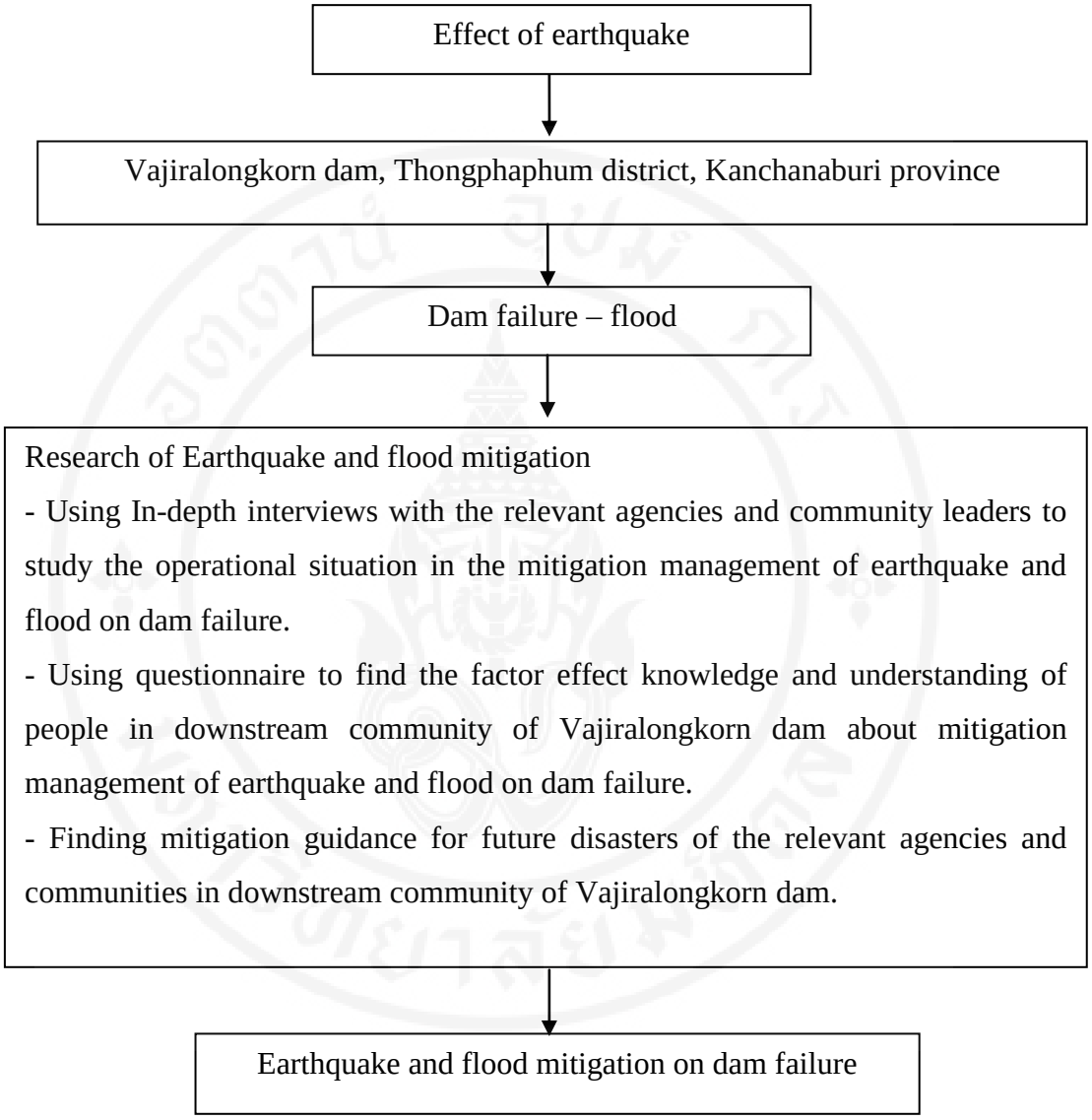

Figure 1-1 Diagram of conceptual framework

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1.6 Expected outputs

1.6.1 Know the operational situation of relevant agencies in mitigation management of earthquake and flood on dam failure.

1.6.2 Know the factor affect knowledge, participation, opinions on the problems and solutions of people in earthquake and flood mitigation on dam failure of downstream community.

1.6.3 Get mitigation guidance for future disasters of relevant agencies and people in downstream community of Vajiralongkorn dam.

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CHAPTER II
LITERATURE REVIEW

In the study of "Earthquake and flood mitigation on dam failure of downstream community of Vajiralongkorn dam, Thongphaphum District, Kanchanaburi Province" have been reviewed a conceptual frame work, theory, and research include:

2.1 Vajiralongkorn dam

2.2 Faults in Kanchanaburi province

2.3 Statistics of earthquake in Kanchanaburi province

2.4 Dam and dam failure

2.5 Dam safety and earthquakes

2.6 Damage of Concrete Face Rockfill Dam (CFRD) from an earthquake.

2.7 Effects of dam failure

2.8 The damage of dam failure in Thailand.

2.9 The readiness preparation of related institutions.

2.10 The readiness preparation of disaster for the communities

2.11 Related researches

2.1 Vajiralongkorn dam

Vajiralongkorn dam is a part project of the Mae Klong River Basin Development Plan that has been developed by the Electricity Generating Authority of Thailand (EGAT), and that increased benefit to the public by produce electricity. A characteristic of Vajiralongkorn dam is the first Concrete Face Rock fill Dam (CFRD) which is located on the Khwae Noi River, and that away from Tha Khanun sub-district about 6 kilometers in Thongphaphum district, Kanchanaburi province. Dam height is 92 meters, length of dam is 1,019 meters, the volume of water stored by the dam is 8.1 million cubic meters, the slope is 1.4 per 1, and above mean sea level of 162 meters (MSL.). The reservoir areas are located in Thongphaphum and Sangkhlaburi district

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which is 388 square kilometers +155.0 m level and that catchment area rain is 3720 square kilometer. The amount of water flowing into the basin is averaged 5,500 million cubic meters and a capacity of 8860 million cubic meter reservoir (Vajiralongkorn Dam, n.d.).

A length of Khwae Noi River has 390 kilometers of from Tenasserim Hills. Tenasserim Hills is border line in Western of Thailand among Myanmar and that has 3 rivers are important include Songkalia River, Bikli River, and Runtee River. Khwae Noi River and Khwae Yai River are flowing converge at Pak Phraek Sub-district Meuang Kanchanaburiprovince that has renamed is Mae Klong River. The government has assigned the Electricity Generating Authority of Thailand to developed maximum benefit of this river which has built the dam blocking the river above 5 kilometers from Thongphaphum district. The history in April 1968, a survey was started in Khwae Noi project in Ban Phu Toei, Sai Yok District by Yanhee Electricity Authority (YEA) and on May 1, 1969 the EGAT was studies and surveys Khwae Noi project for marked geographical map, dig a well, drilling rock trenchers, tunneling, and hydrological information that is to a preliminary study with experts from Japan and that is according to under help of the Colombo plan. In August 1970 the study found that the appropriate area is Khao Laem to be construction of dams and hydroelectic power station. On February 28, 1979 the EGAT was approved to construction of the Khao Laem dam by the cabinet (Vajiralongkorn Dam, n.d.).

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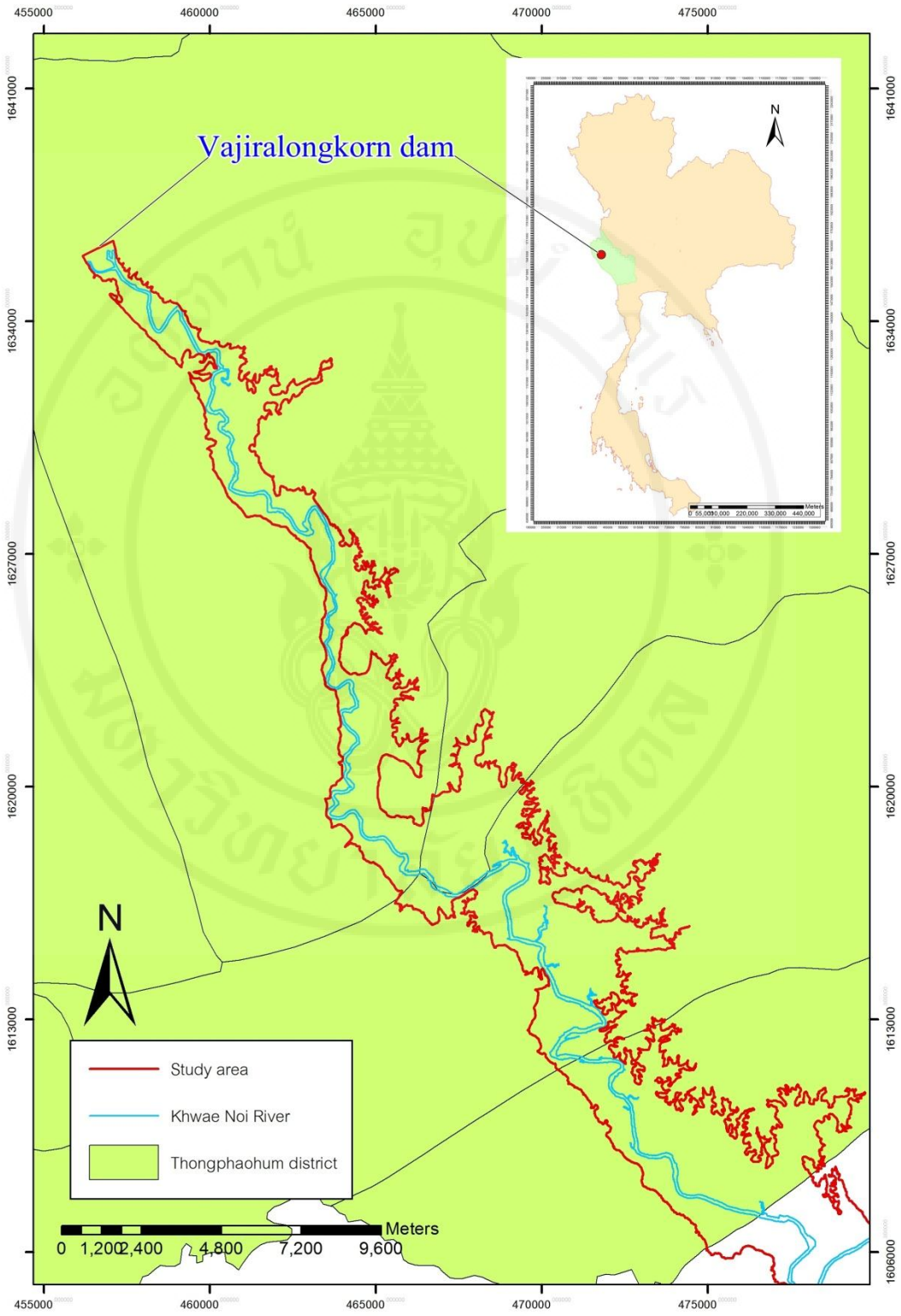

Figure 2-1 Map of Vajiralongkorn dam

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2.2 Faults in Kanchanaburi Province

Fault is crack of rocks which both sides of cracks has relative moved and parallel to each other. Fault may be long only 2-3 cm or several kilometers such as in the past, usually faults are also moved, so there will be earthquakes and can be observed the age of rocks in the fault area. For the fault in the country are mainly in the Northern and Western (Figure 2-1). But some of the faults are related to earthquakes suck as Mae Tha Fault, Si Sawat Fault, and Ranong Fault etc (Nutalai and Mansetha, 2000).

From the study of earthquake in Western of Thailand was showed that the 2 areas include Srinagarind dam, Vajiralongkorn dam and their reservoirs. The quakes were felt just shortly after reservoirs are catchment. Generally epicenters are located in mainly limestone which is affected by water (Konchuaerat, 1998).

Three Pagoda Fault

This fault is located on Khwae Noi River until Sakaing Fault in Myanmar, so the length during in Thailand is longer than 250 kilometers. Many thousands earthquakes are reported from the fault. Vajiralongkorn Dam was located on Three Pagoda Fault that the building block of the Khwae Noi River on Tha Khanun Sub-district, Thongphaphum District, Kanchanaburi Province (The Disaster Prevention and mitigation Provincial Office Kanchanaburi Thongphaphum Brance, Subdistrict, 2010).

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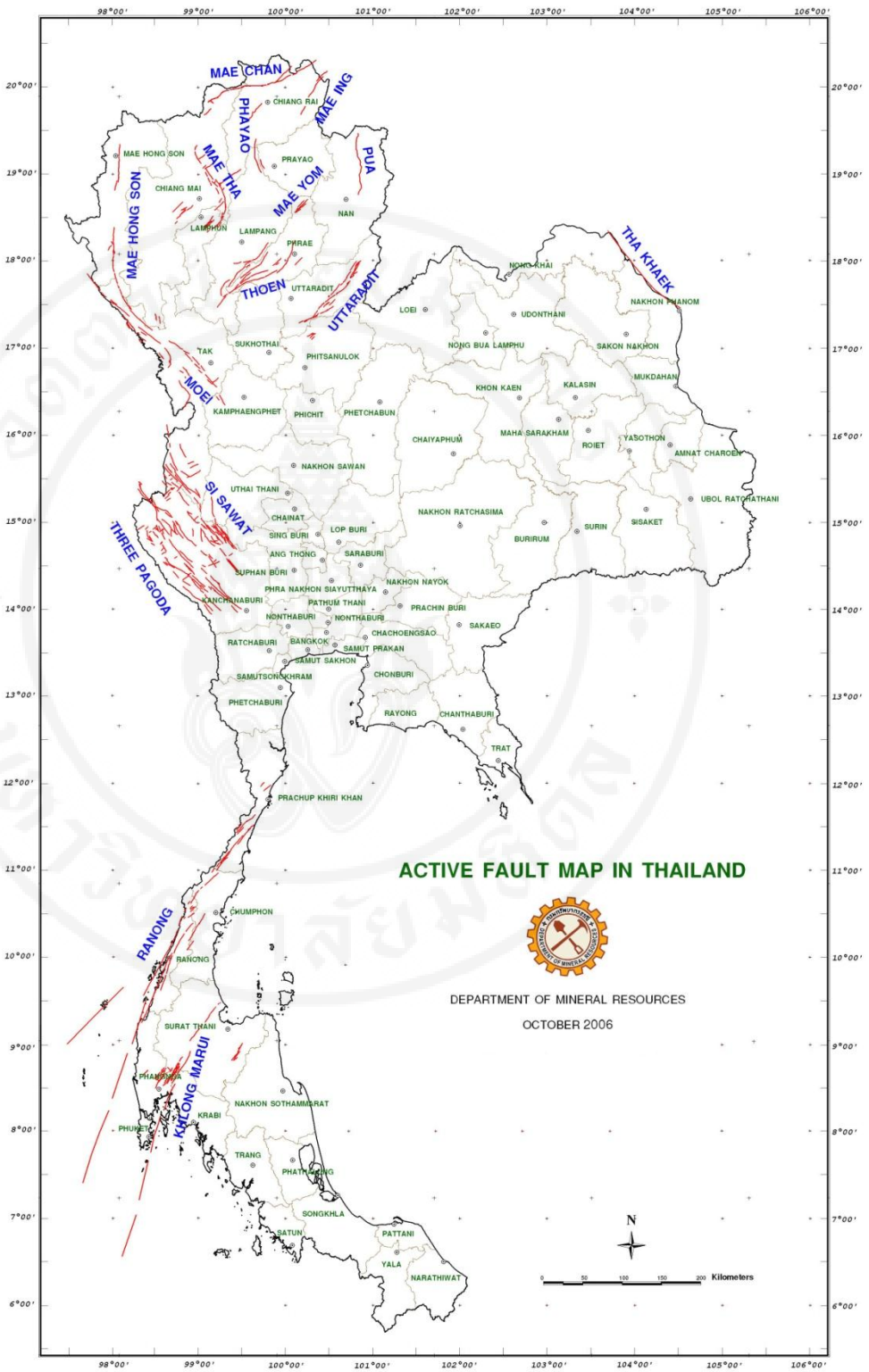

Figure 2-2 The active fault in Thailand (Department of Mineral Resources, 2006)

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2.3 Statistics of earthquake in Kanchanaburi province

Kanchanaburi has the 2 active fault including Srisawat fault and Three Pagoda fault, so frequently earthquake are occurred in Kanchanaburi. Thai Meteorological Department has statistics of earthquake in Kanchanaburi province (Table 2-1) (Seismological Bureau, Thai Meteorological Department, n.d.).

Table 2-1 Statistics of earthquake in Kanchanaburi province

Date	Time	Locate	Lat.	Long.	Mag	Detail
1886		Kanchanaburi	-	-	-	At about 2 pm An earthquakes, thunderstorms, and landslide were occurred in Kanchanaburi.
26/02/1979	4:23 pm.	Kanchanaburi	14.91N	99.10E	5.5 Mb	An earthquake was clearly felt in Bangkok.
18/03/1979	7:37 am.	Kanchanaburi	14.93N	99.00E	5.9 Mb	An earthquake was felt in throughout Central and Northern, so many people were panic and building was damaged in Bangkok
10/02/1980	10:21am.	Kanchanaburi	14.93N	99.07E	5.2 Mb	An earthquake was felt in throughout Central and Northern, so many people were panic and slightly building was damaged in Bangkok.
22/12/1980	0:48 am	Kanchanaburi	15.20N	99.02E	4.7 Mb	A quake was felt at Banpong district, Ratchaburi province.
23/12/1980	5:09 am	Kanchanaburi	14.92N	99.15E	4.2 Mb	A quake was felt at Kanchanaburi province.
15/04/1983	6:56 pm.	Thonphaphom district	14.88N	98.69E	3.5 Ml	A quake was felt at Khao Laem dam.
1/03/2532	00.28 am	Kanchanaburi	14.90N	99.80E	4.0 Ml	A quake was felt at Si Sawat district.

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Table 2-1 Statistics of earthquake in Kanchanaburi province (continued)

Date	**Time**	**Locate**	**Lat.**	**Long.**	**Mag**	**Detail**
20/08/1989	6:23 pm	Kanchanaburi	14.90N	99.80E	4.2 Ml	A quake was felt Si Sawat district.
15/12/1989	9:51 pm	Kanchanaburi	15.30N	98.90E	4.0 Ml	A quake was felt at Si Sawat district.
17/08/1999	05.03น.	Khao Laem Dam.	14.97N	98.59E	4.3 Ml	A quake was felt at Thongphaphum district.
25/12/2007	3:59 pm.	Si Sawat district	14.41N	99.08E	2.6	-
02/06/2010	1:53 pm	Chalae Sub-district, Thongphaphum district	15.02N	98.73E	3	-
11/06/2010	0:37 am	Nong Ri Sub-district, Bo Phoi district	14.59N	99.34E	3.1	-
13/06/2010	8:19 am	Dan Mae Chalaep sub-district, Si Sawat district	14.55N	99.23E	3.7	A quake was felt at Ban Khao Lek, Si Sawat district.
13/06/2010	12.20 am	Nong Prue Sub- district, Nong Prue district	14.68N	99.32E	2.2	-
27/06/2010	11:19 am	Ban Na Suan, Si Sawat district.	14.64N	99.22E	2.7	A quake was felt at Si Sawat district.
5/07/2010	6:19 am	Chalae Sub-district, Thongphaphum district	15.18N	98.93E	2.7	-
23/07/2010	9:45 pm	Tha Sao Sub-district, Sai Yok district	14.23N	99.05E	2	-

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Table 2-1 Statistics of earthquake in Kanchanaburi province (continued)

Date	Time	Locate	Lat.	Long.	Mag	Detail
09/08/2010	1:43 pm	Hin Dat Sub-district, Thongphaphum district	14.62N	98.79E	3.1	-
09/08/2010	1:44 pm	Hin Dat Sub-district, Thongphaphum district	14.6N	98.78E	2.7	-
09/08/2010	3:21 pm	Dan Mae Chalaep sub-district, Si Sawat district	14.56N	99.18E	1.5	-
16/08/2010	1.40 am.	Si Sawat district	14.69N	99.2E	3.4	A quake was felt at Si Sawat district.
18/08/2010	8:30 pm	Chalae Sub-district, Thongphaphum district	14.91N	98.97E	2.8	-
02/09/2010	1:22 pm	Ban Na Suan, Si Sawat district.	14.74N	99.04E	1.7	-
27/10/2010	2:32 pm	Somdet Charoen Sub-district, Nong Prue district.	14.72N	99.32E	3.5	-
04/03/2011	1:06 am	Ban Na Suan, Si Sawat district.	14.84N	99.13E	2.3	-
02/09/2011	9:14 pm	Chalae Sub-district, Thongphaphum district	14.97N	98.96E	1.9	

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Table 2-1 Statistics of earthquake in Kanchanaburi province (continued)

Date	Time	Locate	Lat.	Long.	Mag	Detail
04/09/2011	1:27 am	Chalae Sub-district, Thongphaphum district	14.93N	98.9E	2.52	-.
03/03/2012	11:33 pm	Chalae Sub-district, Thongphaphum district	14.99N	98.69E	3	-
21/05/2012	4:51 am	Sai Yok district.	14.25N	99.06E	2.3	-
03/07/2012	1:49 pm	Thongphaphom district	14.97N	98.89E	2.1	-
28/09/2012	1:04 pm	Thongphaphom district	14.88N	98.92E	2.9	-
04/11/2014	1:44 pm	Thongphaphom district	14.93N	98.92E	2.5	-
16/12/2014	4:58 pm	Si Sawat district.	14.82N	99.19E	3.6	-
11/01/2015	1:57 am	Thongphaphom District	14.77N	98.80E	3.1	-

2.4 Dam and Dam failure

Dams are engineering structure for water storage, control or water diversion in reservoir. Dam failure can be occurred in several forms, while the damage was caused flood that related to the volume of stored water are significantly. Dam failure was as a result of one or many reasons include: (Concho Valley Hazard Mitigation plan update, 2012).

- During rains, rainfall, flood, prolonged flood
- Spillway has insufficient capacity that is affect to water overflowing of dam.
- Internal erosion of dam or leaking pipes in foundation of dam.

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- Improper maintenance including repairing of internal leaks, gates, valves, and other components in operation.
- Design or improper materials
- A failure of upstream dams in the same drainage basin.
- Landslides into reservoirs, which waves are overtopping of dam.
- High winds, which significant action of waves are effect to erosion.
- Destruction of terrorist.
- Earthquakes, which normally linear cracks of dam are leading to structural failure.

Dams are large engineering structures that are classified as a structure with low potential for disaster, but will be caused high damage, so engineers has designed a dam that can be used safety in normal conditions, floods, and earthquakes (Hoeg, 1996). In 1983, United States Cold Storage (USCOLD) are summarizes dam are break down of disaster from 240 dams in the United States. A dam was found that caused by an earthquake is 1 percent (Table 2-2).

Table 2-2 Statistics of the disaster are caused by the dam from USCOLD (Hoeg, 1996).

Causes of Incident or failure	**% of 240 dam**
External erosion (overtopping / wave action)	29
Internal erosion (in dam body / foundation)	38
Foundation instability	14
Excessive dam deformations	13
Deterioration (chemical / physical)	2
Malfunction of gate	2
Earthquake effects	1
Construction error	1

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For Thailand, can be considering that the seismic risk map by the Department of Mineral Resources in 2005. In pink area is low to intermediate vulnerable of damage and in orange area is intermediate vulnerable of damage (Represent in Figure 2-2). With all of the information found that were 488 dams, pink areas are 37 dams, and 178 dams in orange area. Dams are located in the area must be measures to prevent disasters from earthquakes whole, management and engineering for the safety of life and property of the people (Department of Mineral Resources, 2005).

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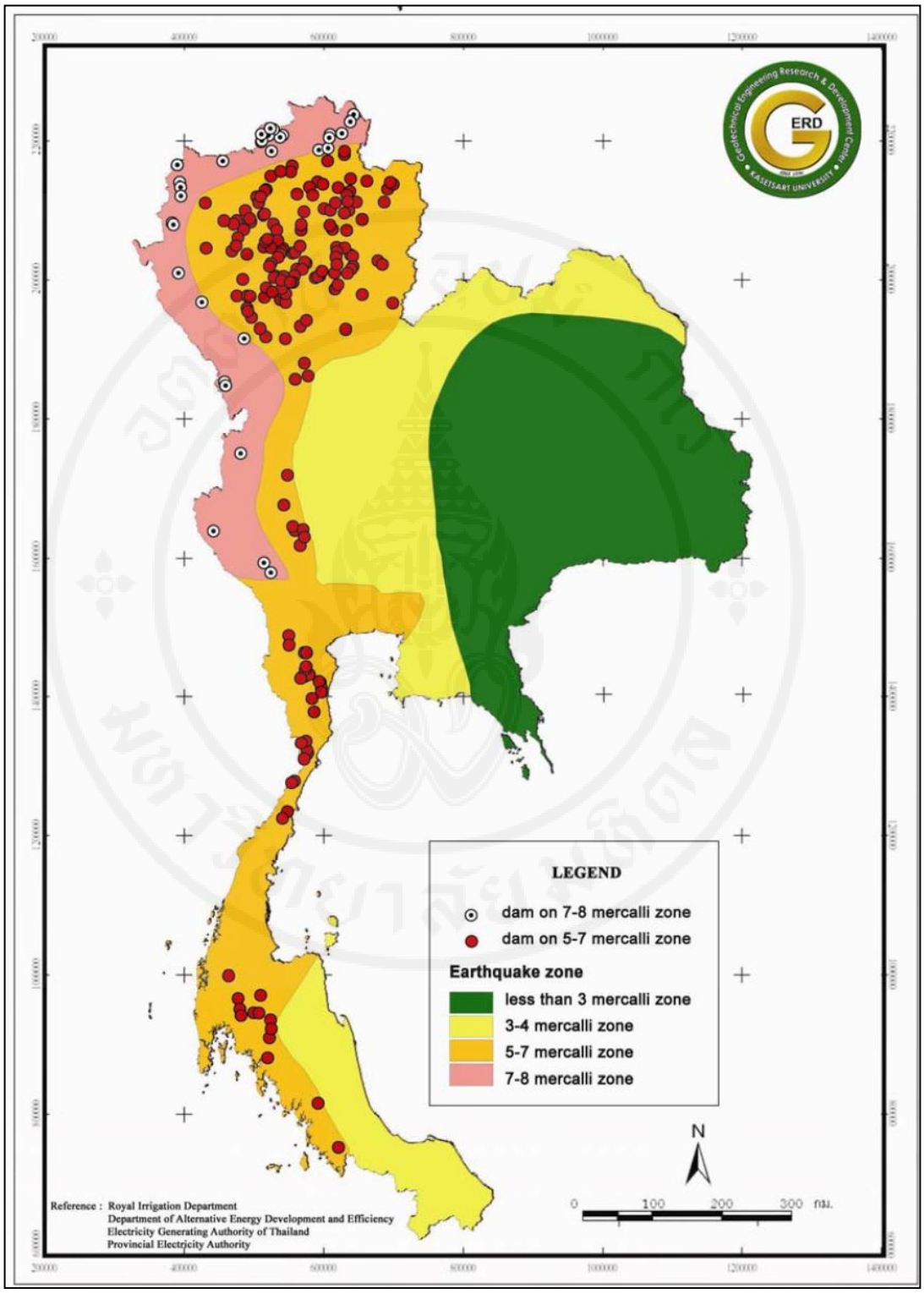

Figure 2-3 the dam in risk areas from earthquake (Department of Mineral Resources, 2005)

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Vajiralongkorn dam is into pink area has 7-8 Mercalli. Intensity shows the intense of the earthquake are occurred that measuring from between and after earthquake phenomenon such as people are felt, damage of building, or changing of landscape etc. In Thailand has Mercalli scale to comparison intensity of earthquake in 12 ranks. Magnitude is quantity associated with the earth energy are release in the form of vibration and that has measuring value is calculated from the height of wave from seismograph in epicenter has Richter scale, so intensity and distance are comparing an effect on Table 2-3 and 2-4 (Department of Mineral Resources, n.d.).

Table 2-3 Comparison of Magnitude, Intensity, and Peak Ground Acceleration at the epicenter (Department of Mineral Resources, n.d.).

Magnitude (Richter)	Intensity (Mercalli)	Peak Ground Acceleration:PGA (%g)
< 3.0	I-II Do not felt by people and detected only by seismographs.	< 0.1 - 0.19
3.0 - 3.9	III Felt quite noticeably by people indoor.	0.2 - 0.49
4.0 - 4.9	IV-V Felt by many to all people.	0.5 - 1.9
5.0 - 5.9	VI-VII Felt by most people; some breakage of dishes, window, and plaster; disturbance of tall objects.	2.0 - 9.9
6.0 - 6.9	VII-VIII Everybody runs outdoors and the building was moderate damage.	10.0 - 19.9
7.0 - 7.9	IX-X The building was heavily damaged	20.0 - 99.9
> 8.0	XI-XII Damage nearly total.	> 100.0

Note. Earth's standard surface gravity, $g = 9.8\ m / s^2$

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Table 2-4 Comparison of Magnitude, Intensity, and Distance of effects (Department of Mineral Resources, n.d.).

Magnitude (Richter)	Intensity (Mercalli)	Distance (Kilometers)
3.0 - 3.9	II - III	24
4.0 - 4.9	IV - V	48
5.0 - 5.9	VI - VII	112
6.0 - 6.9	VII - VIII	200
7.0 - 7.9	IX - X	400
8.0 - 8.9	X - XI	720

2.5 Dam safety and earthquakes

Sometimes, when an earthquake occurs in an area which can affect the structure of the human need to much load, such as dams where water is stored above the dam are numerous if earthquakes are occurred in dam area or nearby dam because many of the dam located on the old fault such as Srinagarind dam and vajiralongkorn dam in Thailand. Furthermore in foreign country was dam failure by the earthquake such as Hebgen dam in the United States (Soralump, 2007).

Statistics of dam failure and damage in the dam are divided of violence into 2 levels include:

A. Catastrophic Failure is suddenly disaster, very serious and widespread damage that often caused by overtopping, internal erosion (in dam body / foundation), landslides, and liquefaction from earthquakes etc.

B. Repairable Damage is phenomenon or indication leads to damage. When the first stages are detected this can be repaired, if there are omissions the severity of disaster may be increase. Many agencies are collected statistics on disasters of dam and cause of dam failure. In the United States is a unit of dam safety monitoring (U.S. Army Corps of Engineer's National Dam Inspection Program). After the failure of several consecutive dam that has said from 4906 dams which have checked to March 1980, the dams are unsafe have 32% or 1563 dams (Soralump, 2007).

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An earthquake is caused force adding to the dam moreover existing of statistics force. The force from earthquake is a short period in characteristics of cyclic, and that is occurred both horizontally and vertically that are depended on the size of severe of earthquake, the foundations, landscape, and size of dam. In the United States has collection and processing of dam disaster caused by presenting information in the Engineering New Record, as shown in Figure 2-3.

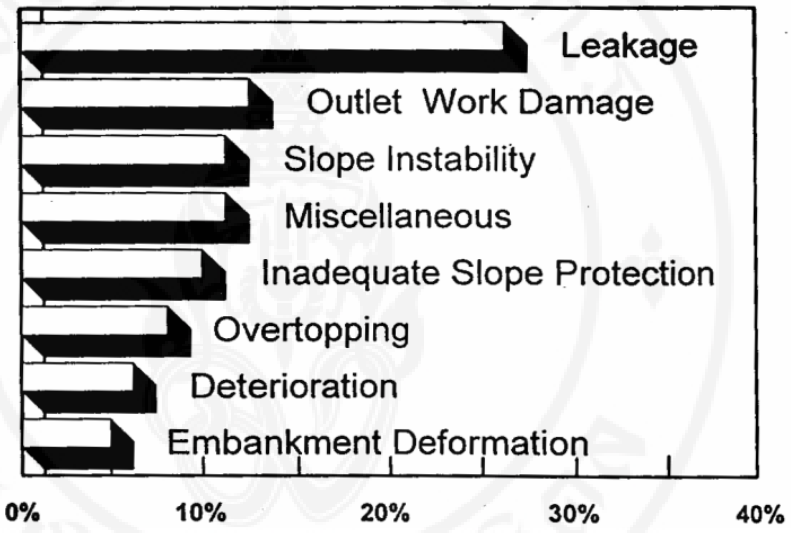

Figure 2-4 The characteristics of dam failure in the United States. (Engineering New Record, 2007) (Soralump, 2007)

Figure 2-3 shows the statistics of dam damaged are several reasons. Most reason of dam failure is flowed of water through the dam (in normal conditions) that because are wrong kind of choosing material or soil embankment dams, survey is not enough, failure of compaction and subsidence of different foundations etc. For earthquake found that effect are variations behavioral on the dam which led to dam failure are follows.

1) The vertically fault near the dam is moved
2) The motion of the fault under the dam.
3) The waves from water in reservoir by the quake
4) Landslides in reservoir are overtopping by earthquake
5) Failure of water building control cannot be drained
6) Water is flowed through cracks in across dam

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7) Vertical dam are collapsed by vibrations.

8) Dam or foundation is losses of soil from liquefaction that are affect to slippage or collapse of the dam

The above orders are sorting less to more of opportunity in dam failure. The reasons 1-4 are a low risk, and that is hard analysis to predict the damage. The reasons 5-8 are more likely to occur and can assessments damage by geotechnical theory to analysis detailed causes damage of dam from the earthquake (Soralump, 2007).

2.6 Damage of Concrete Face Rockfill Dam (CFRD) from an earthquake

Currently, concrete face rockfill dam are popularity in many countries because this method is fast. However, common problem of water leakage due to material support page paving are collapsed by water pressure so concrete face is split and broken (Mori, 1999).

Vajiralongkorn dam is the first concrete face rockfill dam (CFRD) so the dam is stable because of high material strength in the construction of the dam. However, usually damage to the dam and concrete paving are especially under the pressure of the earthquake. The studies are concluded of damage in CFRD dam that is occurred in the past include: (Jinagoolwipat, 2010)

Cogoti dam in Chile was completed in 1938 with the construction of dumped rockfill that high is 85 meter. The dam is affected by the earthquake such as Illapel earthquake in 2486 was 7.9 Richter and the epicenter of the earthquake away from the dam is 90 kilometers. The dam was immediately collapsed is 40 centimeters by the earthquake (Jinagoolwipat, 2010).

Minase dam in Japan was completed in 1962 with the construction of dumped rockfill that high is 66.5 meters. Niigata earthquake was occurred in two years after the dam is completed that away from the dam is 147 km. After the earthquake is found that the dam was collapsed dam is 14 cm. (Jinagoolwipat, 2010).

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Cogswell dam in California of The United States, that building is homogeneous dumped rockfill. The earthquake was the second time in 1987 was

Whittier Narrows earthquake which 5.9 Richter and epicenter away from the dam are 18 miles and not found damage to the dam. In 1991 was Sierra Madre earthquake which 5.8 Richter and epicenter away from the dam are 2.3 miles and found that the dam is moving vertically is 1.61 inches and 0.63 inches of horizontal and also showed a rupture of the road on the dam. However, the damage was not affected to the stability of the dam (Boulanger *et al*, 1993).

Santa Juana dam in Chile, Two years after the dam was completed in October 2540 that an earthquake is 6.8 Richter and epicenter away from the dam is 250 kilometers. Parapet Wall was subsidence of 9.7 centimeter and other components of the dam have not been damaged (Noguera, *et al*., 2000).

Sugesawa dam in Japan was affected by Tottori earthquake on 6 October, 2000. The survey was found cracking and deformation of the dam (Mutsumoto *et al*., 2001).

Ishibuchi dam in Japan was completed in 1953 that the height is 53 meters. In 26th May, 2003 was earthquake that magnitude is 7.1 Richter and epicenter away from the dam are 84 kilometers. The earthquake has not been confirmed whether or not the motion of the dam. But the report was noted that before the earthquake that the amount of leakage measured is 2800 liters per second and after the earthquake, the amount of leakage has increased 20% or an amount equivalent to 3500 liters per second. The water flow is opaque consecutive in four hours after the earthquake. The other element of the dam has not been damaged by the earthquake. (Nagayama *et al.*, 2003).

From information found that, the CFRD was damaged by the earthquake but not severely to failure. So this dam is construction by stone is compacted as well. When an earthquake is shakes, the water can be drained off from the dams and did not excess pore water pressure. But effects of the earthquake could be to small damage such as the dam is collapsed, seismic deformation is occurred and etc. (Sherard and Cooke, 1987).

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2.7 Effects of dam failure

According to Sustainable management Fund (2000), dam failure can take several forms, while dam damage that can happen in many types with various causes bring out flood and related to the violence of damage on dam and the volume of water stored in reservoir, and there are effects on human and environmental such as downstream environment, public safety, property, and livelihood.

2.7.1 Effects of dam failure on the downstream environment

1) Potential impacts

Dam failure can be caused loss of life, destruction of property, and damage to the environment in downstream of the dam. So there are many factors that can be affected the potential impact of dam failure there are include: dam height, volume of water stored by the reservoir, extent of the flood zone downstream of the dam, character of community development in the flood zone (residences, school, economic buildings, other dam, farms, public utilities, roads, etc.), natural environment in the flood zone (wetland, cultivated area, grazing, etc.). Effects of dam failure include:

- Death or injury of people.
- Damage to other dam.
- Loss of productivity, immediate and in the future.
- Loss of benefits is provided to the community by the dam such as water supply and electricity.
- Cost of operations in an emergency.
- Individual and the community has damaged
- Impacts on the environment such as river change and loss of wildlife habitat.

2) Characteristics of floods from dam failure there are differences between floods of dam failure and natural floods that are passed by a dam is spillway. Floods of dam failure are typically:

- Larger than any natural flood.
- Water velocities are higher.
- The rate of water level are increased that higher than normal.
- A steep wave front
- A large quantities of debris and sediment.

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They can be eroded soil materials and bedrock in areas with large sediment accumulation with large sediment is accumulation. . If the dam has fail during a natural flood, there would be a dynamic flood wave, with a rapid rise in existing water levels. This is likely to produce significant incremental damages (International Consultants: Ministry for the Environment, Sustainable Management Fund, 2000).

Area and depth of flood, and time delay between dam failures and the arrival of the flood wave can be evaluated from a dam failure analysis by the computational analysis to determine the volume of water stored behind the dam, dam dimensions, scenarios of dam, and downstream topography failure. The results from such an analysis can be developed into a flood maps and flood travel times. To know the depth and the speed of the water to be prevent loss of life and property damage. The warning time of the dam failure flood wave is an important factor (International Consultants: Ministry for the Environment, Sustainable Management Fund, 2000).

2.7.2 Effects of dam failure on public safety

The population at risk (PAR) during potential failure of a dam including all those who have been directly affected by the flood water within the dam failure affected zone if they are not able to evacuate. The factors leading to loss of life amongst the PAR include:

- River distance from the dam
- Time for the flood wave to reach risk areas.
- Velocity and depth of the water near risk areas.
- Effectiveness of the emergency plan, including warning time.
- The alarm and warning and evacuating of the population at risk in different situations.

The warning time has a very important role in reducing the loss of life. The analysis, conducted in the United States on dam failure and flood that show a significant reduction in loss of life with a warning time. The population in risk areas need about 1 hour if the PAR has been a warning time greater than 1 hr. 30 min or more than, the average of victims is about 0.02% of the PAR. If the warning time is less than 15 minutes, the average of victims is about 50% of the risk (International Consultants: Ministry for the Environment, Sustainable Management Fund, 2000).

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2.7.3 Effects of dam failure on property and livelihood

Dam failure can lead to property damage within the risk area by the dam failure flood. The violent of wave is likely to destroy buildings, roads and utilities. The escaping water is likely to cause extensive erosion and deposit silt over most of the inundated area. Costs will be incurred for rehabilitation and rebuilding of land.

The impacts on livelihoods are likely to go beyond the area of damaged property. Property owners affected by the dam failure flood will suffer loss of livelihood that may be temporary or permanent. Productive and buildings in floods area will cease until it can rehabilitate and buildings and services replaced. Downstream users of the river can also be affected by the changed nature of the river, sediment transport etc. (International Consultants: Ministry for the Environment, Sustainable Management Fund, 2000).

2.8 The damages of dam failed in Thailand

In Thailand, there was statistic reports of several dam failed from the Royal Irrigation Department (1996) as followed;

1970-1972: There were 4 dams of the Royal Irrigation Department namely Lam Sam Lai Dam and Lam Cheing Krai Dam in Nakhon Ratchasima, Am Preun Dam in Ubon Ratchathani, and Sawai Dam in Buri Ram. However, there was no damage records as all of them were small dams. The Royal Irrigation Department had repaired and they can be used until present.

1979: There was a typhoon named Kids causing large quantities of water flew into reservoir. As a result, water levels over Ubonrat Dam, as earth core rock fill dam, had reached over the level of impervious core resulting in water leaking. The Dam was drainage by open all the gate valves in order to prevent the collapse. After that, the Electricity Generating Authority of Thailand came to repair by increase the crest levels and expand the length of spillways.

1990: There was a heavy rain causing from Era and Lola typhoons over the Moon Bon Dam, Nakhon Ratchasima. As a result, the water levels over the dam had increased rapidly and reached the level of 220.35 meters from the mean sea level. The dam capacity was approximately 130.70 cubic meters. This caused the large

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leakage on the crest in the middle of the dam and released the water not less than 20 cubic meters per second or 1,728,000 cubic meters per day. The Royal Irrigation Department was trying to block the holes while filling the rocks around the leaking areas. Since the water levels in the dam were lower than overflow spillway, therefore, it had to apply the siphon method to drain the water in order to protect the dam from damages. The Royal Irrigation Department had modified and built the new Moon Bon Dam and available to use until present (the Royal Irrigation Department, 1996)

1997: There were heavy rains in many provinces of Thailand causing 6 small dams of the Royal Irrigation Department collapsed since there were large amounts of water flew into the reservoirs than usual. The details are as followed;

1) Mar Sod Dam, Tak: caused from the scour at downstream of spillway

2) Mar Na Wang, Chiang Mai: caused from the scour at the spillway and there were 1 dead person with 60 damaged household

3) Mae Laeng Luang Dam, Chiang Mai: there was a flood during the construction which causing the damage of agricultural areas

4) Mae Tak Neua Dam, Lam Pang: there was no damage recorded, however, 146 households were damaged

5) Mae Thang, Phrae: flood over the crest during the construction

6) Mae Sakuen, Phrae: caused from the scour at the basement of spillway

In addition, except the dam collapse of the Royal Irrigation Department described above, there was also a dam of the Land Development Department collapsed that was Mae Salang Dam, Chiang Mai. It was damaged from the scour at the spillway which caused damages to 10 households (The Royal Irrigation Department, 1993).

2.9 The readiness preparation of related institutions

2.9.1 The emergency plan to evacuate people from risky areas, case of Kanchanaburi Dam. The Disaster Prevention and Mitigation Kanchanaburi Center, the Disaster Prevention and Mitigation Kanchanaburi Provincial from the Disaster Prevention and Mitigation Kanchanaburi Provincial (2010)

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There are 3 objectives of this operation described below;

1. To prepare the readiness of the main institution and the supporting to take action in keeping up with damages from floods

2. In order to manage the evacuation to the safety areas systematically and able to protect and restrain the panics of people

3. To maintain the safety of life and reduce the damages to assets of government services and people

The main operation institute is the Disaster Prevention and Mitigation Kanchanabuti Center. The responsibilities are to protect and mitigate the public hazards, direct, control, sustain, command, manage and request assistants from nearby institutions in the case that it is unable to monitor the situations. The supporting institutions are as followed;

1) The Disaster Prevention and Mitigate District Center where the district-chief officer is the director. The responsibility is to prevent and alleviate the public hazards inside its district and assist the director regarding to the requirements.

2) The Disaster Prevention and Mitigation Municipality Center where the mayor is the local director. The responsibility is to prevent and alleviate the public hazards inside its municipality area and assist the director regarding to the requirements.

3) The Disaster Prevention and Mitigation Center under the Subdistrict Administrative Organization where the Chief Executive of the SAO is the local director. The responsibility is to prevent and alleviate the public hazards inside its subdistrict area and assist the provincial director and the subdistrict director regarding to the requirements.

2.9.2 The Electricity Generating Authority of Thailand, Vajiralongkorn Dam

The Electricity Generating Authority of Thailand collaborates with the provincials, related institute and citizen network to define the monitoring measures and the readiness of people from the EGAT as followed;

2.9.2.1 The monitoring measures and the readiness of people are the preparation of flood map in order to identify the safety and risky areas, the specification of water violated situations, the installation of warning system etc.

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2.9.2.2 The protection and effect reduction measures are to determine the center point according to the violence, prepare the disaster assistance plans, support the public health, prepare the evacuation plans and facilitate the evacuees etc.

2.9.2.3 The operation measures in case of emergency are the management of notifications, the investigation and evaluation of the situations, the follow up of increased violence, the coordinate with the related institute etc. These measures will be performed under the Disaster Prevention and Mitigation Provincial Center as the main institute.

2.9.2.4 The assurance measures for people are applying the CCTV technology system by installing the CCTV for illustrating the crests and dams currently which people are able to watch via Web site for ensuring them in the case that there are any rumors such as http://cctvsnr.egat.com for Srinagarindra Dam and http://ichpp.egat.co.th/ cctv.php for Bhumibhol Dam and Sirikit Dam etc.

2.10 The readiness preparation of disaster for the communities

The communities are the people who understand the area characteristics, situations and limitations themselves better than others. The reason is that there were no one who would attend the resources and people in the communities including the necessity and communities requirements better than insiders. The operations from the state or the organizations outside the communities might not sufficient and meet the necessity and requirements of the communities. Therefore, the successful of the readiness preparation of disaster for the communities may require the collaborations and cooperation from every agency and all levels of the communities to locals, regional and national. The local communities will be the center for the collaboration with the supporting from the government sector and other organization about the necessity and exceed the capacity limit of the communities to manage the disasters themselves (Soopanich, 2006).

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2.10.1 The processes of the practice in a normal situation (before the disasters)

2.10.1.1 Define the subcommittees to take responsibilities several sections such as the Committee of Surveillance and Warning Center, the Committee of the Evacuation and Emergency Camp, the committee of the Rescue Center, the Committee of Emergency Management Department etc.

2.10.1.2 Warning and Notification Systems

They are the methods and processes for the collections of weather atmosphere and landscape information. These are to evaluate and analyze the simulations, expectation and forecast the disasters in the future in order to realize the types of disasters, size, violence, expected areas and periods of the situations including guidelines for decreasing the risky and disasters. This warning maybe a forehand warning standard in long-term as yearly, seasonal and monthly for the related institute to prepare the guidelines, measures and methods for protecting and reducing the effects including the efficient and appropriate restoration plans. It can also a short period warning just before or during the disasters for evacuating and prepares the rescue in time. This short period warning must be accurate, explicit and proper otherwise it might cause the damages. In addition, these warning and notification system should be managed via the organization, institute or the persons who are assigned.

2.10.1.3 The installment, sustain and preserve the instruments, and the communication tools should be ready to use at all time. These readiness methods also include the communities' warning tower, audio line system, manual sirens, megaphone, whistle, radio communication, basic telephone number and mobile number. The Subcommittees prepare the name lists of the Committee of Disaster Management, persons and related institute in the disaster management and currently update all the information.

2.10.1.4 Specify the searching and life rescue teams for the communities and take responsible in each areas and should practice annually such as One Tambon One Search and Rescue Team (OTOS). This sample team provides the training for the searching and rescue team to have sufficient knowledges and skills for the actual operations.

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2.10.1.5 Preparations

To prepare the lists of materials, tools and instruments by specify the responsible person and storage and also prepare the vehicle lists in the communities for evacuating people. Moreover, to prepare the lists of institute and government sectors that related to the communities in the districts and provinces with the telephone numbers. Define the schedule of the trainings and evacuating practices including the frequency of these trainings and evacuating practices especially within the communities and cooperated with related institute or other communities.

2.10.1.6 The Preventions for reducing the effects

The subcommittee of General Administration should collaborate with related institute in every parts for the protection preparations especially the basic constructions such as clean and dredge the canals and swamps, coordinate with the Royal Irrigation Department to construct the soil dams or others as appropriate, plant the forests for preventing and decreasing the effects from floods, construct the special paths for the use of evacuations, build the buildings or camps for the evacuation of the communities etc.

2.10.1.7 Provide the information to educate people

The subcommittee of General Administration should cooperate with other subcommittees from other departments for the information and facts to the communities including the activities to educate people about the types of disasters, preventions, risk reductions and correct practices. Some examples are as followed;

1) Notify the people to reserve food, water, drinks and necessary tools to be ready.

2) Educate children and students in order to take the right actions by using the easy instruction media such as drawings, cartoons, movies, and role play that children create themselves and the Subcommittee inserts the correct information.

3) Educate the communities via several media such as entertainment radio alternate with broadcasts from communication tower, brochures and flyers.

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2.10.1.8 Surveillance by the communities and networks

1) The Subcommittees of Prevention and Warning Department should collect and record the weather atmosphere and landscape on the communities

regularly and append this data with information from the state or related institute for anticipate the situations and predict the disasters in the communities and nearby areas beforehand. The surveillance can be easy methods, lower costs, use local intellects and resources which the communities are able to manage by them where the results are not incorrect from the facts such as the measurement of water level in the canals or rivers by the gage and rainfall measurement tools in the villages.

2) Should suggest and support all members of the communities to monitor the disasters by observe the nature signal which is one of the anticipation and predict system for the situations in the communities. These can also mean as the local intellects. The evacuation of animals before the storms is occurred such as ants, birds, and wildlife. The behavior observations of several animals which are able to acknowledge the earthquake such as cockroaches running loose or fish jump over the water surface. The observation of water changed in the pools such as turbid water, a swirl water, water level modification, bubble and taste bitter etc.

2.10.1.9 The early warning and news distribution

1) Every early warning and news distribution should be based on the risk information, risk assessment and the situation from the warning system in the communities appending with information from government sector and related institute. There should be the meeting between the Committees of Communities Disasters Management to agree and decide the news distribution, warning and suggest the safety actions for their communities.

2) Specify and assign the person to perform the emergency announcement and warning at least 2 persons in order that they will be able to work in the emergency case and should specify the meeting point for the Committees of Communities Disasters Management in the case of disaster warning.

3) Should coordinate with the Department of Disaster Prevention and Mitigation Provincial, the Disaster Prevention and Mitigation Center and the National Disaster Warning Center for the training and suggestions to the communities about the warning methods, news distribution, getting to know and understand the symbols and other warning signs such as warning siren firm the warning tower, manual siren, megaphone or whistle.

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4) In each community, the executor fieldwork and the communities should study, investigate and apply the tools, vehicles and resources within the communities which should be able to apply in the emergency situations before supply or purchase new stuffs.

5) The warning in the communities can be done in many ways. The examples are as followed;

- Determine the local radio network especially the communities that the geography locations are in the same areas in both normal and emergency situations such as the warning signal from the warning tower and local news distribution center.

- The related institute should install the observation towers, loudspeakers and signal receiver machines from the news distribution center in the important point and buildings in the communities as possible such as schools, hospitals, police stations, health stations, fire stations, Sub-district Administration Organization and offices of the Village Headman.

- The news distribution by the amplifier microphone should be installed in a small truck in the communities or using the megaphone to warn the communities by the related institute or the persons who are assigned from the communities.

- The collaboration assistant with the government and public media in order to spread the warning in terms of speech or writing which can be in the alphabet running format.

- Apply the schools and students to be the data collecting center, evaluate the situations and distribute the disaster warning.

2.11 Related researches

The safety of a downstream community: A case study of Ban Gand Khaep , A community downstream of Srinagarind dam, Tha Kradan subdistrict, Sri Sawat district, Kanchanaburi province was studied by (Arunchartrakool, 2003), found that the operation of related agencies in preparation of emergency due to the dam. The

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response of a community downstream of Srinagarind dam on the dam safety issues and finding guideline to be improved the preparedness of emergency due to the dam.
The research was collected data by research documented and field research using questionnaires, in-depth interviews, and non-participant observation. The findings showed that there is few operation of organization to prepare for emergencies caused by the dam. The response of the community on dam safety, the majority is very little known and they are through of the dam is safe all the same and without the risk of disaster. Who knows if the dam disaster will be very dangerous and they are known that the consequences may be occurred but there is not anxiety on safety of the dam. They are never received practice, do not know how to practice, and do not know what agencies are planning for emergency preparedness due to the dam. The agency will be accepted directions in case of emergency by the community is the EGAT and the EGAT should be prepared for emergencies responsible.

Howard and Opper (2004) was studied valuing community safety in the management of dams: developing the partnership between dam agencies, the communities at risk and emergency managers in New South Welsh, the planning of dam safety there must be many those associated for information sharing and so there are operate and coordinated properly. The State Emergency Service is a law enforcement agency for the fight against the flood in New South Welsh which responsible for the planning and execution for alarms and evacuation of communities at risk of flood as well as impact of the dam. The operation successful is depends on the commitment and continuous development of cooperation between the dam and related agencies, regulatory authorities of dam, and The State Emergency Service.
So a combination effectively that are correspond to expectations of the community in the planning of dam safety. This article is explores some of the ways in which relationships can be meet the expectations that are acceptable to the community in the part of the risk to life and property and progress of dam safety plan along with plan of the emergency response which are incomplete. And the article is also described the difficulties of the State Emergency Service in its role as a planning agency response and that is suggested some principles to increase interaction between key stakeholders in the future.

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Lin Y-J, *et al.,* (2011) was studied on the national Policy of watershed management and mitigation of the flood after 921 Chi-Chi earthquakes in Taiwan found that 921 Chi-Chi earthquakes was on September 21, 1999 that is 7.3 Richter in the left side of Taiwan island where soils are fragile and often flood are lost resources. Taiwan is densely population so people are needed to take the hill for agriculture and development. Flood in 2004 was lost many people and lots of money. The government is invented new strategies for land use in order to more efficiently land use and that is environmentally friendly. Council for Economic Planning and Development, Executive Yuan of Taiwan government has presented Strategic Action Plan for the recovery of land in 2006, which a key concept is respecting and adapting to nature. To achieve this goal, watershed management and mitigation policy is important factors that are affected to safety, economy, and ecology, which are included in the policies of the two strategies. All this are made understanding and other countries are similar conditions to reference.

Krasovskaia I, *et al*., (2001) was studied the perception of the risk of flood the case of 1995 in Norway found that flood risk is often studied in the natural sciences and engineering. Flood is a natural phenomenon instead of the specific risks relating to human society so a human response is important to assess flood risk. This article is presents a study of awareness of flood risk among decision makers and the general public in the areas affected by flood in Norway.

The data are collected from surveys of public opinion in the area, decision makers, and experts. Data were analyzed focusing on (a) the perception of the risk to life and health (b) Loss of the economy and the environment by both groups (c) the communication link of flood risk, and (d) measures of flood mitigation in the properly circumstances and the ability of decision makers are to be visualizes the impact and cost. The result found that the perception of danger of flood by the general public is not operation and flood risks should be communicated is better. The decision in every situation during the floods and their impact on the level of risk has to be improved. The knowledge can be used to develop policies to assess flood based on the participation.

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CHAPTER III
MATERIALS AND METHODS

The objectives of this research are to study the operational situation of community and relevant agencies in the mitigation management of earthquake and flood on dam failure, so this research study on people's knowledge and understanding, participation attitude towards the problem, and problem solving of earthquake and flood mitigation on dam failure to find mitigation guidance for future disasters of the relevant agencies and communities. The study area is at Thongphaphum District that is the location of the Vajiralongkorn dam and is the first area receives water from the dam if an earthquake disaster and flood happen. In process of the study, questionnaire is used as the quantitative study and qualitative study by using in-depth interviews and non-participant observation.

3.1 Study area

Study area locate on downstream community of Vajiralongkorn Dam that is the first area receives water from the dam adjacent to Khwae Noi River, so it is risk area to be affected by the earthquake disaster ,which caused flood disaster behind the dam. Those area are include 4 Sub-district with 12 communities (Table 3-1)

1) Tha Khanun Sub-district include Ban Tha Khanun, Ban Ong Thi, Ban Prang Ka Si

2) Sahakon Nikhom Sub-district include Ban Sahakon Nikhom

3) Hin Dat Sub-district include Ban Wang Hin, Ban Hin Dat Tawan Tok, Ban Hin Dat Tawan Ok, BanKui Mang

4) Lin Thin Sub-district include Ban Phu Thong Ban Nam Kui Ban Lin Thin Ban Nong Charoen

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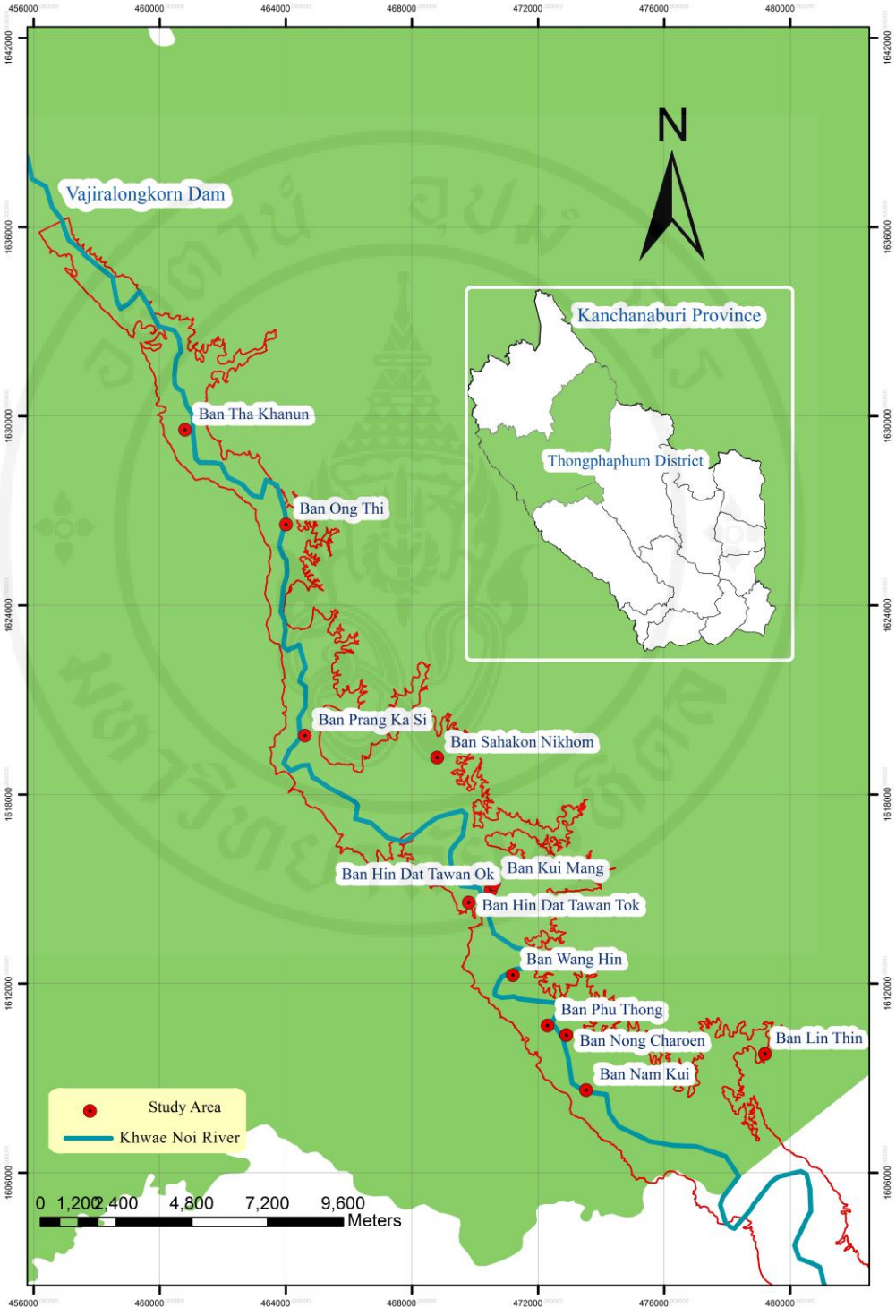

Figure 3-1 Map of community in study area is within extent of the red line, which is the risk area of Earthquake and flooding on dam failure in Thongphaphum District Kanchanaburi Province.

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3.2 Population and sample

To find the factor effect knowledge and understanding of people in downstream community about mitigation management of earthquake and flood on dam failure. The sample size was calculated by Krejcie and Morgan, 1970

n	=	Sample size
N	=	Population Size
e	=	Error
x^2	=	(x^2 = 3.841) Chi-square df = 1 and a confidence level of 95%.
p	=	Estimating the Population Proportion

Table 3-1 Studies area

Station	**Sub-district**	**Households**	**Sample size**
1.Ban Tha Khanun	Tha Khanun	3294	158
2.Ban Ong Thi	Tha Khanun	791	38
3.Ban Prang Ka Si	Tha Khanun	739	35
4. Ban Sahakon Nikhom	Sahakon Nikhom	551	26
5.Ban Wang Hin	Hin Dat	223	11
6.Ban Hin Dat Tawan Tok	Hin Dat	176	8
7.Ban Hin Dat Tawan Ok	Hin Dat	693	33
8.BanKui Mang	Hin Dat	296	14
9.Ban Phu Thong	Lin Thin	223	11
10.Ban Nam Kui	Lin Thin	111	5
11.Ban Lin Thin	Lin Thin	277	13
12.Ban Nong Charoen	Lin Thin	283	14
Total		7657	366

3.2.1 Informants in quantitative research

Quantitative study by using questionnaire with people who live in risk areas in downstream community of Vajiralongkorn Dam which include 4 Sub-district 12 communities add up to 366 households

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3.2.2 Informants in qualitative research

For qualitative are study by using in-depth interviews with leaders of community and related agencies.

1) Village headman from 12 communities

2) Related agencies conclude:

- 4 representatives from Vajiralongkorn Dam include 1 head emergency support from the earthquake and 3 staffs.

- 4 representatives from Disaster Prevention and mitigation Provincial Office Kanchanaburi Thongphaphum Brance include 1 Head of Disaster Prevention and mitigation Provincial Office Kanchanaburi Thongphaphum Brance and 3 staffs.

3.3 Data Collection

3.3.1 Documentary Research - To study the experience of dealing with the earthquake and flood from the dam disaster, the domestic and foreign information from researches, documents, reports, and articles that were taken from government agencies and involved educational institutions were studied. The result in this section will be used in data analysis and recommendation creating to develop the earthquake and flood mitigation management on dam failure of downstream community of Vajiralongkorn Dam.

3.3.2 Field Study – Data are collected by using the questionnaire, in - depth interview, and Non – participant observation. As following:

1) 366 copies of questionnaire are used as quantitative research in order to determine the knowledge and awareness of community on the issue of earthquake and flood mitigation management on dam failure by study the general characteristics of population, knowledge and awareness of disaster risks caused by the dam, recognition in practices in case of dam failure, and opinion and participation of communities in the earthquake and flood mitigation management on dam failure.

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2) An in - depth interview is used as qualitative research in order to collect information about the current situation of related agencies in earthquake and flood preparation on dam failure by interview leaders of community and related agencies

with more information from the questionnaire to analyses the response of community in the earthquake and flood mitigation on dam failure issue.

3) Non – participant observation is used to observe the situation and train operation plan in practice to earthquake mitigate of Thongphaphum district and Vajiralongkorn dam. Observations of participants are cooperation to practice. Practical training and in the annual plan of Thongphaphum district and Vajiralongkorn dam within the area of the Vajiralongkorn dam

3.4 Data Analysis

Data collected by both field study and documentary research will be applied in different knowledge creating according to the objectives of the study as following.

1) Study general information about the personal factors of the respondents by using Frequency and Percentage.

2) Studies public's opinion on the earthquake and flood mitigation management on dam failure from general knowledge, the risk of probable disasters including public's awareness ,and opinion in the earthquakes and flood mitigation on dam failure by finding the mean ($\overline{X}$) and standard deviation (SD).

3) Analysis the relationship of various factors that affect knowledge, awareness, and opinions of people in risk areas in earthquake and flood mitigation management on dam failure by using Yule's Q coefficient.

4) Use the data which obtained from the questionnaire with leaders and related agencies by the mitigation management in - depth interview to reduce the impact. First, the responsible government was interviewed about aid guidelines when those disasters happen. Second, Village headman and people in risk areas were asked that are they agree with those responsible government interview or not. Then analyze all data from both questionnaire and in-depth interviews in term of accuracy, consistency and difference to achieve the best management of people in areas and according to most scholars.

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CHAPTER IV
RESULTS AND DISCUSSION

4.1 Population

In downstream community of Vajiralongkorn dam, Thongphaphum district, Kanchanaburi province the selected population are sampledof 366 households, which divided into 177 male and 189 female as shown in Table 4-1.

Table 4-1 Percentage of the samples in downstream community of Vajiralongkorn dam, Thongphaphum district, Kanchanaburi province by station.

Station	**Households**	**Male (persons)**	**Female (persons)**
1.Ban Tha Khanun	158	66	92
2.Ban Ong Thi	38	25	13
3.Ban Prang Ka Si	35	15	20
4. Ban Sahakon Nikhom	26	14	12
5.Ban Wang Hin	11	7	4
6.Ban Hin Dat Tawan Tok	13	4	9
7.Ban Hin Dat Tawan Ok	28	17	11
8.BanKui Mang	14	5	9
9.Ban Phu Thong	11	3	8
10.Ban Nam Kui	5	3	2
11.Ban Lin Thin	13	7	6
12.Ban Nong Charoen	14	11	3
Total	366	177	189

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4.2 Demographic Characteristics

4.2.1 Personal information

This category is divided into 5 subcategories: gender, age, educational level, occupation, and position. The table 4-2 shows that was more female than male respondents: 51.64% of respondents were female and 48.36% of respondents were male. For percentage of the respondents by age found that the majority of respondents were 18-30 years (31.97%) and secondly 23.77% of respondents were 31-40 years. For the educational percentage of the respondents found that the majority of respondents were primary level 27.87% and secondly 23.77% of respondents were high school level. For the occupational percentage of the respondents found that the majority of respondents were agriculturist 30.33% and secondly 30.05% of respondents were employee. Finally, for the positional in village percentage of the respondents found that the majority of respondents were people 88.5% and secondly 8.47% of respondents were village health volunteer.

Table 4-2 Percentage of the respondents by personal information

Personal Information	**Number**	**Percentage**
Gender		
Male	177	48.36
Female	189	51.64
Total	366	100.0
Age		
18 – 30 years	117	31.97
31 – 40 years	87	23.77
41 – 50 years	66	18.03
51 – 60 years	57	15.57
Over 60 years	39	10.66
Total	366	100.0

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Table 4-2 Percentage of the respondents by personal information (continued)

Personal Information	**Number**	**Percentage**
Education levels		
Primary (grade 1 - 6)	102	27.87
Secondary (grade 7 - 9)	86	23.50
High school (grade 9 - 12)	87	23.77
Vocation certification	17	4.64
High vocation certification	18	4.92
Bachelor	45	12.30
Other (adult education, master, un education)	11	3.01
Total	366	100.0
Occupation		
Agriculturist	111	30.33
Trading	52	14.21
Employee	110	30.05
Government officers	35	9.56
State enterprises	7	1.91
Other (housewife, maid, retiree, student)	51	13.93
Total	366	100.0
Position		
Village health volunteer	31	8.47
Village headman	3	0.82
Member of the Sub-district Administrative Organization Council	8	2.19
People	324	88.5
Total	366	100.0

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4.3 Knowledge and awareness of disaster

Table 4-3 shows the knowledge and awareness of disaster by the people in the downstream community of Vajiralongkorn dam. The knowledge of people in the area of Kanchanaburi province has the 2 faults including Sri Sawat fault and Three Pagoda fault that were isolated from Sakae Fault in Myanmar movement and are likely caused earthquakes was agreed 77.47%, not sure 22.53%. The earthquake occurs in an area which can be affected the structure of the human was 80.82%, not sure18.08%. . The natural flood is violence more than the dam failure floods was not sure 20.66%, disagree 32.78%. The dam in that area can be failure, by the earthquake was 50.41%, not sure 45.48%. The earthquake and flood disaster was affected to the community in area was agreed 69.04%, not sure 26.95%. Finally, alarming before the accident in a properly time will be reduce the chances of loss from disaster was agreed 84.66%, not sure 15.34%

Table 4-3 Knowledge and awareness of disaster

Opinion of people	**Number**	**Percentage**
1. Kanchanaburi province has the 2 faults including Sri Sawat fault and Three Pagoda fault that were isolated from Sakae Fault in Myanmar move and are likely to cause earthquakes.		
Agree	282	77.47
Not sure	82	22.53
Total	364	100.0
2. The earthquake occurs in an area where can be affected the structure of the human.		
Agree	295	80.82
Not sure	66	18.08
Disagree	24	1.10
Total	365	100.0

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Table 4-3 Knowledge and awareness of disaster (continued)

Opinion of people	**Number**	**Percentage**
3. The natural flood is violence more than the dam failure floods.		
Agree	75	20.66
Not sure	169	46.56
Disagree	119	32.78
Total	363	100.0
4. The dam in that area can be failure, by the earthquake.		
Agree	184	50.41
Not sure	166	45.48
Disagree	15	4.11
Total	365	100
5. The earthquake and flood disaster was affected to the community in area.		
Agree	252	69.04
Not sure	102	27.95
Disagree	11	3.01
Total	365	100.0
6. Alarm before the accident in a properly time will be reduced the chances of loss from disaster.		
Agree	309	84.66
Not sure	56	15.34
Total	365	100.0

From Table 4-3, the population of risk (PAR) have a little bit knowledge of the disaster is still not know the difference between natural flood and dam failure flood, because an earthquake in the area has not affect to the dam and community building. The significant factor may be that there is no event of a dam failure accident happening in Thailand. Even though there were some small dam accidents, the people

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do not know them much, as little information and news reporting in this topic is not realized.

The table 4-4 shows that house settling in the risk area has been through was 78.39%. Most people think a house adjacent waterfront will be affected to floods, because a house adjacent waterfront has been affected by flash flood in the annually rainy season. And because their houses were located in the plateau which was at foothill, so they could be escape safety by climbing to the hill. These respondents that inhabitants in valley would be affected from dam failure floods. Conform to the study of Katarzyna Kreft-Burman (2000) describes that people have inclination to the not to my home attitude while thinking about disasters.

Table 4-4 Percentage of respondents by housing live in the risk area.

Do you think your house live in the risk area?	Number	Percentage
Yes	272	78.39
No	75	21.61
Total	347	100

Table 4-5 shows that guideline had been prepared disaster by the community was 76.75%. Every village has not a guideline for the management; however they have Village Security Team. Some villages have been agency shared knowledge and to define rally point, risk area, safety area, and give equipment for warning such as siren, megaphone, but over time, the villagers may be lose and forgotten.

Table 4-5 Percentage of respondents by prepares disaster.

In the past, had been the guideline prepares disaster by the community?	Number	Percentage
Yes	83	23.25
No	274	76.75
Total	357	100.0

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Table 4-6 shows that the disaster information is followed by people was 86.5% and majority of source information is television was 31.7% and secondary of source information is village leaders was 18.2 %. At the present, the people can get the news in more channels, and most people interested in news about the disaster, both inside and outside their area. The most popular channels are via television and the monthly meeting of village leaders in each village.

Table 4-6 Percentage of respondents by disaster information

Are you follows about disaster information in your country?	Number	Percentage
Yes	314	86.5
No	49	13.5
Total	363	100.0
Source of disaster information	Number	Percentage
Television	286	31.7
Radio	90	10.0
Community radio	108	12.0
Village leaders	164	18.2
Volunteer Protection	74	8.2
Neighbor	87	9.6
Vajiralongkorn dam	76	8.4
Internet	17	1.9
Total	902	100.0

Table 4-7 shows that the risk area of dam failure is known by people was 55% and 45% is not known. For the safety area of dam failure is known by people was 38.63% and 61.37% is not known. Most people are aware that where the risk area are especially lowland and the area adjacent waterfront to Kwai Noi River, therefore they have to migrate to the upland and hill by climbing for the safety areas but they have not known the exact locations such as rally point, risk, and safety area in community.

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Table 4-7 Percentage of respondents by risk area and safety area of dam failure

Do you know where risk area of dam failure is?	Number	Percentage
Yes	198	55.0
No	162	45.0
Total	360	100.0
Do you know where safety area of dam failure is?	Number	Percentage
Yes	141	38.63
No	224	61.37
Total	365	100.0

Table 4-8 shows that if the disaster occurs in risk area people who cannot migrate was 50.68% and people need of evacuation time about the majority of respondents was 1 hour 39.62% and secondly 34.15% of respondents were 2 hours. So, people who want to spend the time on migration is very different due to the respondent understands the question differently. Because the question is not clearly listed in disaster situations such as disaster during the day or night, and other factors involved such as gender and age of the respondents. So, the next line of questions in the questionnaire should be described clearly situation and give a detail so that the respondents understood.

The warning time is very important thing to in reduce loses of their life due to dam failure. Analysis undertaken in the USA on flood of dam failure shows a significant reduces in loss of life with a warning time of more than about one hour to the population at risk (PAR). For a warning time greater than 1 hour 30 minutes, the number of sufferer is about 0.02% of the PAR. If the warning time is less than 15 minutes, the average number of sufferer is about 50% of the risk. (Sustainable management fund, 2000). The warning of small towns and large city are not equal. (U.S. Department of the Interior Bureau of Reclamation, 2014).The time and conditions of dam failure such as day, night, season, and the number of people at risk are inequality in warning time (Wayne J. Graham, 1999).

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Table 4-8 Percentage of respondents by migration time

If a disaster in the area, you can migrate in time?	Number	Percentage
Yes	180	49.32
No	185	50.68
Total	365	100.0
The time that you can evacuate timely?	Number	Percentage
10 minutes	9	2.46
30 minutes	43	11.75
1hour	145	39.62
1hours 30 minutes	35	9.56
2hours	125	34.15
More than 2 hours	5	1. 37
24 – 48 hours	4	1.09
Total	366	100.0

The table 4-9 shows that study, the agencies have not been informed are involved in surveillance, emergency response, by people was 62.91% , and who should be a warning on the disaster is village leaders was 52.2% and the second is volunteer protection was 29.2%. Village header would be serving as a warning to people in the village, because they live in the area and closeness to the population. The agency can be contact directly or inform to the village leaders, and people can trust in the information that they received. Because of the rumor with unknown source made the villagers panic in the past.

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Table 4-9 Percentage of respondents by agencies

Do you know any agencies if the disaster occurs that are involved in surveillance get emergency?	Number	Percentage
Yes	135	37.09
No	229	62.91
Total	364	100.0
Who do you think should be alert when a disaster occurs?	Number	Percentage
Village header	291	52.2
Neighbor	104	18.6
Volunteer Protection	163	29.2
Total	558	100.0

The table 4-10 shows that the people who get knowledge about local disasters, and practice to be prepared for disaster were 26.37 %. The agency cannot approach all villages in the area, and some people who have never attended a village meeting and did not known the knowledge for disaster prevention in the community. However people can be getting more knowledge and access to information from different sources.

Table 4-10 Percentage of respondents by practice for disaster.

You always get knowledge about local disasters , and practice to be prepared for disaster?	Number	Percentage
Yes	96	26.37
No	268	73.63
Total	364	100.0

In the study, the respondents when receive warning, it is found that the majority of respondents were compose yourself were 34.2% and secondly 22.3% of respondents were immediately exodus. On the other hand, the response when did not receive warning, it is found that the majority of respondents were compose oneself 43.3 % and secondly 29.4 % of respondents were immediately exodus. (Table 4-11,

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4-12). Behavioral response to disaster between the public when receive and not receive warning was similar. The first compose are composed yourself and immediately exodus. But some people who are also stayed in home to asset surveillance can cause increase tend to loss of life.

Table 4-11 Percentage of respondents by the response when receive warning.

The response when receive warning.	Responses	
	Number	Percentage
1 Compose yourself	288	34.2
2 Immediately exodus	188	22.3
3 Keep up the high	118	14.0
4 Alert to neighbors	180	21.4
5 Moving Pets	42	5.0
6 Stay in home to asset surveillance	26	3.1
Total	842	100.0

Table 4-12 Percentage of respondents by the response when did not receive warning.

The response when did not receive warning.	Responses	
	Number	Percentage
1 Compose yourself	280	43.3
2 Immediately exodus	190	29.4
3 Keep up the high	54	8.4
4 Alert to neighbors	91	14.1
5 Moving Pets	23	3.6
6 Stay in home to asset surveillance	8	1.2
Total	646	100.0

From the study, the majority of the respondents are worried about Vajiralongkorn Dam was 63.46% (Table 4-13) In the past, the frequency of earthquakes are more often in the area is not severe, and the people will be able to feel

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the vibration. However, the people do not have knowledge of preparedness to the disaster.

Table 4-13 Percentage of respondents by worried of dam safety.

Are you worried about Vajiralongkorn dam?	Number	Percentage
Yes	231	63.46
No	133	36.54
Total	364	100.0

The table 4-14 shows that the people who need help by the agency was 81.11%; it is found that the majority of respondents were before disaster 38.94%and secondly 31.16% of respondents were during disaster. As a result of table 4-14, the respondents are worried about Vajiralongkorn Dam, so the people need help from agencies all of time (before, during, after). Most of the demand for aid before disaster are knowledge and practices to preparedness the disaster for the basic to help oneself.

Table 4-14 Percentage of respondents by help from the agency.

You need help from the agency?	Number	Percentage
Yes	292	81.11
No	68	18.89
Total	360	100.0
The time interval that needs help?	Number	Percentage
Before disaster	155	38.94
During disaster	124	31.16
After disaster	119	29.90

4.4 Opinions on the problems and solutions in disaster management of the communities.

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From the comments in response to the flood disaster, it was found that the majority of respondents were leaders of community or those involved should be

announced community guidelines on practice in prepared from the flood to the people were 94.21% and secondly 93.09% of respondents were the community should be encouraged and supported the volunteer for alert to flood disaster to the people in the community. Finally, Approach to reduce the impact and violence causing damage to life and property of the people in the community is a powerful to flood warning in advance were 92.29% (Table 4-15).

Table 4-15 Percentage of respondents by opinions on the problems and solutions in disaster management of the community.

Opinions on the problems and solutions in disaster management of the community.	Number	Percentage
1. The community should be surveillance in flood to reduce the violence caused by the floods.		
Agree	319	89.36
Not sure	38	10.64
Total	357	100.0
2. Surveillance flood in communities effectively should be cooperation from people in the community, government agencies and private organizations.		
Agree	324	90.76
Not sure	33	9.24
Total	357	100.0
3. Surveillance of flood disaster is effective in community should be monitored the situation		
Agree	335	92.29
Not sure	28	7.71
Total	363	100.0

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Table 4-15 Percentage of respondents by opinions on the problems and solutions in disaster management of the community (continued).

Opinions on the problems and solutions in disaster management of the community.	Number	Percentage
4. Good and effective surveillance flood in community should be a reliable source of information, coordination and cooperation between agencies and partners in surveillance.		
Agree	319	87.88
Not sure	44	12.12
Total	363	100.0
5. Approach to reduce the impact and violence causing damage to life and property of the people in the community is a powerful to flood warning in advance		
Agree	335	92.29
Not sure	28	7.71
Total	363	100.0
6. The community should be encouraged and supported the volunteer for alert to flood disaster to the people in the community.		
Agree	337	93.09
Not sure	25	6.91
Total	362	100.0
7. The volunteers of flood warning in the community should be a person with knowledge, reliable, and acceptable to the people.		
Agree	317	87.81
Not sure	43	11.91
Disagree	1	0.28
Total	361	100.0

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Table 4-15 Percentage of respondents by opinions on the problems and solutions in disaster management of the community (continued).

Opinions on the problems and solutions in disaster management of the community.	Number	Percentage
8. Good and effective warning should have been known and agreed from the people in the community.		
Agree	321	88.43
Not sure	42	11.57
Total	363	100.0
9. The community should have been prepared of the flood by operating center.		
Agree	321	89.17
Not sure	39	10.83
Total	360	100.0
10. The community should have been a plan prepared before the flood.		
Agree	316	86.58
Not sure	49	13.42
Total	365	100.0
11. The community should have been a plan and practice before the flood.		
Agree	300	82.64
Not sure	63	17.36
Total	363	100.0
12. The community should be prepared tools, materials, equipment and places of shelter to flood victims.		
Agree	321	88.43
Not sure	42	11.57
Total	363	100.0

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Table 4-15 Percentage of respondents by opinions on the problems and solutions in disaster management of the community (continued).

Opinions on the problems and solutions in disaster management of the community.	Number	Percentage
13. Leaders of community or those involved should be announced community guidelines on practice in preparedness from the flood to the people		
Agree	342	94.21
Not sure	21	5.79
Total	363	100.0

4.5 The relation of various factors affect to knowledge, aware, and opinion of public in the risk area are response from the earthquake and flood from the dam

Yule's Q is a simple stats and powerful analysis. The formula for Q is simple and easily calculable and available with nominal scale data in the form of a 2 x 2 table. It is generally accepted that the majority of social science data are nominal or ordinal level, so statistics is suitable to levels of information available. Obtains values in the range from -1 to 0 to +1 so, which is desirable properties of the statistics used to measure related content. This statistics are useful to measure the relationship between variables used in the content. It can be said that the Yule's Q is the value of r (correlation coefficient) but as r in nominal scale, while r (Pearson) is of the interval and ratio scale. The interpretation of Q is similar to the r and the value of Q as the value is greater than 0.7 to show that the relationship in a positive and very high. But the limit of the Yule's Q is the statistics are calculated from raw numbers of a 2 x 2 table 2 only, so the research may be grouped groping into two groups if there are more than two groups, a group less could be made to reduce the difference.

The relation between acknowledged information in risk areas and safety area are positive and very high. (Q = + 0.74) When disasters occur people can be immigrate to the appropriate area.

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The relation between people who has been known local agencies involved in disaster management in the area and the people have been taught by the agency. If the disaster occurs, people can be behaved and known local agencies are responsible for providing assistance is positive and very high. (Q = + 0.88)

The relation between the people who has been worried about the safety of the dam and requires the assistance of the relevant agency is positive and very high. (Q = + 0.75)

The relation between people who thought their live in risk area to earthquakes and flood from the dam disaster and the assistance of the relevant agency is positive and very high. (Q = + 0.86)

4.6 Operation situation of relevant agencies in dam preparedness.

4.6.1 Vajiralongkorn dam

In normal conditions the Vajiralongkorn dam is monitored behavior of dam such as subside, movement, damage from usability to support production system. Automatic and manual monitoring systems are checked in every day. For the monitoring in special case is Emergency Action Plan (EPA) has the 4 plans including fire plan, flood plan, earthquake plan, and victims of flood plan. A case of severe earthquake is checked by the Central Committee. The dam safety section of central committee is determined the place (office or power plan) and plan (fire plan, flood plan, earthquake plan, and victims of flood plan) to be practice in each year and this year had been practice in earthquake plan.

There plans has the 3 levels, so level of practice is depended on the availability at that time. Level 1-2, practice plans are inside of Vajiralongkorn dam and the director is a head of the percentage, or the director of Vajiralongkorn dam. In level 3, a practice plan is collaborated with external agencies such as Disaster prevention and mitigation provincial office Kanchanaburi in Thongphaphum brance, Subdistrict Administration Organization (SAO), Thongphaphum hospital, police station, Lat Ya specific unit. In addition, the Vajiralongkorn dam has been covenanted in memorandum of understanding (MOU) about earthquake with four agencies, so all agencies are measured earthquake station include;

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1. Thai Meteorological Department is a single agency to identify the magnitude of the earthquake for reliability of the information.
2. EGAT informed of the acceleration (g) on the dam.
3. Royal Irrigation Department
4. Department of Mineral Resources

And the earthquake disaster monitoring has a message automatic alerts are notification by The National Disaster Warning Center.

At present, the Vajiralongkorn dam is very prepared to the earthquake and flood mitigation on dam failure. But, the external agencies were never joined to the practice in the dam, because people may be panicked and worried about safety of the dam by full scale of the practice. In the present, The National Disaster Warning Center have orders to the agencies need to be practice of an earthquake plan, so the people and local agencies are attended and observe at various times. The people are very interested because they are lived in the area that will be directly affected by disasters. For obstacles to the practice plan is not deftness, if they will be more practice, so will be habituate. And agencies should be explained to the community for understood and not worried in safety of the dam. The community should be shared and listen to suggestion in disaster plan, so they can be survived by an emergency.

For reliability in full scale practice is investigated and observed by committee, academics, and mass media.

In the future, Vajiralongkorn Dam will be improved the operational plan to provide the local community is more involved by understanding with the people and present the easier information to understand. The people can be observed and practice to be deployed on their own.

4.6.2 Disaster Prevention and mitigation Provincial Office Kanchanaburi Thongphaphum Brance, Subdistrict (DDPM)

DDPM is improved plans and full scale practice in annual, and this practice has a format similar to the Incident Command System (ICS). The DDPM is coordinating with community and local agencies. In the past, Thongphaphum district was never practices in the earthquake plan but, they have been invited by

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Kanchanaburi province to training and getting information of the process to operation and rescue in affected area.

At present, the DDPM is very prepared to the earthquake and flood mitigation on dam failure. They have the disaster prevention and mitigation plan for emergencies situations. In addition, they are surveillance and coordinated the relevant agencies in 24 hours a day. Villagers and agencies have been invited in emergency practice plans by the DDPM. So people are cooperated as well, because who have been directly affected by the disaster.

The center to coordinate has been established in four levels by Thongphaphum district includes:

Level 1 District and Sub-district level, the commander is district chief and chief executive of the SAO.

Level 2 Province level, the commander is provincial governor.

Level 3 Serious events are affected to many provinces; the commander is Minister of Interior

Level 4 Extremely serious incident, the commander is Prime minister

The earthquake plan was practiced on September 10, 2015 found that, there problems and obstacles in this plan is local agencies were not familiar in Table-top Exercise (TTX) that is planned to practice at the executive level as a practice is showed the preparedness of agencies in the area but they were accustomed to full scale exercise.

In the future, DDPM will be improved the operational plan to provide the local community is more involved by directly approached to people and coopered with local agencies which is made the prevention action plan in each sub-district and that they are proficiency in prevention must be practiced in every year. For example, same district can be shared the practice to be reduced budget and that provided the high risk community is a model and that they should be made the video, documents, and the media on disaster response to the people for the community is not ready to practice. The people should be known to help themselves and their families moreover they can be helping other residents. The folkways and the priorities of disaster of each community are different. However, if the community is not prepare to respond on

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disaster that they may be mistakes, so the exercise it must be to known of defects and adapted in every situation.

4.6.3Village headman

Most villages have received information of risk areas on flood by Vajiralongkorn dam and they have been known that their community settling in risk areas of earthquake and flood on dam failure. Preparedness for disasters in the community is apprise of information and alarms at the community meeting hall by the village headman. If the disasters are suddenly occurred that is informed and warning to the people by motorcycle, so the people will be come together to the rally point area and the safety area at the mountain.

The communities need to help from the agencies outside community that is budget to create broadcast tower, alarm station, and alarm equipment such as siren and fireworks etc. And they need to be known an information and knowledge of how to do before, during, and after disaster to increase people is participation in disaster management by agencies. Related organization will be come to designated risk area and safety area for community. In addition, they need to be known agencies that can be specializes and give serviceable each agency of avoid confusion in contacting for assistance. Cooperation practice of prevention and mitigation disaster plan in many levels such as community, sub-district, district, and province levels should be exercise in every year.

Community has been informed of disaster by EGAT, DDPM, and SAO. Moreover, there was established of a group Civil Defense Volunteer, Village Security Team. Most people are attended and cooperate in disaster prevention and preparedness includes evacuation drills to safety. But some people who do not cooperate because that they are thought of their village that are not located in risk areas and in the past have never been a disaster in the area.

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4.7 Non – participant observation

Exercise on Disaster Prevention and Mitigation of Thongphaphum district in 2015 (Table-top Exercise: TTX) case of earthquake.

Location: Vajiralongkorn dam, Thongphaphum district, Kanchanaburi province

Agencies participate

1. Director/Vice-Director/Assistant to the Director and worker section in Disaster prevention and mitigation of 8 Sub-district Administration Organization (SAO) in Thongphaphum district.
2. Head of Government/Deputy Head of Government and Worker of emergency action plan all of agencies include Thongphaphum hospital, police station, school, Lat Ya specific unit, Vajiralongkorn dam, Provincial Electricity Authority, Provincial Waterworks Authority, and rescue foundation.

Tools

1. Disaster Prevention and Mitigation Plan
2. Emergency action plans (EAP) of local governments.

Operating Procedure

1. Delivers Policy and open the an exercise plan by Chief District Officer
2. The participants were educating about prevention and mitigation plans, and details of the exercise by Head of Disaster Prevention and mitigation Provincial Office Kanchanaburi Thongphaphum Brance.
3. Related agencies were informing objectives, describe an earthquake scenario, and debate in situation of fielded questions by the lecturer.
4. Exercise plan were commented and summarized by related agencies.
5. A guideline of public relations was concluded for People in the risky areas affected by the release of water from the dam by the director of Vajiralongkorn dam.
6. The practice of Disaster Prevention and Mitigation in district level was closed by the President of Operations.

Feedback after the exercise

1. Participants of practice are more understood of each exercise.
2. Executive authorities are understood role of their own and focus on prevention and mitigation plan.

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3. Reaction on feedback from scenario in practice is reflected to availability of agencies and can be motivated mechanism driven plan of agencies for situations that may be occurred in all cases.
4. Readiness of agencies was investigated.

Opinion and Suggestion

1. Coordination of participate in the exercise is unclear.
2. Participant in executive level and head of government are not understood the process and content of Table-top Exercise because they were accustomed to full scale exercise. Therefore, they have question beyond expectations to the design for tabletop exercises.
3. The development model of supposition and situation should be throughout described after that the questions are ask for answer or approach to objectives of the practice are set and to discuss the guidelines.

Table 4-16 Observational practice plan are observed in plan of during the earthquake in Vajiralongkorn dam, Electricity Generating Authority of Thailand, there are observed as follows:

No.	Detail	Very low	Low	Moderate	High	Very high
1.	The practice facility					✓
2	The personal availability of trained.			✓		
3	The tools and equipment availability of training					✓
4	The situation is clearly.			✓		
5	Participating agencies are fully equipped.				✓	
6	The seriousness of participant.			✓		
7	Duration of the exercise.				✓	
8	The cooperation of everyone.				✓	
9	Overview Training Plan during an earthquake.			✓		

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CHAPTER V
GUIDELINES ON DEVELOPING DAM MITIGATION PREPAREDNESS

5.1 Recommendations for EGAT as the Authority of Vajiralongkorn Dam

5.1.1 Developing and maintenance emergency action plan (EAP).

An Emergency Action Plan (EAP) is identifies potential emergency conditions that could occur at a dam, and determine procedures to follow to reduce loss of life and property damage. Although, all of operations are intended to reduce the risk of dam failures such as the dam design, construction, operation, maintenance, and monitoring of dams. However, emergency situations that may be effect on dam failure. So, there is thoughtful for dam authority to develop and maintain an EAP, which can be initiated, that could prevent or reduce the consequences to life and property. The important function of an EAP is to notifying downstream communities of failure or impending failure of a dam, so that the communities can be evacuated in a timely manner. The EAP must be provided procedures to evaluate those conditions at the dam that could lead to failure, that to prevent failure, or alternatively to delay failure until after downstream communities have been alerted (The Department of Ecology, Dam Safety Office DSO, 2013).

From the EAP above, the following are the recommendations for improving the EGAT operation of mitigation preparedness of Vajiralongkorn dam:

- The Emergency Action Plan should be developed, in every year should be evaluate the safety of the dam, assess the profile of the downstream community and update the flood hazard and update the information sent to participating agencies.

- Conduct annual practice for internal personnel and preparation of practice such as emergency equipment, telephone numbers, etc.

- Regular investigation and checking of warning systems are indicated in the plan.

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- Should be made dam flood information and information easily accessible.

5.1.2 Coordination between the dam authority and agencies related to public safety.

The development of the EAP should be coordinated with all agencies that would be affected by an emergency at the dam or that agencies have responsibilities for warning, evacuation, and actions after accident. The EAP should be comprised clearly defined roles and responsibilities for each agency. So coordination between the dam authority and agencies related for warning and evacuation the public is essential for ensuring agreement on agencies responsibilities. In addition, coordination will provide opportunities to discuss critical emergency planning concerns such as the order of public official notification, use of booster personnel, alternate means of communication (Federal Emergency Management Agency, 2013). From the studies, the valuing community safety in the management of dams: developing the partnership between dam agencies, the communities at risk and emergency managers in New South Welsh (Howard and Opper, 2004) found that the planning of dam safety there must be many those associated for information sharing and so there are operate and coordinated properly.

So, the suggestions for establishing coordination between agencies are following:

- The copies of the EAP are distributed to other agencies related to public safety such as the Disaster Prevention and mitigation Provincial Office Kanchanaburi Thongphaphum Brance, Subdistrict (DDPM), Sub-district Administration Organization (SAO) of downstream community, Thongphaphum district to provide necessary information for developing their own plans, as the dam authority should be operated with the assistance and cooperation of agencies related in case of the dam emergency.

- Regularly meeting with the related agencies to updates of essential information to the response of the emergency action plan such as scenarios of flood, extent of the flood area, travel times of flood waves, changes to existing warning systems and preparation.

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- Continuing coordinated with the Local Government and the community at risk, within the terms of agreed preparations between the related agencies.

5.1.3 Enhancing the level of public awareness and participation on dam safety issues.

Preliminary of enhancing the level of public awareness and participation on dam safety issues is providing accurate information to the public. In according with the study of Almeida A.B. et al (n.d.) that concludes public participation and information are implies a reflection on ethics related to communication and effects of risk. Some dam experts and safety officials have the opinion that risk information may be frightened so much to the population but, that can be a problem to resolve or mitigate. According to Katarzyna Kreft-Burman, 2000 that information presented to the public should be simple and comprehensive which should emphasize the safety of a dam and remind that the EAP has been created to make the dam even safer. One problem to provide information to the public is some people will move away or into the community. The possible solution to this problem is to create the web pages idealistic to the dam failure and flood issues and updated interesting information.

Enhancing the level of public awareness and participation on dam safety issues as following:

- Educating to the public in other channels such as community radio, community leader, local T.V., news board, and community meeting etc.

- A compact guide for the population on how to act in the event of a dam failure and flood.

- Should be the Mass Relation activities to meet regularly with downstream communities for open discussions about effectiveness of the operation of dam, condition of dam, and how to act in case of the emergency by the dam officers responsible.

- Development of access to information on the dam via news board in the important places in the downstream communities i.e. in front of the communities, school, and community hall.

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- General disaster preparedness is recorded for announcement in radio public service.

5.2 Recommendations for the Disaster Prevention and mitigation Provincial Office Kanchanaburi Thongphaphum Brance, Subdistrict (DDPM)

As the Emergency evacuation plans in risk areas of flood in case of the dam in Kanchanaburi of Disaster Prevention and mitigation Provincial Office Kanchanaburi, 2010 indicates that are responsible for prevention and mitigation of the provincial by command and control operations with the cooperation of the relevant authorities. This is the second unit in district, parish, and councils. The purposes of the operation are to prepare the main and support agencies for the evacuation of people to the shelter in a safe location and prevention of public panic, and to maintain the safety of life and reduced losses property.

The following are suggestions for developing operation of the DDPM:

- Continuing coordinated with the dam authority.
- Developing a specific warning of dam failure and flood.
- Investigated that emergency preparedness are made known to all participating agencies.
- Investigated that it is the emergency action plan is usually reviewed.
- Where its facilities and equipment are developed to emergency response plans at risk from flood.
- There must be preparedness for communication between the dam authority, the DDPM, Local Government, the community at risk, and related agencies that preparedness should be developed jointly and coordinated by the dam authority.
- Review the emergency warning and communication such as the radio wave and telephone number.
- Maintain response personnel and equipment that are readily available.
- Educating to the public in the initial disaster response by themselves.

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- Encourage communities to help themselves by Community-Based Disaster Risk Management (CBDRM).

5.3 Recommendations for Thongphaphum District as Local Government

The following are the suggestion for developing operation of Thongphaphum district:

- Local Government must be intended to it is role of a major participant as that have resources to support a local emergency management plan, with regular situation and practice.

- Developing a plan to safeguard life and property from flood from dam failure or stream flows such as instituting an emergency operations center, evacuation, and actions in after flood.

- Local Government has a role in determining land use within the downstream flood area.

- Continuing coordinated with the dam authority, the DDPM, and related agencies.

- Coordinate with other related agencies in an education and creation an emergency response plan for the public in community at risk.

5.4 Recommendations for Downstream communities

The main factor lead to success in disaster risk management is the participation of the community because the community is known demand in mitigation and prevention for disasters of their community (Supanich N., 2006).

From the result, found that the downstream communities of Vajiralongkorn dam are lacking of information and disaster preparedness. The following are the suggestion for improving mitigation of downstream community from the risk in flood of vajiralongkorn dam emergency:

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- Learning guidelines for field practitioners to implement the Community-Based Disaster Risk Management in Thailand: CBDRM and applied to their communities.

- The community should be trained and be leader for the general disaster and dam emergency management. So, they should know how to act in case of dam emergency such as the safe place and risk area of the community, and they will be cooperating with the dam authority, and they can be contact the dam and relate agencies when necessary.

- From the study, it shows that the village headman and local broadcasting station are the primary means of communication in the community. But some community do not has broadcasting station in community therefore, the development of communication systems it is important. There should be distributing necessary information via them, especially for the local broadcasting station. For example, there should be reporting the condition of weather, the level of water in the river or level of water that will be released from the dam. Moreover, the capability of local broadcasting station should be improving to ensure all of the inhabitants in the community could obtain information.

- There should be developing other means of communication in the community and updated information of the disaster. For example, there should be setting up a news board in important places in the community such as community hall and school. The information that should be identified is condition of how to act in the event of a dam failure and flood, contact of agencies (police, fire, local emergency response coordinators).

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CHAPTER VI
SUMMARY AND SUGGESTIONS

6.1 Summary

This research aimed to study the operational situation in the mitigation management of earthquake and flood on dam failure of downstream community of Vajiralongkorn Dam and also investigate people's knowledge, participation towards the problems from earthquake and flood including finding of mitigation guidance for future disasters. This research revealed the results in many aspects which can be summarized as followed.

6.1.1 Operation situation of related agencies in dam emergency preparedness

From the study, it shows that the main relevant agencies serving to preparedness disaster in Thongphaphum district are EGAT and DDPM. These agencies have their emergency and preparedness plans. they also serve as an intermediary in coordination with other agencies to sharing planning and exercises together such as 8 Sub-district Administration Organization (SAO) in Thongphaphum district, Thongphaphum hospital, police station, school, Lat Ya specific unit, Provincial Electricity Authority, Provincial Waterworks Authority, and rescue foundation.

6.1.2 Communities are response towards earthquake and flood mitigation on dam failure.

From the study, the result shows that:

- Communities are response towards knowledge and awareness of disaster

1) The population of risk has a little bit knowledge of the disaster

2) The house settling in the risk area has been through was 78.39%. Most people think a house adjacent waterfront will be affected to floods,

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3) Guideline had been prepared disaster by the community was 76.75%. Every village has not a guideline for the management;

4) The disaster information followed by people was 86.5% and majority of source information television was 31.7% and secondary of source information is village leaders was 18.2 %.

5) Risk area of dam failure known by people was 55% and 45% is not known. For the safety area of dam failure known by people was 38.63% and 61.37% is not known.

6) If the disaster occurs in risk area people who cannot migrate was 50.68% and people need of evacuation time about the majority of respondents was 1 hour 39.62% and secondly 34.15% of respondents were 2 hours.

7) The agencies have not been informed are involved in surveillance, emergency response, by people was 62.91%, and who should be a warning on the disaster is village header was 52.2% and the second is volunteer protection was 29.2%.

8) The people who get knowledge about local disasters, and practice to be prepared for disaster were 26.37 %.

9) The respondents when receive warning, it is found that the majority of respondents were compose yourself were 34.2% and secondly 22.3% of respondents were immediately exodus. On the other hand, the response when did not receive warning, it is found that the majority of respondents were compose yourself 43.3 % and secondly 29.46 % of respondents were immediately exodus

10) The majority of the respondents are worried about Vajiralongkorn Dam was 63.11%

11) That the people who need help by the agency was 81.11%; it is found that the majority of respondents were before disaster 38.94%and secondly 31.16% of respondents were during disaster. As a result of table 4-14, the respondents are worried about Vajiralongkorn Dam, so the people need help from agencies all of time (before, during, after).

- Opinions on the problems and solutions in disaster management of the communities

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The response to the flood disaster, it was found that the majority of respondents were leaders of community or those involved should be announced

community guidelines on practice in prepared from the flood to the people were 94.21% and secondly 93.09% of respondents were the community should be encouraged and supported the volunteer for alert to flood disaster to the people in the community. Finally, Approach to reduce the impact and violence causing damage to life and property of the people in the community is a powerful to flood warning in advance were 92.29%

- The relation of various factors affect to knowledge, aware, and opinion of public in the risk area are response from the earthquake and flood from the dam.

1) The relation between acknowledged information in risk areas and safety area are positive and very high. (Q = + 0.74) When disasters occur people can be immigrate to the appropriate area.

2) The relation between people who has been known local agencies involved in disaster management in the area and the people have been taught by the agency. If the disaster occurs, people can be behaved and known local agencies are responsible for providing assistance is positive and very high. (Q = + 0.88)

3) The relation between the people who has been worried about the safety of the dam and requires the assistance of the relevant agency is positive and very high. (Q = + 0.75)

4) The relation between people who thought their live in risk area to earthquakes and flood from the dam disaster and the assistance of the relevant agency is positive and very high. (Q = + 0.86)

6.1.3 Guidelines on developing of dam mitigation preparedness

6.1.3.1 Recommendations for EGAT as the dam Authority of Vajiralongkorn dam

The following are the measures and activities that EGAT should do:

- The Emergency Action Plan developed, in every year should be evaluate the safety of the dam, assess the profile of the downstream community and update the flood hazard and update the information sent to participating agencies.

- Conduct annual practice for internal personnel and preparation of practice such as emergency equipment, telephone numbers, etc.

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- Regular investigation and checking of warning systems are indicated in the plan.

- Should be made dam flood information and information easily accessible.

- The copies of the EAP are distributed to other agencies related to public safety such as the Disaster Prevention and mitigation Provincial Office Kanchanaburi Thongphaphum Brance, Subdistrict (DDPM), Sub-district Administration Organization (SAO) of downstream community, Thongphaphum district to provide necessary information for developing their own plans, as the dam authority should be operated with the assistance and cooperation of agencies related in case of the dam emergency.

- Regularly meeting with the related agencies to updates of essential information to the response of the emergency action plan such as scenarios of flood, extent of the flood area, travel times of flood waves, changes to existing warning systems and preparation.

- Continuing coordinated with the Local Government and the community at risk, within the terms of agreed preparations between the related agencies.

- Educating to the public in other channels such as radio, website, news board, and community meeting etc.

- A compact guide for the population on how to act in the event of a dam failure and flood.

- Should be the Mass Relation activities to meet regularly with downstream communities for open discussions about effectiveness of the operation of dam, condition of dam, and how to act in case of the emergency by the dam officers responsible.

- Development of access to information on the dam via news board in the important places in the downstream communities i.e. in front of the communities, school, and community hall.

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- General disaster preparedness is recorded for announcement in radio public service.

6.1.3.2 Recommendations for the DDPM

The following are suggestions for developing operation of the DDPM:

- Continuing coordinated with the dam authority.
- Developing a specific warning of dam failure and flood.
- Investigated that emergency preparedness are made known to all participating agencies.
- Investigated that it is the emergency action plan is usually reviewed.
- Where its facilities and equipment are developed to emergency response plans at risk from flood.
- There must be preparedness for communication between the dam authority, the DDPM, Local Government, the community at risk, and related agencies that preparedness should be developed jointly and coordinated by the dam authority.
- Review the emergency warning and communication such as the radio wave and telephone number.
- Maintain response personnel and equipment that are readily available.
- Educating to the public in the initial disaster response by themselves.
- Encourage communities to help themselves by Community-Based Disaster Risk Management (CBDRM).

6.1.3.3 Recommendation for Thongphaphum district as Local Government

The following are the suggestion for developing operation of Thongphaphum district:

- Local Government must be intended to it is role of a major participant as that have resources to support a local emergency management plan, with regular situation and practice.

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- Developing a plan to safeguard life and property from flood from dam failure or stream flows such as instituting an emergency operations center, evacuation, and actions in after flood.

- Local Government has a role in determining land use within the downstream flood area.

- Continuing coordinated with the dam authority, the DDPM, and related agencies.

- Coordinate with other related agencies in an education and creation an emergency response plan for the public in community at risk.

6.1.3.4 Recommendations for communities

-Learning guidelines for field practitioners to implement the Community-Based Disaster Risk Management in Thailand: CBDRM and applied to their communities.

- The community should be trained and be leader for the general disaster and dam emergency management. So, they should know how to act in case of dam emergency such as the safe place and risk area of the community, and they will be cooperating with the dam authority, and they can be contact the dam and relate agencies when necessary.

- From the study, it shows that the community leaders and local broadcasting station are the primary means of communication in the community. But some community do not has broadcasting station in community therefore, the development of communication systems it is important. There should be distributing necessary information via them, especially for the local broadcasting station. For example, there should be reporting the condition of weather, the level of water in the river or level of water that will be released from the dam. Moreover, the capability of local broadcasting station should be improving to ensure all of the inhabitants in the community could obtain information.

- There should be developing other means of communication in the community and updated information of the disaster. For example, there should be setting up a news board in important places in the community such as community hall and school. The information that should be identified is condition of how to act in

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the event of a dam failure and flood, contact of agencies (police, fire, local emergency response coordinators).

6.2 Suggestions for further study

6.2.1 The questionnaire should be described clearly situation and given a detail so that the respondents understood such as disaster during the day or night and other limited (Power Outage, lack of road, and communication failure).

6.2.2 There should be studying a process of community participation such as increase education to public and increase of public participation in dam emergency preparedness.

6.2.3 There should be studying for developing of communication between the related agencies and downstream communities.

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APPENDICES

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เลขที่แบบสอบถาม.....

แบบสอบถามการวิจัย

หัวข้อ การจัดการรับมือจากแผ่นดินไหวและน้ำท่วมจากเขื่อนพิบัติของชุมชนท้ายเขื่อนวชิราลงกรณ อำเภอทองผาภูมิ จังหวัดกาญจนบุรี

คำชี้แจง:

1.โปรดทำเครื่องหมาย / ลงในช่อง □ และตอบคำถามให้ตรงกับความคิดเห็นของท่านให้มากที่สุด

2. การศึกษาวิจัยนี้เป็นการศึกษาทางวิชาการ ผลการศึกษาที่ได้จึงไม่มีผลกระทบต่อผู้ให้ข้อมูลแต่อย่างใด หากแต่จะเป็นประโยชน์ต่อส่วนรวมในอนาคต จึงขอให้ท่านกรุณาตอบแบบสอบถามตามความเห็นของท่าน เพื่อประโยชน์ต่อการนำข้อมูลไปใช้ในการพัฒนารูปแบบการเตรียมความพร้อมตอบโต้ภาวะฉุกเฉินด้านภัยพิบัติทางธรรมชาติที่เกิดจากภัยแผ่นดินไหวและน้ำท่วมจากเขื่อนพิบัติที่มีประสิทธิภาพต่อไป

ด้วยความเคารพอย่างสูง
นางสาวกมลฉัตร เกิดมั่นคง
นักศึกษาปริญญาโท คณะสิ่งแวดล้อมและทรัพยากรศาสตร์
มหาวิทยาลัยมหิดล

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ส่วนที่ 1 ข้อมูลด้านคุณลักษณะทางประชากร

รหัสแบบสอบถาม……

1. เพศ □ 1. เพศชาย □ 2. เพศหญิง

2. อายุ .....ปี

3. วุฒิการศึกษาสูงสุด

□ 1. ระดับประถมศึกษา □ 2. ระดับมัธยมศึกษาตอนต้น □ 3. ระดับมัธยมศึกษาตอนปลาย

□ 4. ระดับ ปวช. □ 5. ระดับ ปวส./อนุปริญญา □ 6. ระดับปริญญาตรี

□ 7. อื่นๆ (ระบุ.....)

4. อาชีพ

□ 1. เกษตรกรรม □ 2. ค้าขาย □ 3. รับจ้างทั่วไป

□ 4. รับราชการ □ 5. รัฐวิสาหกิจ □ 6. อื่นๆ (ระบุ.....)

5. ตำแหน่งหน้าที่ทางสังคมในชุมชนของท่าน

□ 1. อาสาสมัครสาธารณสุข □ 2. กำนัน □ 3. ผู้ใหญ่บ้าน

□ 4. สมาชิก อบต. /เทศบาล □ 5. ประชาชนทั่วไป □ 6. อื่นๆ (ระบุ.....)

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ส่วนที่ 2 ข้อมูลความรู้เรื่องภัยพิบัติ

ความรู้ และการตระหนักเกี่ยวกับภัยพิบัติ	**ระดับความ**คิดเห็น		
	เห็นด้วย	ไม่แน่ใจ	ไม่เห็นด้วย
1.จังหวัดกาญจนบุรีตั้งอยู่บนแนวแขนงรอยเลื่อนศรีสวัสดิ์ และรอยเลื่อนเจดีย์สามองค์ที่แยกจากแนวรอยเลื่อนสะแกงในประเทศพม่าซึ่งเป็นรอยเลื่อนที่มีการเคลื่อนตัวและมีโอกาสทำให้เกิดแผ่นดินไหว			
2.เมื่อเกิดแผ่นดินไหวในพื้นที่ใดพื้นที่หนึ่ง สามารถส่งผลกระทบต่อสิ่งก่อสร้างของมนุษย์			
3. น้ำท่วมปกติจะมีความรุนแรงมากกว่าน้ำท่วมที่เกิดจากเขื่อนพิบัติ			
4.ท่านคิดว่าเขื่อนในพื้นที่ของท่านมีโอกาสพิบัติจากการเกิดแผ่นดินไหวหรือไม่			
5.ท่านคิดว่าหมู่บ้านของท่านจะได้รับผลกระทบหากเกิดกรณีเขื่อนแตกหรือไม่			
6.การเตือนภัยก่อนเกิดเหตุในเวลาที่เหมาะสมลดโอกาสในการสูญเสียจากการเกิดภัยพิบัติ			

คำชี้แจง ขอความกรุณาให้ผู้ตอบแบบสอบถามโปรดพิจารณาเติมเครื่องหมาย ลงในช่องสี่เหลี่ยม □ ให้ตรงกับความเป็นจริงมากที่สุด

7.ท่านคิดว่าที่อยู่อาศัยของท่านอยู่ในพื้นที่เสี่ยงภัยหรือไม่

□ ใช่ □ ไม่ใช่

8. ปัจจุบันหมู่บ้านของท่านมีแนวทางในการเตรียมพร้อมรับมือกับพิบัติภัยหรือไม่

□ มี □ ไม่มี

ถ้ามี อย่างไร……

……

……

9. ท่านได้ติดตามข่าวสารเกี่ยวกับพิบัติภัยในพื้นที่ของท่านหรือไม่

□ ติดตาม □ ไม่ได้ติดตาม

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10. ท่านสามารถรับรู้ข่าวสารเกี่ยวกับพิบัติภัยในพื้นที่ได้จากแหล่งใดบ้าง (ตอบได้มากกว่า 1 ข้อ)

□ 1. โทรทัศน์ □ 2.วิทยุ □ 3.เสียงตามสาย □ 4.ผู้นำหมู่บ้าน

□ 5.อาสาสมัครป้องกันภัย □ 6.เพื่อนบ้าน □ 7.เขื่อนวชิราลงกรณ

□8.อื่นๆ (ระบุ.....)

11. ท่านเคยเห็น หรือทราบข้อมูลไหมว่าพื้นที่ใดบ้างเป็นพื้นที่เสี่ยงภัย

□ เคย □ ไม่เคย

12. ท่านทราบหรือไม่ว่ามีพื้นที่ใดบ้างเป็นพื้นที่ปลอดภัยที่สามารถอพยพเมื่อเกิดพิบัติภัยได้

□ เคย □ ไม่เคย

ถ้าเคย ที่ใด

13. ท่านคิดว่าหากเกิดพิบัติภัยในพื้นที่ ท่านสามารถอพยพ หลบหนี ได้ทันหรือไม่

□ ทัน □ ไม่ทัน

ด้วยวิธีใด……

……..

14. ท่านคิดว่าต้องมีการแจ้งเตือนล่วงหน้าเป็นเวลาเท่าไหร่จึงจะอพยพออกจากพื้นที่ได้ทัน

□10 นาที □ 30 นาที □ 1 ชั่วโมง □1 ชั่วโมงครึ่ง

□มากกว่า 1 ชั่วโมงครึ่ง □ อื่นๆ…….

15.เมื่อได้รับการแจ้งเตือนภัย ท่านจะต้องทำสิ่งใดบ้าง (ตอบได้มากกว่า 1 ข้อ)

□ ตั้งสติ □ อพยพทันที □ เก็บของขึ้นที่สูง □ แจ้งเตือนเพื่อนบ้าน

□เคลื่อนย้ายสัตว์เลี้ยง □ อยู่กับบ้านเพื่อเฝ้าระวังทรัพย์สิน

16.เมื่อเกิดเหตุฉุกเฉิน ถ้า**ไม่ได้รับการแจ้งเตือนภัย**ท่านจะทำสิ่งใดก่อนเป็นอันดับแรก

□ ตั้งสติ □ อพยพทันที □ เก็บของขึ้นที่สูง □ แจ้งเตือนเพื่อนบ้าน

□เคลื่อนย้ายสัตว์เลี้ยง □ อยู่กับบ้านเพื่อเฝ้าระวังทรัพย์สิน

17.ในชุมชนของท่านใครควรเป็นผู้เตือนภัยเมื่อเกิดภัยพิบัติ

□ผู้ใหญ่บ้าน □เพื่อนบ้าน □ อาสาสมัครป้องกันภัยพิบัติ □ อื่นๆ……

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18. ท่านทราบไหมว่าหน่วยงานใดบ้างที่มีส่วนเกี่ยวข้องในการเฝ้าระวังรับเหตุฉุกเฉินหากเกิดพิบัติภัย

□ ทราบ □ ไม่ทราบ

ถ้าทราบ หน่วยงานใดบ้าง……...

……...

19. ท่านเคยได้รับความรู้เกี่ยวกับพิบัติภัยในท้องถิ่น การปฏิบัติตัว การเตรียมพร้อมรับมือกับพิบัติภัยหรือไม่

□ เคย □ ไม่เคย

ถ้าเคย จากหน่วยงานใด……...

……...

20. ท่านกังวลเกี่ยวกับความปลอดภัยของเขื่อนวชิราลงกรณหรือไม่

□ เคย □ ไม่เคย

21. ท่านต้องการความช่วยเหลือเกี่ยวกับภัยพิบัติจากภาครัฐ และหน่วยงานที่เกี่ยวข้องหรือไม่

□ ต้องการ □ ไม่ต้องการ

ถ้าท่านต้องการความช่วยเหลือ ต้องการเมื่อไร (ตอบได้มากกว่า 1 ข้อ)

1. ก่อนเกิดภัยพิบัติ คือ ช่วงระยะเวลาที่ปลอดจากภัยต่างๆ เป็นช่วงที่ต้องเตรียมความพร้อมตั้งแต่ด้านวิชาการ ด้านการวางแผนการรับมือของภาครัฐ ด้านการเตรียมความพร้อมของชุมชน และการช่วยเหลือแต่เนิ่นๆของทุกฝ่าย ซึ่งเป็นช่วงเวลายาวนานจนกว่าจะเกิดภัย

□ ก่อนเกิดภัยพิบัติ อย่างไร……

……...

2. ระหว่างเกิดภัย คือ ช่วงที่เกิดภัยพิบัติ เป็นช่วงที่ต้องดำเนินการต่างๆเพื่อลดความรุนแรงหรือสร้างความปลอดภัยให้กับประชาชนมากที่สุด โดยการป้องกันภัย การต้านภัย การอพยพ การปฐมพยาบาลฉุกเฉิน เป็นต้น

□ ระหว่างเกิดภัยพิบัติ อย่างไร……

……...

3. หลังเกิดภัยพิบัติ คือ ช่วงที่ต้องมีการตอบสนองอย่างรวดเร็วที่สุด เพื่อให้สถานการณ์กลับมาเป็นปกติมากที่สุด ต้องมีการฟื้นฟูระบบของท้องถิ่นและกิจกรรมของมนุษย์ให้กลับมาเป็นดังเดิมให้เร็วที่สุด ซึ่งอาจจะใช้เวลายาวนานไม่เท่าเทียมกันในแต่ละท้องถิ่น

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□ หลังเกิดภัยพิบัติ อย่างไร……

……...

ส่วนที่ 3 การมีส่วนร่วมของประชาชน ความคิดเห็นต่อปัญหาและแก้ไขปัญหาในการจัดการภัยพิบัติของชุมชน

คำชี้แจง ขอความกรุณาให้ผู้ตอบแบบสอบถามโปรดพิจารณา และทำเครื่องหมาย / ลงในช่องสี่เหลี่ยม □ ให้ตรงกับความเป็นจริงมากที่สุด

พฤติกรรมในการตอบโต้กับภัยพิบัติน้ำท่วม	ระดับความคิดเห็น		
	เห็นด้วย	ไม่แน่ใจ	ไม่เห็นด้วย
1. ชุมชนควรมีการเฝ้าระวังภัยน้ำท่วมในชุมชนเพื่อลดผลกระทบที่มีความรุนแรงที่เกิดจากภัยน้ำท่วม			
2. การเฝ้าระวังภัยน้ำท่วมในชุมชนที่มีประสิทธิภาพ ควรได้รับความร่วมมือจากคนในชุมชน หน่วยงานภาครัฐ เอกชน และองค์กรต่างๆ ภายในชุมชน			
3. การเฝ้าระวังภัยน้ำท่วมที่มีประสิทธิภาพในชุมชน ต้องมีการติดตามสถานการณ์อย่างสม่ำเสมอ			
4. การเฝ้าระวังภัยน้ำท่วมที่ดีและมีประสิทธิภาพในชุมชนควรมีแหล่งข้อมูลที่น่าเชื่อถือ และมีการประสานร่วมกันระหว่างหน่วยงานภาคีเครือข่ายในการเฝ้าระวัง			
5.การแจ้งเตือนภัยน้ำท่วมล่วงหน้า เป็นแนวทางให้การลดผลกระทบ ความรุนแรงที่ก่อให้เกิดเสียหายแก่ชีวิต และทรัพย์สินของคนในชุมชนที่มีประสิทธิภาพ			
6. ชุมชนควรส่งเสริม สนับสนุนให้มีอาสาสมัครในการแจ้งเตือน ภัยน้ำท่วมให้แก่คนในชุมชน			
7. อาสาสมัครแจ้งเตือนภัยน้ำท่วมในชุมชน ควรเป็นบุคคลที่มีความรู้ มีความน่าเชื่อถือ และเป็นที่ยอมรับของคนในชุมชน			
8. การแจ้งเตือนภัยที่ดี และมีประสิทธิภาพ คนในชุมชนต้องทราบและมีการตกลงร่วมกันไว้ล่วงหน้า			
9. ชุมชนควรมีศูนย์ปฏิบัติการในการเตรียมความพร้อมรับมือจาก ภัยน้ำท่วม			
10. การเตรียมความพร้อมก่อนการเกิดภัยน้ำท่วม ชุมชนควรมีการจัดทำแผนเตรียมความพร้อม			
11. การเตรียมความพร้อมก่อนการเกิดภัยน้ำท่วม ชุมชนควรมีการซ้อมแผนเตรียมความพร้อม			
12. ชุมชนควรมีการเตรียมความพร้อมด้านเครื่องมือ วัสดุ อุปกรณ์ และสถานที่พักพิงให้แก่ ผู้ประสบน้ำท่วม			
13. ขณะเกิดภัยน้ำท่วมในชุมชน ผู้นำชุมชนหรือผู้ส่วนเกี่ยวข้องควรมีการประกาศแจ้งให้คนในชุมชนทราบถึงแนวทางการปฏิบัติตนในการเตรียมความพร้อมรับมือจากภัยน้ำท่วม			

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ส่วนที่ 4

ข้อเสนอแนะ.....
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ขอขอบพระคุณสำหรับความกรุณาให้ข้อมูลความคิดเห็นและข้อเสนอแนะในการศึกษา

ด้วยความเคารพอย่างสูง

กมลฉัตร เกิดมั่นคง

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แนวคำถามในการสัมภาษณ์เชิงลึกหน่วยงานที่เกี่ยวข้อง และผู้นำชุมชน เรื่องการจัดการรับมือจากแผ่นดินไหวและน้ำท่วมจากเขื่อนพิบัติของชุมชนท้ายเขื่อนวชิราลงกรณ อำเภอทองผาภูมิ จังหวัดกาญจนบุรี

<u>แนวคำถามการสัมภาษณ์เชิงลึกหน่วยงานที่เกี่ยวข้อง</u>

1.หน่วยงานของท่านมีนโยบายหรือแผนงาน ในการการเตรียมความพร้อมรับภัยพิบัติจากแผ่นดินไหวและน้ำท่วมจากเขื่อนพิบัติหรือไม่ อย่างไร การดำเนินงานเป็นไปตามแผนที่วางไว้หรือไม่

2.หน่วยงานของท่านมีการร่วมมือวางแผนหรือฝึกซ้อมร่วมกับหน่วยงานอื่นหรือไม่ หน่วยงานใดบ้าง และมีการร่วมมืออย่างไรบ้าง

3.ความถี่ของการร่วมประชุมวางแผน หรือฝึกซ้อมร่วมกัน

4.ณ ปัจจุบัน ท่านคิดว่าหน่วยงานของท่านมีความพร้อมในการเตรียมความพร้อมรับภัยพิบัติจากแผ่นดินไหวและน้ำท่วมจากเขื่อนพิบัติเท่าใด

5.ท่านคิดว่าหน่วยงานของท่านยังขาด หรือต้องการอะไร หรือมีอุปสรรคใน การดำเนินงานอย่างไรบ้าง

6. หน่วยงานของท่านได้ให้ชาวบ้านในพื้นที่เข้ามามีส่วนร่วมด้วยหรือไม่ อย่างไร และชาวบ้านในพื้นที่มีการแสดงผลตอบรับอย่างไรบ้าง

7. ท่านคิดว่าชุมชนในพื้นที่ควรมีส่วนร่วมในเรื่องใดบ้าง มากน้อยเพียงใด

8. ในอนาคตท่านคิดว่าหน่วยงานของท่านมีแผนที่จะปรับปรุงการแผนการดำเนินงานอย่างไรบ้างเพื่อให้ชุมชนในพื้นที่เข้ามามีส่วนร่วมมากขึ้น

<u>แนวคำถามการสัมภาษณ์เชิงลึกผู้นำหมู่บ้าน</u>

1.ท่านทราบหรือไม่ว่าหมู่บ้านของท่านอยู่ในพื้นที่เสี่ยงภัย จากแผ่นดินไหวและน้ำท่วมจากเขื่อนพิบัติ

2.ในหมู่บ้านเองมีการการเตรียมความพร้อมรับภัยพิบัติจากแผ่นดินไหวและน้ำท่วมจากเขื่อนพิบัติ โดยที่ไม่ต้องอาศัยหน่วยงานภายนอกหรือไม่ อย่างไรบ้าง

3.ท่านคิดว่าหมู่บ้านต้องการความช่วยเหลือจากหน่วยงานภายนอกหรือไม่ อย่างไรบ้าง

4.ท่านทราบหรือไม่ว่ามีหน่วยงานใดบ้างในพื้นที่ของท่านที่เกี่ยวข้องในการเตรียมความพร้อมรับภัยพิบัติจากแผ่นดินไหวและน้ำท่วมจากเขื่อนพิบัติ

5. เคยมีหน่วยงานใดบ้างที่เข้ามาในชุมชนเพื่อให้ความรู้ และร่วมวางแผนกับชุมชนในการเตรียมความพร้อมรับภัยพิบัติจากแผ่นดินไหวและน้ำท่วมจากเขื่อนพิบัติ

6. ชาวบ้านในชุมชนมีความสนใจ และให้ความร่วมมือมากน้อยเพียงใด

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แบบสังเกตการณ์ฝึกซ้อมแผนการดำเนินงานระหว่างเกิดแผ่นดินไหว
ของการไฟฟ้าฝ่ายผลิตแห่งประเทศไทย เขื่อนวชิราลงกรณ

ข้อที่	รายละเอียด	1 น้อยมาก	2 น้อย	3 ปานกลาง	4 มาก	5 มากที่สุด
1.	สถานที่ฝึกซ้อม					
2	ความพร้อมในการฝึกซ้อมด้านบุคคล					
3	ความพร้อมในการฝึกซ้อมด้านเครื่องมืออุปกรณ์					
4	การสร้างสถานการณ์ได้ดีและชัดเจน					
5	หน่วยงานที่เข้าร่วมมีครบตามความต้องการ					
6	ความจริงจังของผู้เข้าร่วมทุกคน					
7	พฤติกรรมการตอบสนองเมื่อได้ยินสัญญาณเตือนภัย					
8	การประกาศใช้แผนฉุกเฉิน					
9	ระยะเวลาในการฝึกซ้อมแผน					
10	การให้ความร่วมมือของทุกคน					
11	สามารถไปถึงจุดรวมพลในเวลารวดเร็ว					
12	การควบคุมดูแล เคลื่อนย้ายผู้ประสบภัย					
13	การประสานงานกับหน่วยงานภายนอก					
14	การรายงานผลการปฏิบัติงานต่อผู้อำนวยการแผนฉุกเฉิน					
15	ภาพรวมการฝึกซ้อมแผนการดำเนินงานระหว่างเกิดแผ่นดินไหว					

หน่วยงานที่เข้าร่วม/ฝ่ายที่ทำหน้าที่รับผิดชอบ.....
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เครื่องมือที่ใช้.....
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ขั้นตอนการดำเนินตั้งแต่เริ่มต้นจนจบการฝึกซ้อม……
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ผลตอบรับหลังการฝึกซ้อม……
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ข้อเสนอแนะ/ความคิดเพิ่มเติม
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