CHAPTER 1

INTRODUCTION

1.1 Disaster Scenario of Thailand

Thailand has been suffered a lot from various kinds of natural disasters each year (Chalermpong, 2002). The country does not face destructive natural disasters such as volcanic eruption and earthquake due to its geographical and geological settings, the country, however, faces both natural and man-made disasters such as floods, droughts, storm, landslide and forest fires frequently every year. The prioritization of disaster risk in Thailand is given in Table 1.1. The level of disaster intensity, vulnerability, managing competency level and risk levels of Thailand is shown in Table 1.2. One disaster which causes heavy loss of lives and property is landslide in hilly areas. Extremely intense rainfall in November 1988 in Southern Thailand triggered the worst landslide in the history of the country, leaving three hundred and seventy three people dead and lost and property damage amounting to US$ 280 million (Phien-wej *et al.*, 1993). Thailand's Country Report prepared by the Department of Disaster Prevention and Mitigation, Ministry of Interior showed that in the year 2000, the flashflood and inundation in Hat Yai district of Songkhla province, southern Thailand and a year later in 2001, the flashflood and landslides in Prae and Petchaboon provinces, north and northeastern Thailand had resulted in damaging consequences on people's lives, property, natural environment and national economy. Statistical data of disasters and damages in Thailand during 2001 – 2004 is given in

Table 1.3. Another most destructive disaster, triggered by a continuous heavy rainfall, occurred in Nakhorn Srithammarat province in 1983. A great deal of land was eroded and transported by a huge water flow from the top of the high mountain and then slid down to low-lying land, burying the Phipun town located at the foot hills. This incident caused hundreds of deaths and a large amount of property damage. Vast agricultural areas were covered with thick sediment and debris (Thailand Country Report, 1999).

Table 1.1 Prioritization of Disaster Risk in Thailand (after Civil Defense Plan 2005, Civil Defense Secretariat Office, Ministry of Interior, Thailand).

Type of Disaster	Risk Level	Weight
Flood	High	2.39
Accident	High	2.37
Explosives	High	2.34
Tropical Cyclone	Moderate	2.31
Drought	Moderate	2.24
Fire	Moderate	2.20
Landslide	Moderate	2.15
Earthquake	Moderate	1.97
Social Unrest	Moderate	1.87
Agricultural Pest and Diseases	Moderate	1.77
Human Epidemics	Low	1.63

Table 1.2 The level of disaster intensity, vulnerability, managing competency level and risk levels of Thailand (after Civil Defense Plan 2005, Civil Defense Secretariat Office, Ministry of Interior, Thailand)

Type of Disaster	Intensity Level	Vulnerability Level	Managing Competency	Risk Level
Flood	High	Moderate	Moderate	High
Tropical Cyclone	High	High	Moderate	Moderate
Earthquake	Low	Low	Poor	Moderate
Landslide	Moderate	Low	Poor	Moderate
Drought	High	Moderate	Moderate	Moderate
Fire	High	Moderate	Moderate	Moderate
Explosives	High	Moderate	Poor	High
Accident	High	Moderate	Poor	High
Human Epidemics	Low	Low	Moderate	Low
Agricultural Pest and Diseases	Moderate	Low	Poor	Moderate
Social Unrest	Low	Low	Poor	Moderate
Influx of refugee	Moderate	Low	Moderate	Moderate

Table 1.3 Statistics of disasters and damages in Thailand during 2001 – 2004 (after Civil Defense Secretariat, Royal Thai Police, and Department of Pollution Control)

Year	Type of Disaster	Frequency	Affected Province	Damages		
				Injuries (Person)	Fatality (Person)	Loss (Million Baht)
2001	Flood	14	60	-	244	3,666.28
	Storm	1061	-	-	6	501.01
	Drought	-	51	-	-	71,962.97
	Earthquake	4	-	-	-	-
	Fire	1498	-	-	-	1529.28
	Road Accident	17616	-	53,960	11,652	1,240.80
	Chemical Hazard	20	-	160	32	na
2002	Flood	-	72	-	216	13,385.31
	Storm	594	-	11	18	213.37
	Drought	-	68	-	-	330.37
	Earthquake	12	-	-	-	-
	Fire	1,135	-	150	24	805.81
	Road Accident	88,390	-	62,054	13,398	1,560.50
	Chemical Hazard	24	-	-		40.50
2003	Flood	17	66	10	53	2,066.08
	Storm	3,213	76	434	74	457.43
	Drought	-	63	-	-	174.33
	Earthquake	1	-	-	-	-
	Fire	2,213	-	167	56	565.54
	Road Accident	na	-	952,238	13,290	na
	Chemical Hazard	15	10	56	5	na
2004	Flood	6	48	8	27	4,700.10
	Storm	3,843	76	63	73	398.41
	Drought	71	-	-	-	7,565.86
	Earthquake	6	-	-	-	-
	Fire	1,712	76	69	31	487.02
	Road Accident	124,530	76	94,164	13,406	1,623.08
	Chemical Hazard	29	-	140	27	200

Recently flash flood and landslide struck northern Thailand in 2006. The Department of Disaster Prevention and Mitigation (DDPM) announced that in 2006 (as of 19 June 2006), the flash flood and landslide have affected five provinces, 26 districts (*amphoe*), 171 sub-districts (*tambon*) and 1200 villages in northern Thailand (Table 1.4). The number of death toll reached 87 while there are still tens of people missing. Houses were swept away including other infrastructures such as bridges, roads, drainage systems and agricultural areas.

Table 1.4 The effect of flash flood and landslide on human lives and property (after Department of Disaster Prevention and Mitigation, 2006)

Province	District/Amphoe	Dead	Missing/Lost	House Damage	
				Total	Partial
Uttaradit	Lap Lae	23	4		
	Tha Pla	29	24		
	Muang	23			
	Subtotal	75	28	483	3478
Sukhothai	Si Satchalanai	6	1		
	Si Samrong	1			
	Subtotal	7		89	156
Phrae	Muang	5		135	345
Nan				1	
	Total	87	29	708	3979

Besides, in the past two decades, Thailand has also encountered numerous man-made disasters such as industrial accidents, chemical spills and chemical related plant explosions, urban fire and road accidents as the undesirable consequences of rapid progress in economic and social development (Thailand Country Report, 1999).

1.2 Rationale

The occurrence of landslide and its damage to the lives and property cannot be altogether prevented no matter how well a country is scientifically equipped or economically prosperous to counter landslide. The most reliable way of minimizing damages is to prevent developing cities, towns or villages in an area where the likelihood of landsliding is high. To adopt this method, the planners and decision makers need to have prior knowledge of different hazard and risk potentials of different areas. Delineation of an area into different classes of hazard and risk potentials is therefore an important task. This study is aimed at delineating the study area into different classes of hazard and risk to aid planners and decision makers with understandable information. Further, no literature has been found on hazard and risk assessment of the study area and that motivates me to take this research.

1.3 Research Objectives

The general aim of the study is to assess the landslide hazard and risk of the Doi-Suthep Pui area in northern Thailand in Chiang Mai province. To achieve the above aim, the following specific objectives are set:

- To study and analyze factors including slope, soil, geology and landuse, that control landslide hazard;
- To delineate a landslide hazard zonation using Geographic Information System (GIS) technique;
- To produce a landslide risk map of the study area considering the settlement of people in different zones of the landslide hazard zonation map.

1.4 Usefulness of the Research

The research aims at establishing a landslide hazard zonation and risk map of the study area. The zonation of landslide hazard and risk of the area will be useful for landslide mitigation strategy and provide planners and decision-makers with adequate and understandable information. Based on risk assessment map, a management programme can be planned to avoid a possible risk to the human population, land and property including engineering structures. Areas with high and very high risk should be assigned top priority for remedial/control measures. Immediate short-term measures such as grading of slopes, proper drainage, retaining walls may be identified and implemented. Moreover, the long-term measures such as biotechnical stabilization, maintenance of existing drainages, provision of subsurface drainages, anchors and additional catch water drains may also be planned.

1.5 Scope and Limitations of the Study

The scope of the research is to study and prepare landslide hazard and risk map of the Doi Suthep-Pui area in Chiang Mai Province, northern Thailand by integrating landslide causing factors namely slope, stream proximity, geology, and landuse using GIS.

Two factors, preconditioning and triggering factors, influence the occurrences of landslides in the area. In undertaking landslide risk assessment with an objective to delineate areas into different hazard and risk potentials, it is important to integrate all landslide contributing factors. The preconditioned factors, generally naturally induced, which govern the stability conditions of slopes area are only considered in this study. Among the several preconditioning factor that exist in nature, the present study included only few factors namely geology, land use, slope and stream proximity. Landslide triggering factors such as rainfall, earthquake etc. are not included in this study. Despite being one of the most important triggering factors causing soil water saturation and pore-water pressure to increase leading to landsliding (Clerici *et al*., 2002), rainfall was not included in the present study.

1.6 Study Area

The study area is located to the west of Chiang Mai city in Chiang Mai Province, northern Thailand covering an area over 700 km^2 (Figure 1.1). The study area is in the Universal Transverse Mercator (UTM) zone number 47 and between latitude 18° 45′ to 19° 00′ North and longitude 98° 45′ to 99° 00′ East. The study area covers six districts (Amphoe) namely Samoeng, Mae Rim, San Sai, Hang Dong, Muang Chiang Mai and Mae Wang. The study area has two main mountains Doi Suthep and Doi Pui, which is a North-South aligned mountain rising from about 350 m to 1610 m (Doi Suthep) and 1685 m (Doi Pui). The area has different ranges of elevation and slope with rugged and dissected landscape making the area vulnerable to landslides. These have been coupled with frequent heavy precipitation and accelerating human impact to produce frequent landslide problems.

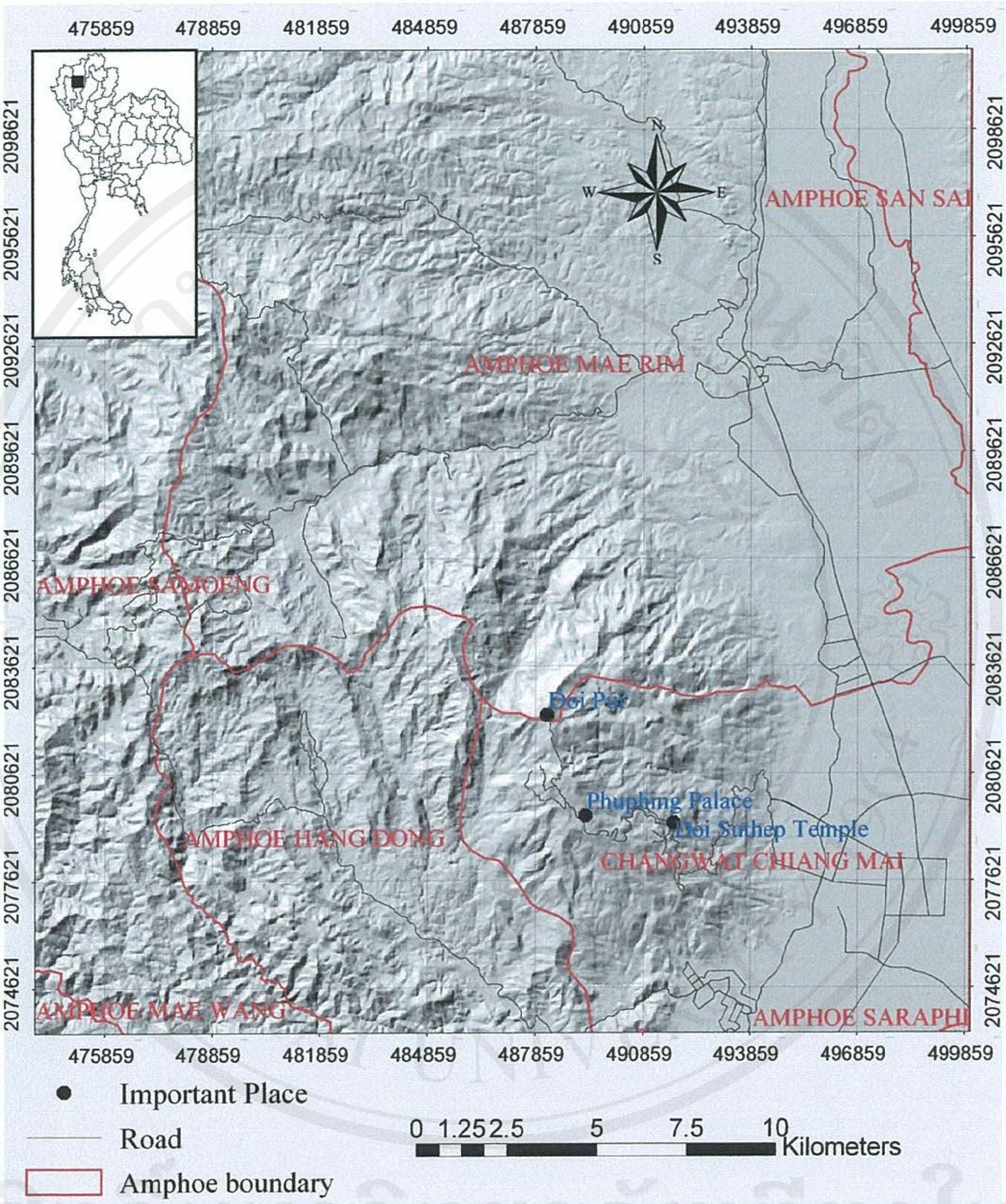

Figure 1.1 Shaded relief map showing the location of the study area.

1.7 Climate of Chiang Mai Area

Climate of Chiang Mai and Northern Thailand in general is characterized by seasonal monsoon. The southwest monsoon usually arrives from India at the end of May and lasts until November. The annual rainfall in Chiang Mai city, i.e. at the base of Doi Suthep-Pui Mountain, for the last 19 years ranges from around 700 mm to more than 1600 mm with an annual mean rainfall of 1147 mm (Figure 1.2). The average monthly rainfall ranges from 5 mm in the driest month to about 250 mm in the wettest month (Figure 1.3). Most of the downpour occurs between June and October; and the wettest month is August. The northeast monsoon lasts from mid-November until early May and brings cool air from northern Vietnam/China but no rain for Northern and Central Thailand except for the occasional showers.

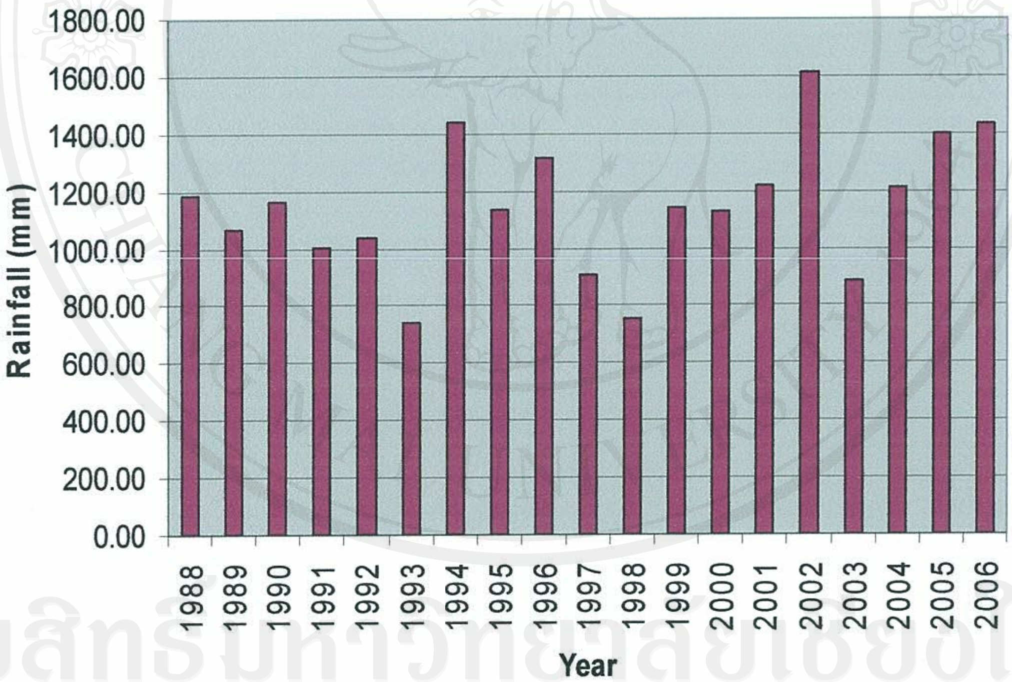

Figure 1.2 Rainfall pattern for Chiang Mai in the past 19 years, 1988 - 2006 (Data from Thai Meteorological Department)

This provides northern Thailand a dry season of about six months every year. From March to May, heat is on the agenda and maximum daytime temperatures reach 40°C (Figure 1.3). Still, at night it mostly cools down, morning can be quite pleasant, and evening is balmy. Throughout the year, the air is less humid than in other parts of the country. Low humidity is the main reason why the air seems more pleasant. Moreover, the temperature difference between day and night and between the seasons is greater than in the other regions.

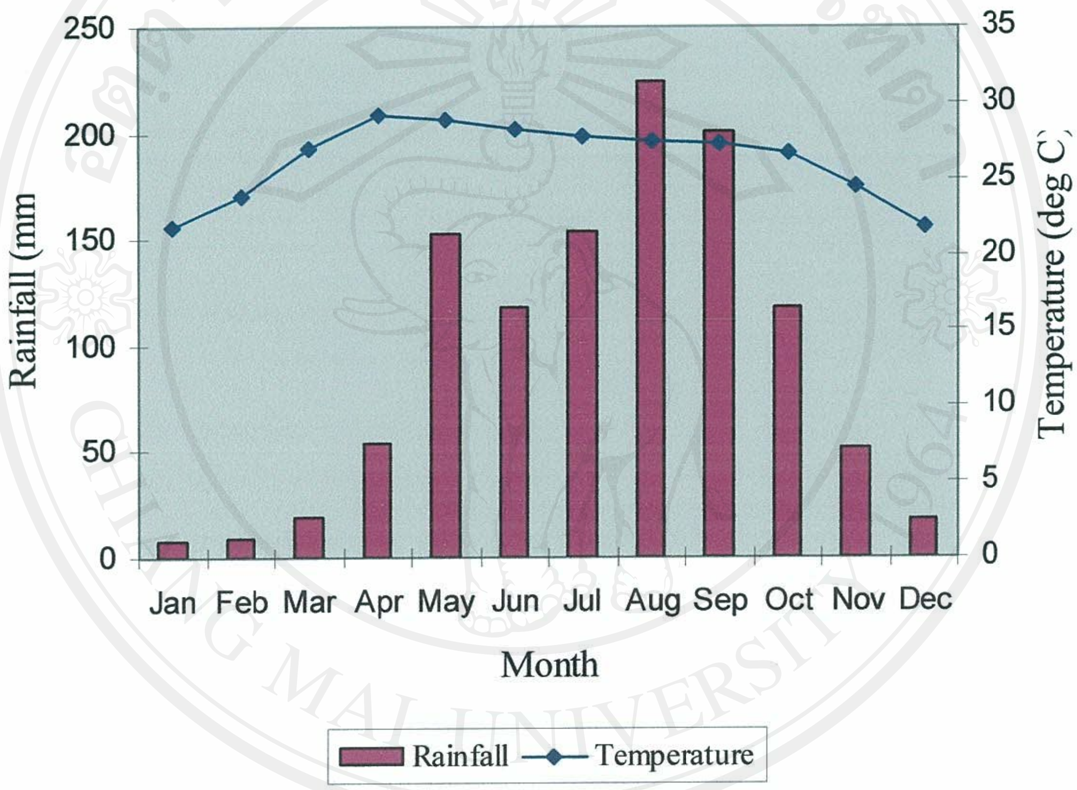

Figure: 1.3 Average monthly temperature and rainfall of Chiang Mai (after, Thai Meteorological Department)

1.8 Geological Setting of Northern Thailand

The rocks of northern Thailand can be divided into four categories including Precambrian rocks, Paleozoic rocks, Mesozoic rocks, and Cenozoic rocks/sediments. Precambrian rocks, characterized by gneiss and associated high-grade metamorphic rocks, are normally exposed along high mountain ranges extending from north to south in the west from Chiang Mai, Lampang, to Tak via Doi Inthanon, Doi Pui, Doi Suthep, and Lan Sang and extending to Kanchanaburi (Uttamo, 2000; Silaratana, 2005). Figure 1.4 shows the geologic map of northern Thailand.

Silaratana (2005) and Uttamo (2000) subdivide Paleozoic rocks in northern Thailand into three series, Lower Paleozoic, Middle Paleozoic, and Upper Paleozoic rocks.

Lower Paleozoic rocks include Cambrian and Ordovician rocks distributed in the western part of northern Thailand. The Cambrian rocks are quartzite, sandstone and shale. The Ordovician rocks are argillaceous limestone, limestone, dolomitic limestone, and shale.

Middle Paleozoic rocks include Silurian-Devonian rocks consisting of phyllite, carbonaceous phyllite, and quartzite normally distributed from north to south in the central part of northern Thailand from Chiang Rai via Chiang Mai to Lampang.

Upper Paleozoic rocks of Carboniferous-Permian age include conglomerate, sandstone, shale, chert, and limestone.

Mesozoic rocks in northern Thailand are lithologically divided into two facies, marine and younger continental facies. The marine facies comprise the Triassic Lampang Group, the Upper Triassic to Jurassic Mae Moei Group, the Triassic Nam Pat Formation, and the Jurassic Huai Pong, Hua Fai, and upper Umphang Groups. The continental facies are characterized by red bed sandstone, siltstone, mudstone, with conglomerate, relatable to the red bed Khorat Group in the Khorat Plateau. Triassic igneous rocks including migmatite and granite are widely distributed throughout northern Thailand.

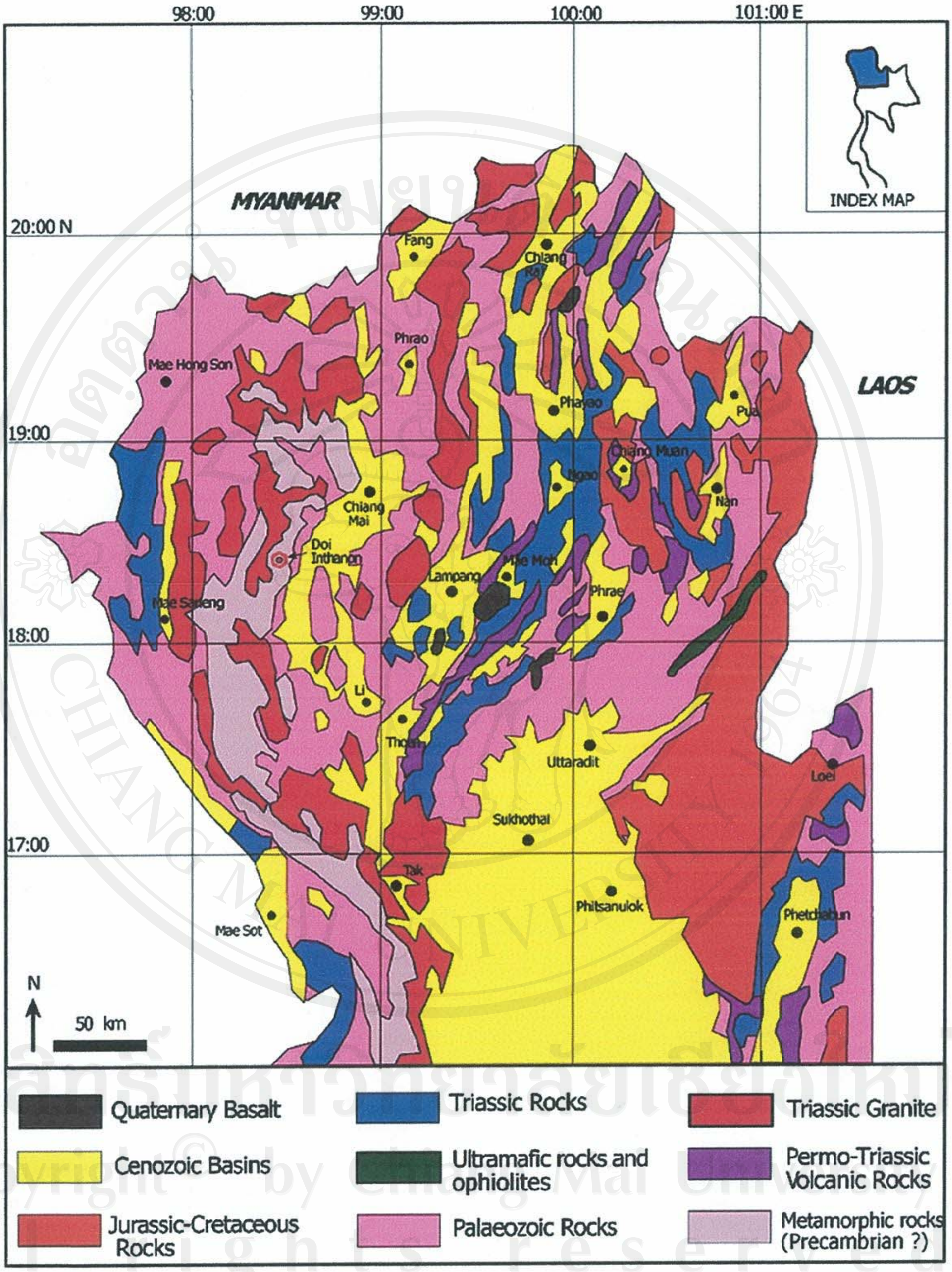

Figure 1.4 Geologic map of northern Thailand showing the age series of rocks (modified after Uttamo, 2000)

Cenozoic sediments occur mainly in the intermontane basins in the lowland. Several small basins are also found on the high mountains. The basins are characterized by graben and half-graben structures. The basin-fills are composed of Tertiary and Quaternary deposits. Tertiary strata are unconformably covered by younger Quaternary deposits. Some Tertiary rocks are naturally exposed along the basin margins, as well as along streams. The Tertiary deposits are characterized by semi-consolidated sediments consisting of mudstone, siltstone, sandstone, conglomerate, oil shale, coal, and diatomite together with fossil fauna and flora. Quaternary sediments include unconsolidated clay, silt, sand, and gravel of mainly fluviatile in origin.