CHAPTER I
INTRODUCTION

1.1 Preamble

Chiang Mai intermontane basin is the biggest Cenozoic structural basin in the Northern Thailand. The vast plain area of the basin is covered by two provinces, Chiang Mai province and Lamphun province, including the large municipal areas of the two capital cities of the provinces. The population of Chiang Mai and Lamphun provinces are 1,432,270 and 388,717, respectively, (Department of Provincial Administration, Thailand, 2006). Owing to the rapid increase of the population and the expansion of the municipal areas, especially in the Chiang Mai City, the needs for water resources are rapidly rising. The ever increasing demand of water supply is inevitable, so is the wise and efficient exploitation of groundwater resource. In order to optimize the exploitation of the groundwater resource to its full potential, we need to thoroughly understand the groundwater system including recharge and discharge areas, flow rates, and other relevant parameters, etc. In addition, the Chiang Mai Basin is selected for this research because this basin covers suitably aerial size with only a few outlets and it has monitoring wells covering throughout the basin.

1.2 Rationale

Groundwater recharge is an important parameter in evaluating water resources. Recharge rate is required for groundwater evaluation, especially for modeling. There are a few studies on groundwater recharge in the Chiang Mai Basin (Fongsaward Suvagondha, 1979; Fongsaward Suvagondha and Santichai Jitapunkul, 1982; Teerawash Intrasuta, 1983; Pisanu Wongpornchai, 1990; Tinnakorn Tatong, 2000; Sirirat Uppasit, 2004). A wide variety of techniques are available for quantifying rates of groundwater recharge, such as water budgeting, direct measurement, tracer techniques, isotope dating, chloride mass balance (CMB), hydrograph analysis, Darcian approach, water table fluctuation (WTF) and numerical modeling. Each method has its own advantages and limited accuracy. It depends on field constraints and availability of field data. This study uses a unique approach requiring the specific set of knowledge of groundwater temperature for estimating vertical groundwater velocity. In the study, the groundwater recharge and discharge are evaluated at each selected monitoring well, and the vertical groundwater flow velocity (i.e., discharge or recharge rate) can be calculated from temperature-depth profile for each selected hydrogeological unit in the monitoring wells. Finally, the results from the study will help determine the overall precipitation-derived replenishment of the Quaternary aquifers in the Chiang Mai Basin, Northern Thailand.

1.3 Location of the study area

The Chiang Mai Basin, shown in Figure 1.1, is located in the northern part of Thailand, between latitudes 18°30′ N and 19°00′ N and longtitudes 98°45′ E and 99°15′ E. The study area covers about 2,771 square kilometers. The Chiang Mai and Lumphun municipality areas are located within this basin.

1.4 Objectives

The purposes of this study are listed as follows;

1) to review and study hydrogeological setting of the Chiang Mai Basin,

2) to collect and use groundwater temperature data for the determination of recharge and discharge areas and its respective vertical flow velocity in the Chiang Mai Basin, and

3) to find relationship among groundwater temperature, vertical groundwater flow velocities and hydrogeology of the Chiang Mai Basin.

1.5 Scope of Study

This research is limited to study on groundwater temperature data to identify the discharge or recharge areas and the vertical flow velocity from monitoring wells covering the entire basin. The scopes of study are listed as follows;

1) Compile of geological and hydrogeological data in the study area. The monitoring wells were selected based on the following criteria: spatially distributed

throughout the study area, various depths, not equipped with pumps, screened through different geologic formations, good accessibility, and geologic log or driller's log on record.

2) Select the wells which lithology and electrical logs are available.

3) Use heat transport equation to solve the relevant parameters i.e., vertical flow direction and vertical flow velocity. This study will use the computational tool i.e., Microsoft Excel Solver for calculation numerical solutions to the heat transport equation.

4) Find the relationship of thermal gradient with hydrogeology by using temperature-depth profile, vertical flow direction, and vertical flow velocities.

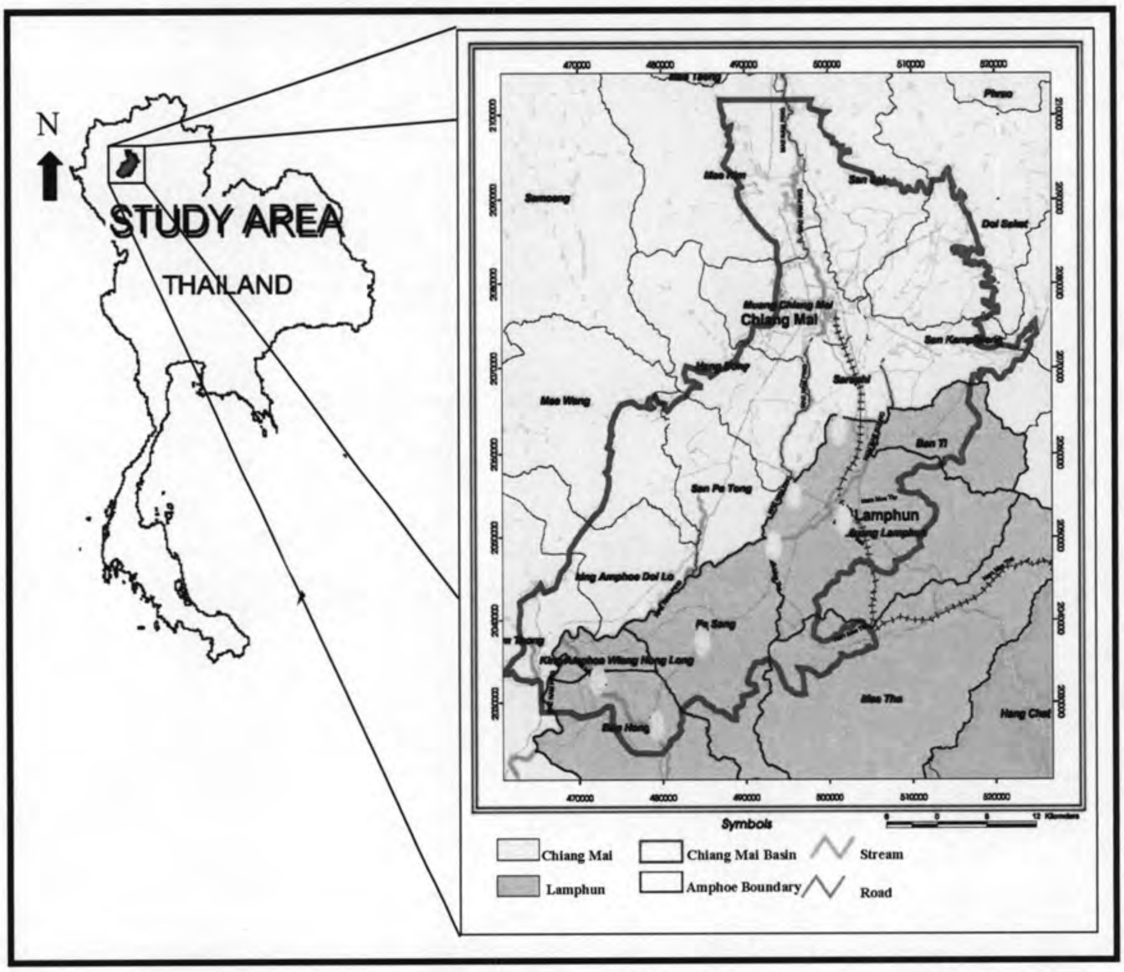

Figure 1.1 Index map of the study area.

1.6 Method of study

The method of study can be briefly illustrated in a flow chart shown in Figure 1.2. The first part of the research was the literature review. The first review was on the hydrogeology overview of the Chiang Mai Basin in order to understand the groundwater system and develop plan for the subsequent field investigation. The Department of Groundwater Resources (DGR) provided information about the existing wells in Chiang Mai basin. This includes previous records of observation wells such as site description, accessibility, depth of well, type of pump installation, lithologic logs, aquifer depth, water level, and water quality. The details of the hydrogeology of Chiang Mai basin are presented in Chapter II. The second review was on the previous hydrogeological studies in the area. The third review was on the theoretical review on groundwater temperature techniques and respective applications including heat transport and mathematical modeling to develop the flow velocity equations. The details on theoretical background and mathematical modeling are referred in Chapter III.

The second part of the research was the field investigation, data acquisition, and evaluation. Data derived from monitoring wells distributed in the basin were selected for the study. The groundwater temperature data derived from these wells were systematically collected and evaluated. Chapter IV includes all the details of data collection and evaluation.

The third part of the study was the evaluation and presentation of the results. After collecting groundwater temperature data from the fieldwork, the next process was to apply the theory of heat transport to identify whether each of selected hydrogeological units in those wells was a recharge or discharge or not a well defined zone. Subsequently, vertical flow velocities were calculated and identify direction of vertical movement in relation to hydrogeology of the area. This part also includes discussion on the relationship among groundwater temperature, vertical groundwater flow velocity, and hydrogeology of the Chiang Mai Basin. The details of this part are referred in Chapter V. Finally, the conclusions and recommendation for future study are summarized in Chapter VI.

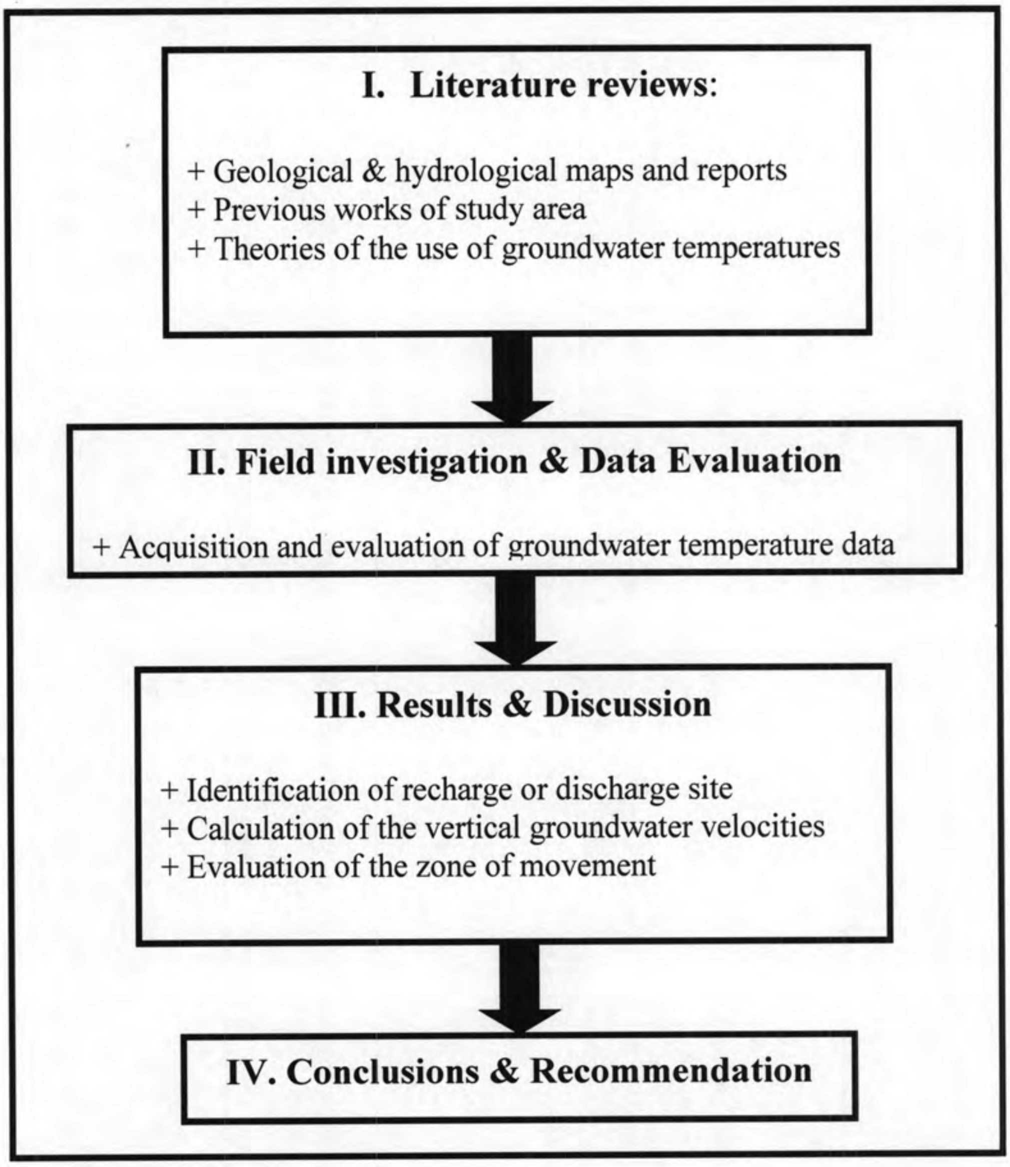

Figure 1.2 Flow chart of methodology.