CHAPTER 1

INTRODUCTION

1.1 Background

Rainwater is one of significant water sources in Thailand due to its abundance. It has been widely used in various sectors in society especially household and agriculture. Being dominated by monsoon, rainwater can be harvested mainly in rainy season which generally starts in June and lasts until October in most parts of the country with average rainfall per annum at 1,500-1,600 mm (Phayomjamsri, 2008). Figure 1-1 presents mean annual rainfall from 1971 to 2000 in Thailand by region. Rainwater utilization has been evidenced for more than 2,000 years in the country (Prempridi, 1982). Runoff from rock and ground catchment systems are mainly used for livestock consumption, nurseries and small scale irrigation while rainwater harvested from rooftop at household is popular for domestic use including drinking and cooking (Visvanathan, 2006).

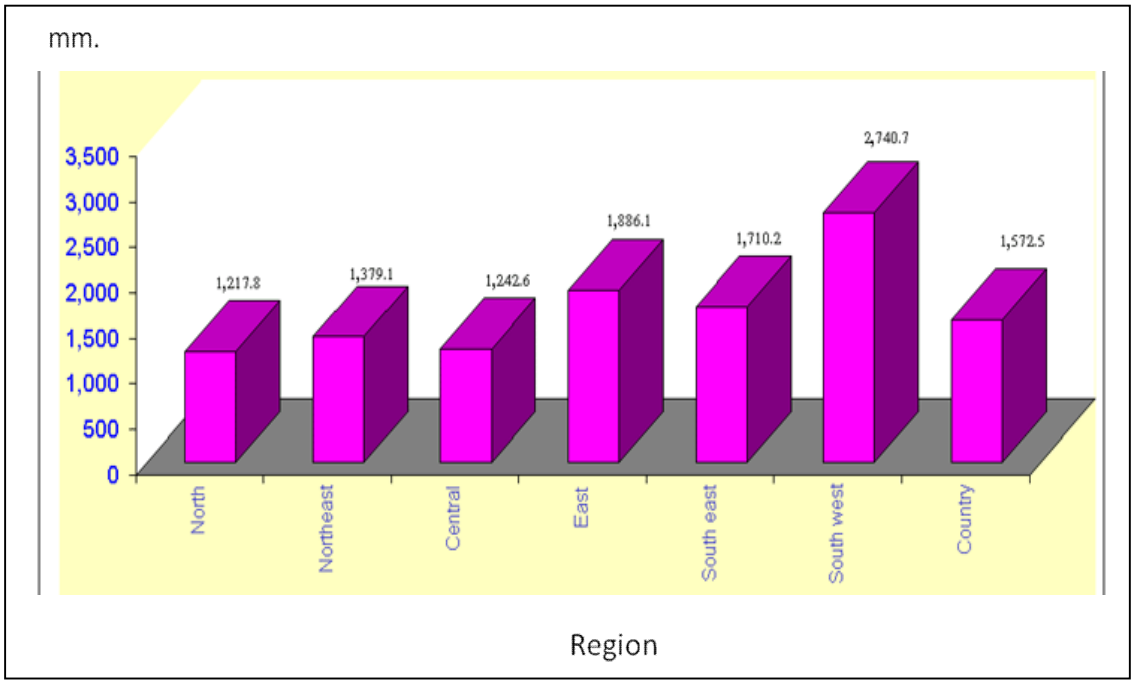

Figure 1-1: Mean Annual Rainfall in Thailand from 1971-2000
Source: www.tmd.go.th

Given the progress of country development, access to basic infrastructure has been considerably increased particularly piped water supply systems serving domestic sectors. In 2002, 95% of Thailand's urban populace accessed to water supply but only 82% had the same

access in rural areas (ADB, 2005). It should be noted that only a small proportion of rural population has access to piped water, which means they must rely on rain water and improved water storage. However in recent years, Thai Government had set a target to provide piped water supply to all villages by the years 2008. As a result, based on a survey conducted in 2005, approximate 85% of the villages were provided with village water supply systems (UN-Water, 2006). Several surveys demonstrate that piped water in Bangkok meets official quality standards but those living in rural areas have slightly lower quality drinking water. This can explain why 50% of rural dwellers selected drinking bottled water whereas only 17.5% of urban dwellers drank piped water based on a survey conducted by the National Statistical Office in 2000. Being popular in inferiority to bottled water, the same survey shows that both urban and rural residents still used rainwater for drinking at the proportion of 25.7 and 16.7 % respectively (NESDB, 2004). Although residents in many areas of Thailand particularly those who live remotely are still using rainwater, they are doubtful in its quality nowadays due to being contaminated from polluted environment. A combination of the increase access to piped water supply, availability and coverage of bottled water in the market and concerns in rainwater quality has made a decline in rainwater utilization.

Demands of rainwater harvesting in central part of the country are actually not as high as other regions for example northeast which is relatively dry and alternative water supplies such as rivers and groundwater are of poor quality. However given current water problems in terms of quality and quantity, seeking alternative water sources like rainwater is becoming essential. In addition water pricing tends to be a future concern of Thai residents as government authorities in charge of water supply may increase water tariffs which are now set at low rates and do not reasonably reflect actual costs. Therefore harvesting rainwater is not only an alternative way of coping with water scarcity but also can help users particularly in household sector to save expenses paid for water bills.

Among other provinces located in Chao Phraya River Basin in the central region, Ayutthaya is one of top ranks, apart from Bangkok Metropolitan Region[1], in water demands which are predominately used in paddy and crop farmings as well as in industrial sector. Mainly water supply in this province comes from two sources namely surface and ground water. Although potential of harvesting rainwater is likely as the length of rainy season is last up to 6 months

[1] Bangkok Metropolitan Region consists of 6 provinces which are Nonthaburi, Pathumthanee, Nakornpathom, Samutprakarn, Samutsakorn and Bangkok.

which the average precipitation is accounted for 300 mm. with a potential to increase to the maximum level of 900 mm., common practices of rainwater utilization are rarely found at present. Similar to other provinces in Thailand, cement and earthern jars were used to be containers for collecting and storing rainwater in Ayutthaya in the past but they were abandoned when the local residents were able to access to piped water and bottled drinking water. Considering circumstances of high growth in water demands, shortage in water supply, increase of water tariffs, sufficient levels of rainfall and availability of the rainwater storage devices, undertaking a pilot project in the province like Ayutthaya which can reflect the situation in central part of Thailand in promoting rainwater harvesting may be an effective way to demonstrate how to combine current technologies with existing resources and materials under cost-effectiveness manner to resolve water crisis in the years to come.

In general, lack of stakeholder involvement and assessment of user needs at the beginning often leads to failure of project implementation. For water supply projects, past experience shows that communities will only maintain and pay for water supplies when they feel are an improvement of existing systems and consider are worth spending their limited resource on (IRC, 1991). Hence, this study gives priority to demand-base approach in investigating user needs to ensure sustainability after the designed harvesting devices are installed. The identified needs of users in the study area would then be incoperated in considering the design of pilot project for rainwater harvesting.

1.2 Research Objectives

With the foregoing background, the main objective of this study is to design rainwater harvesting systems which correspond to demands of users in small urban communities. Bangsaiy Municipality in Ayuthaya province was selected as a case study. To achieve the main objective, three sub-objectives are elaborated as follows:

(1) To evaluate potential of using rainwater as an alternative water source in small urban communities;

(2) To assess user demands in rainwater utilization;

(3) To explore levels of service of rainwater utilization being suitable to small urban communities; and

(4) To design a pilot project of rainwater harvesting and utilization systems which correspond to the user demands.

1.3 Rationale of the Study

In developing countries located in monsoon areas like Thailand where rainwater is currently of no value for urban dwellers due to easily access to piped water supply at each household, studies in rainwater harvesting for domestic use are of low interest. However it is needed to undertake research to find out appropriate rainwater harvesting systems particularly for small urban communities that are recently developed from a full rural structure to urban context. As a matter of fact, in such transitional period, relying on only common water resources is risky. This is due to some challenges including i) provisions of water supply to those communities are not able to be reached to majority of the populations, ii) quality of the services is still poor, iii) current water resources becomes degraded as a result of urban acitivities as well as contamination of hazardous substances used in agriculture, and iv) water tariffs are at an increasing pace. Given that most residents of such urban communities are familiar with rainwater utilization for generations and devices to harvest and store rainwater are available, therefore, integration of rainwater utilization into the existing water supply systems is definitely beneficial to them.

Many studies on rainwater harvesting are focused on issues related to technology particularly research conducted in developed countries. In addition, choosing technology for water supply services in most cases is based on conditions and limitations of supply side rather than considering user demands. It is widely recongnized that projects or studies about water supply which apply principles of demand based approach are likely to be more acceptable and effective. This study, thus, initially approaches water users to identify their demands before steping further to take such considerations in desiging a pilot project of rainwater harvesting which reasonably meets user needs and also fills gaps of exiting water supply services.

1.4 Scope and Limitations of the Study

In Thailand, a large proportion of rainwater is used for agricultural purposes. However the focus of this study is limited to domestic use of rainwater in small urban communities. In line with the size of the urban community studied, designing a pilot project of rainwater harvesting systems would be at small scale under the context of simple structure of involved institutions and stakeholders. With some specific economic settings, land use patterns, and historical and cultural context that dominate perceptions of water users in the study area, the level of service in this study may certainly be different from megacities or cities located in

industrial zones. Thus applying findings of this study to large and complex municipalities must be done with precautions.

Although there is a wide rage of users in the study area, scope of the study is limited to household users and those who provide public services such as temples, schools, village offices, and health stations. Users in business and industrial sectors were excluded because their shares in water use are realtively small compared to household sector.

1.5 Research Methodology

1.5.1 Research Framework

Based on the main objective of this study set up, desigining a pilot project for rainwater harvesting is based predominately on user demands. Since the current water supply services would be related to user demands in alternative water sources like rainwater, identifying gaps of the existing services must be considered thoroughly together with identifying the demands in rainwater harvesting. In general water users, according to literature review, expect to have services in which quality is high or at least meets standards, quantity is sufficient, costs are reasonable, levels of service are convenient, and operation and maintenance of water supply devices, if it must be undertaken by the users, have to be manageable. Hence all these aspects would be investigated both for the current water supply services and rainwater harvesting systems being piloted.

Apart from user demands in rainwater harvesting systems and current gaps in water supply services, characteristics, potential and capacity of users, service providers and other stakeholders in the study area must be determined. As stated earlier, main users this study would focus on include households and public institutions such as temples, schools, government offices, and health stations. All findings from user demandas and background of users, service providers and key stakeholders would then be used to select appropriate pilot project for rainwater harvesting systems based on considerations and criteria of the design. Given that a rainwater harvesting system consists of three basic elements; a collection area, a conveyance system, and storge facilities, the design must be made in all elements accordingly. Figure 1-2 shows the research framework of this study.

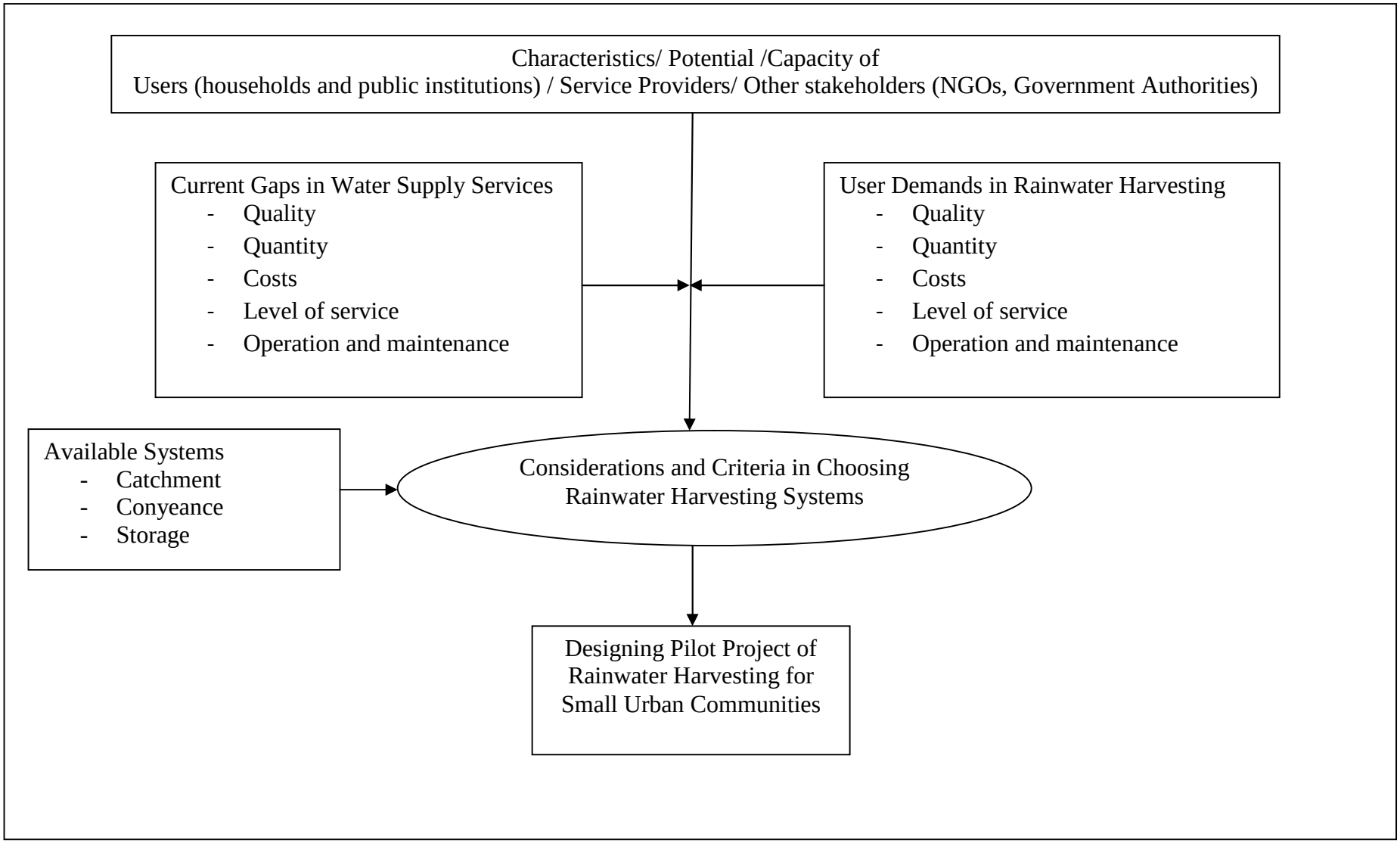

Figure 1-2: Research Framwork

1.5.2 Approaches and Activities

To achieve the objectives, several approaches have beeen used. Critical dataset were collected from various data sources with a range of data collection techniques as elaborated in a matrix shown in Appendix I-A. The data collection-techniques used in this study include survey with designed questionnaires, interview, review secondarty data, focus group discussion and field observation. Secondary data was obtained mainly from local government in the study area as it is a service provider of water supply. At first, collection of secondary data and interview of key officials of relevant departments of the local government would be conducted. After obtaining overview of water supply and rainwater utilization in the study area, such data was subsequently used as a raw material in combination with literature review to design a questionaire. While questionnaire survey was conducting, field observation was undertaken along. Results from the survey and field onservation were preliminary interpreated and summarized and then informed key stakeholders to receive their feedback and comments when the focus group discussion was oraganized.

In some datasets for example an average volume of water used monthly can be obtained from more than one source for the purpose of cross-checking. For example, quantitative water demands per household can be calculated from a number of family members per household in the study area. At the same time, the actual demand can be explored from the local government which has its duty to charge customers based on volumes of water gauged by the water meter. However, because the provision of water supply services of some villages is made by their village committee, it would be plausible to trace back such data only in the villages where water supply services are provided by the local government.

Selection of Study Area

The study area was selected based on the following criteria:

- Small and recently established urban municipality located in Ayutthaya province; and
- To some extent, having potential in rainwater utilization such as having sufficient rainfall, using rainwater in the past, having been put in place rainwater collection and storage devices.

Based on the criteria above, Bangsaiy municipality was selected as the study area. It is located in Bangsaiy District where is situated in western part of Ayutthaya province with a

distance from the province's city center at 34 km. (Figure 1-3). Details of Bangsaiy Municipality and the study area are elaborated in Chapter 3 and 4 respectively.

Figure 1-3: Ayutthaya Province and Location of Study Area
Source: www. thailandmaps.net and www.gofridaytravel.com

Sampling Design

Questionaire survey is one of the main tools used to identify gaps of current water supply services and investigate user demands in rainwater utilization in household sector. Stratified random sampling is the technique applied to design how to sampling households interviewed. In Bangsaiy municipality, there are three sub-districts namely Taoloa, Kaewfah and Bangsaiy The number of households of each sub-district is shown in Table 1-1. 100 households in the study area were interviewed with the structured questionnaire. Out of 100 samples, the number of households surveyed in each sub-district is then divided to correspond proportionately to its number of households. The survey is designed to cover residents in every village located in Bangsaiy municipality. In addition it attempted to collect information from women as much as possible because they are more involved in house work which water is used for such activity.

Table 1-1: Number of Sample Sizes in Three Sub-districts of Bangsaiy Municipality

Sub-district	**Number of households**	**Number of Samples**
Taoloa	512	35
Kaewfah	545	35
Bangsaiy	495	30
Total	1,550*	100

Note: * There are 1,551 housholds in Bangsaiy Municipality in total. There is a household which is not classified in any of the three sub-districts.

User Demands Assessment and Design of Pilot Rainwater Harvesting Systems

User demands in rainwater utilization of household sector are assessed predominately by the questionnaire survey. The questionnaire is designed to cover four dimensions of the demands based on literature review including quantity, quality, costs, and levels of service (Appendix I-B). For the operation and maintenance of rainwater harvesting devices after installation, its demand is assessed by interviewing and field observation. Apart from household users, institutions located in the study area which provide public services to the society including two temples, two schools and a health station were selected to represent other key water users (Table 1-2). Interview and field observation are the technique applied to investigate their demands. The same questions in the questionnaire survey are also used in interviewing those key public institutions.

Table 1-2: Selected Users from Public Institutions

Institution	**Name**	**Remark**
Temple	Bangsaiy Nai	
	Bangsaiy Nok	
School	Wat Bangsaiy Nai	Primary school
	Bangsaiy Wittaya	Secondary school
Health station	Taolao	

Before concluding what user demands are in rainwater harvesting for this study area, focus group discussion is held to reconfirm results from the questionnaire survey and field observation. A leader of each village located in the municipality area, a representative from key public institutions interviewed, officials from municipality and responsible government agencies responsible for water and sanitation and other key stakeholders are invited to the focus group discussion (Table 1-3).

Table 1-3: Key Informants Invited to Focus Group Discussion

Sector	**Key Informant**	**Remark**
Houshold	Village leader	All leader from each village
Public Institution	Principal of the selected schools	Bansayi Nai School Bangsaiy Wittaya School
	Official of the selcted health station	Taolao health station
NGO	Chief of Ayutthaya Natural Resources and Environment Volunteers Network	
Local government	Official of Division of Environment and Public Health, Bangsaiy Municipality	
	Official of Division of Water Supply, Bangsaiy Municiplaity	
	Member of Municipal Council	
Government authority	Official of District Health	

Based on user demands assessed in the earlier steps, a pilot rainwater harvesting system is designed. Apart from technology being selected, other dimensions throughtout construction, installation and operation phases have to be considered. These include location, capacity, target users, cost and potential sources of financial assistance and critical success factors. Mainly the design must cover three elements of the rainwater harvesting system which are catchment, conveyance and storage. However design of treatment systems can propably be added if findings from assessment of user demands show that potable water is needed and the residents are not currently satisfy quality of rainwater.