CHAPTER 5

PRELIMINARY DEVELOPMENT OF RAINWATER HARVESTING IN BANGSAYI MUNICIPALITY

The development of rainwater harvesting in Ayutthaya could be adopted by assessing the value of rainwater harvesting systems. In this area, with reliable municipal water supply for use within commercial developments to supply or augment potable water used in toilet flushing and landscape irrigation. Given the low tariff of water supply (4 to 5 THB per cu.m.), almost end users are satisfied. However, there are some water quality issues which should be concerned such as turbidity, water flow, and contamination of dust as aforementioned in Chapter 4. To develop sizing approach for rainwater harvesting systems, the following water balance should be considered (Heather, 2007);

$$\text{Supply} \geq \text{Demand}$$

To develop the supply side of the equation, monthly rainfall and catchment area must be taken into consideration. For the demand side, it could be developed based on a certain context of study area such as socio-economic conditions and cost estimation. In the study area where water supply tariffs are relatively low compared to the costs of drinking water (at the average of 5 to 12 THB per litre), the highest potential to preliminarily develop rainwater harvesting in terms of demand could be for drinking water compared to other purposes. Based on the questionare survey and interviewing, more than 90% of water users are willing to use rainwater for drinking because of its good taste and the culture of people in this area but the quality of rainwater should be in acceptable level. However, at present, the local residents use rainwater for non-potable purposes such as gardening. Therefore, a pilot project could be set up and applied based on the results in potable and non potable uses. For drinking water purpose, it is necessary to have a treatment system to meet the WHO standards. For non-potable purposes which can be used for toilet flushing, gardening or cleaning, such treatment processes are not much concerned. However it should meet the user demands. From findings of users demand for the household sector, the quantitative demands are at an approximation of 30 to 50 cu.m. per month. For public institutions, quantitative demands of the selected schools are highest compared to other institutions at 100 cu.m. per month.

5.1 Criteria for Designing Appropiate Pilot Project

The main design criteria of rainwater harvesting can be classified as followings.

a) Materials

Roof materials should be avoided painting or using materials which contain lead. Lead based, bitumen- based (tar) coating and paints are not recommend, as they may leach hazardous substances.The lead level detected in the rainwater samples collected from Ayutthaya as stated previously in Section 2.2.2 shows that the cement roofs widely used in the country do not cause lead contamination in rainwater. Hence in the study area, the cement based without coating is suitable for collecting rainwater.

A wide range of materials is made of rainwater tanks and jars such as plastic, ferrocement, stainless steel, and polyethylene. All kind of tanks should be cleaned periodically.

Gutters and pipes can be divided into main two types which are metal and plastic. Material recommended for pipe is polyethylene because metal may contain lead and hazardous substances.

b) Taste and odor

The taste and odor of rainwater can be deteriorated by algae, dead animals, soil and decayed vegetation accumulated in the gutter and tank. Therefore, the tank and gutter must be cleaned and tank should be covered to protect mosquitoes and organic matters.

c) Disinfection methods

The disinfection can be made by chlorination, UV radiation, boiling, and filtration. The most common use in the study area is boiling. UV radiation can be used but the UV lamp has to be changed based on its life time. A water filter can be installed to enhance water quality. If filtration is selected, maintenance needs to be adequate. Filtration processes such as membrane, activated carbon, resin and reverse osmosis (RO) need to be maintained according to instructions recommended by manufacturers to avoid problems.

First flush devices can be additionally installed to reduce contaminants and keep the roof catchments clean.

e) Size of storage vessels

The size of storage vessels depend on:

- Volume of water needed;
- Volume and pattern of rainfall;

- Area of roof catchment; and
- Security of supply required.

Volume of water needed: The volume of water needed may vary from one area to another. Quantitative water demands depend on the number of people, average consumption per person, the ranges of use, the use of water conservation and devices.

Volume and pattern of rainfall: Commonly the information source of rainfall is Department of Meteorology. Additionally, it is important to consider yearly variation, seasonality of rainfall and the occurrence and length of dry periods.

Area of roof catchment: Roof areas must be calculated to estimate volumes of rainwater harvested. The flat or plane area should be determined. The slope and area of tiles or metal is not the main issue.The average catchment area for small, medium and large houses are aproximately 100 – 150, 150 – 200, and > 200 s.q.m respectively.

Security of supply required: In an area without main water supply, rainwater can be a valuable source of drinking water. The study by Conway (1999) examined rainwater harvesting in an arid location in Central Australia where the average rainfall is only 119 mm. per year. A house with a roof catchment area of 266 s.q.m. is able to collect 61.25 kL of water in a 27 kL tank and provide 168 L of water per day. In worst case of 40 years rainfall of 9.5 kL, rainwater could be collected to provide water supply of 26 L per day. The rainwater collected would not be sufficient for all purposes but it could provide drinking water. This could be particularly important in the areas where groundwater is too salinity and hard to treat as drinking water. In the area with plenty of water supply like Ayutthaya, rainwater can be used for non-potable and potable functions. The use of rainwater as an alternative source of water for any purposes has the potential to reduce pressure on the limited surface and ground water resources used to supply water to urban and rural communities.

One problem of designing size of rainwater tanks is space limitation. This problem in the study area can be resolved by installing rainwater tanks at a community centre where a large space is available.

5.2 Design of Pilot Project for Rainwater Harvesting Systems

Based on the survey of user demands, two scales of rainwater harvesting systems are appropriate to the context of Bangsaiy Municiplaity. One pilot system should serve household users and the other serves public institutions.

Capacity: The maximum volume of rainwater can be calculated by using the below equation.

Run off (litres) = A x (rainfall – B) x roof area (s.q.m.)

where

A = 80-85% collection efficiency (Martin, 1980)

B= the lost associated with absorption and wetting of surfaces a value of 2 mm permonth (24 mm per year) (Martin 1980)

The estimate tank size can be calculated by using following equation for each month;

$$V_t = V_{t-1} + (\text{ run off} - \text{Demand})$$

where

V_t = theoretical volume of water remaning in the tank at the end of the month

V_{t-1} = Volume of water left in the tank from the previous month

The volume of run off could be calculated by using 80-85% collection efficiency of using system in first flush**.**

5.2.1 Pilot 1

Technology: The simple treatment for developing countries is a practical treatment method which is inexpensive. Improvement of rainwater quality can be simply made by installing a first flush device which is cut off the first flush of rainwater event. It is easily to be installed, simple operated and available in a number of different sizes to suit to different requirments.

For disinfection, filtration with membranes, radiation with UV and chlorination can be applied. For drinking water, a filtration system with a low- pressure membrane of a pore size of 0.1 mm. can be effectively removed protozoa, bacteria, algae and other microorganisms. A membrane module can consist of a fine-meshed sieve with some 10,000 porous plastic fibers that forms a web within a cylindrical housing. A pump propels contaminated water from outside of the module through the membrane to the inside. Any particle exceeding 0.1 mm. - which includes all bacteria – literally gets stuck. However, the treated water may still be contaminated with some viruses. With a diameter less than 100 nm, viruses are small enough to slip through the pores. That is why a filtration device is therefore coupled with a disinfection system. The study by Areerachakul (2009) demonstrated that the combination of Granular Activated Carbon (GAC) – biofilter- and submerge membrane could be another option to treat the rainwater to meet the drinking water standard.

Therefore, the pilot project of rainwater harvesting system for potable use should compose of i) first slush device, ii) gutter, iii) pipes, iv) storage tanks and v) treatment systems. For the pilot project materials of harvesting systems could be available in various materials based on catchment size, rainfall daily, and cost of material.

Capacity: 5,000 gallons (150,000 litre)

Location: In this study, a possible site suitable for the pilot project is the household where water treatment systems for drinking water are put in place and its location is at the center of the community. This house which is a grocery currently provides drinking water for their relatives and sells bottled water. Additionally, its catchment area is large enough to serve for 3-4 households.

Cost estimation and financial assistance: Costs of a pilot project of rainwater harvesting system serving for a household without water treatment systems are estimated at less than 50,000 to 80,000 THB. Such system consists of below components.

Table 5-1: Components of a Pilot Project and its Cost Estimation Designed for Household Users

Components	**Cost (THB)**	**Specification**
Storage system		
A plastic tank	20,000 - 30,000	Volume of 1,500 to 2,000 gallons per tank
A pump	7,000 to 10,000	1/2 horsepower shallow-well at 20-30 psi
Screen covering the cistern	< 3,000	
Plastic pipes	Costs are varied depending on length and diameter	PVC for outdoor and CPVC for indoor
Conveyance system		
A roof-washer	Varied based on roof area but < 10,000	
Water diaphragm pressure storage tank	5,000	Volume of 20 gallons

Treatment system		
A series of filters	800 bahts each	Pore sizes at 20 and 5 microns
Replaceable filter cartridges	3,000	
An ultraviolet light	15,000	• Sterilizing capacity at 10 gallons per minute • 40 watts

Maintenance costs are approximately 5,000 THB per year which include costs of cleaning the gutters, cisterns and screen. Replacement of UV lamps and filters need to be done periodically. Cost of a fluorescent tube is about 3,500 THB.

Appendix III-A gives an example of detailed designing and cost estimation of a rainwater harvesting system with a 5,000 gallon of ferrocement vessel.
For the system without treatment process because of existing treatment sytem, the cost could less than 100, 000 bahts as shown in table 5.1.

Critical success factors: Public health authorities recommend periodic testing of water for faecal coliform bacteria to make users confident in rainwater quality.

5.2.2 Pilot 2

Technology:
The pilot 2 use similar technolgy with pilot 1. In this study, an estimate each tank size for is 1,500 gallons (30,000 litres). The total tank are 6 tanks, therefore the estimated total volume are 180,000 litre (based on existing tank inschool). The details of calculating tank size are shown in Appendix III-B.

Location: The possible effective site is at Wat Bangsai Nai School.
Costs and financial assistance: Six existing tanks will be selected to be renovated. If the tanks cannot be renovated, estmated cost of purchasing a new tank is about 30,000 to 50,000 THB. The existing filtration system can still be used by connecting it to the renovated rainwater harvesting system. However, the new treatment system may be installed to compare maintainance costs between using groundwater and rainwater. The cost of renovation and installing a new treatment system is about 150,000 to 200,000 THB. Only minor cost of piping system, and maintainance could be a bit higher comparing with pilot 1. However, with first flush device, and higher gravity pressure because of tank size, the cost to treat rain water

and pump is not significantly different comparing with pilot 1. The total cost would be 400,000 THB.

.***Critical success factors:***

The periodic water quality test and maintenance are recommended. The variable of annual rainfall may affect the capacity of rainwater harvesting system.