Promoting Rainwater Harvesting as an Alternative of Freshwater Source for Public Sanitation

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Abstract

This paper aims to analyze the effectiveness of rainwater harvesting facility, applied in the University of Lampung, in order to promote rainwater harvesting as an alternative of freshwater source for public sanitation in Indonesian regions. Simulation is undertaken in order to investigate the supporting capacity of rainwater harvesting facility toward sanitation freshwater supply in the area of study. 365 days of rainfall data of the normal hydrological year has been used to simulate the operational of the facility which consists of 65 m^2 rooftop catchment and 32 m^3 storages when supplying sanitation freshwater for about 600 people in the area. The simulation result showed that supporting capacity of rainwater harvesting facility is quite significant. By using rainwater harvesting facility, the taking of groundwater for sanitation water supply in the area can be reduced about 62%. The quality of rainwater stored also has good quality the application of nylon filter and activated carbon filter. Physically, there is no taste, color, and smell from the water. Result of the research indicated that the application of rainwater harvesting can be good alternative of freshwater source for public sanitation on other communal places such as schools, office areas, and business areas in Indonesia.

Keywords: Rainwater harvesting, Alternative, Freshwater source, Public sanitation

1. Introduction

Indonesia is a country with abundant of rainfall. Rainfall in Indonesia is quite high at more than 2000 mm/year. The average rainfall in Indonesia in average is 2000 - 3000 mm/year. Some areas received very low rainfall and other areas received heavy rainfall. Indonesian people use rainwater mainly for irrigation. In some areas, heavy rainfall often causes flood and cause substantial losses for the people.

Rain water is renewable natural resource. It has an important role as alternative water source in the future. Several studies have showed that rainwater harvesting can be promoted as an important water source for many communities in several countries (Abdulla and Al-Shareef, 2009). Application of rain harvesting is not new. In South Asian countries like India, Bangladesh and Sri Lanka, as well as in some African countries, rain water harvesting through the roof has been done since long ago. A study in Germany showed that the potential savings of the household water due to rainwater harvesting varies between 30% to 60% (Herrmann and Schmida, 1999). On the other hand, in New Castle Australia, rainwater harvesting can reduce the use of groundwater up to 60% (Coombes et al., 1999). In Brazil, one study showed that the use of rainwater harvesting could reduce groundwater use between 34% and 92%, with potential average of 69% (Ghizi et al., 2006).

In Indonesia, the application of rainwater harvesting is rarely done by people. Although Indonesia is rich of rain and the installation of rainwater harvesting through the roof can be carried out simply and inexpensively, rainwater harvesting has not been widely spread in Indonesia. In some dry and peatland areas in Indonesia, such as Riau and Central Java, the application of rain water harvesting is found. However, the design of installation is still simple and non technical design.

There are some things that cause the application of rainwater harvesting is not popular in Indonesia. It is:

- Most people do not realize the importance of rainwater as a source of fresh water
- Lack of knowledge and information to the public about rainwater harvesting
- People still feel confident will not experience water shortages in the future.

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On the other hand, the government's attention to the implementation of rainwater harvesting is still very low. As a consequence, the socialization of rainwater harvesting is still not widely undertaken.

There are several advantages expected from the implementation of rainwater harvesting, namely:

- Households can provide clean water independently, easy, and inexpensive
- Reduce the cost of electricity to pump water from wells
- Become an alternative water source for coastal and peatland areas
- Become a method for groundwater conservation
- Become a method for reducing flood discharge.

Previous study about rainwater harvesting suggested that the quality of rainwater in Indonesia, based on laboratory results for inorganic chemistry, physical, and chemical parameters, is still below the drinking water quality standards required by the Ministry of Health of the Republic of Indonesia (Anuar et al., 2015). Therefore the use of rainwater as a source of fresh water is directed to meeting the needs of water for sanitation.

One of good method to socialize rainwater harvesting application is by educating people using real example. This paper aims to present the effectiveness of operation of rainwater harvesting facility for sanitation water source in the Civil Engineering Department, the University of Lampung. The facility is the example of rainwater harvesting application for water sanitation in educational area in Lampung Province, Indonesia.

2. Study Location and the Facility

The study is located at Civil Engineering Department, the University of Lampung, Bandar Lampung City, Indonesia.

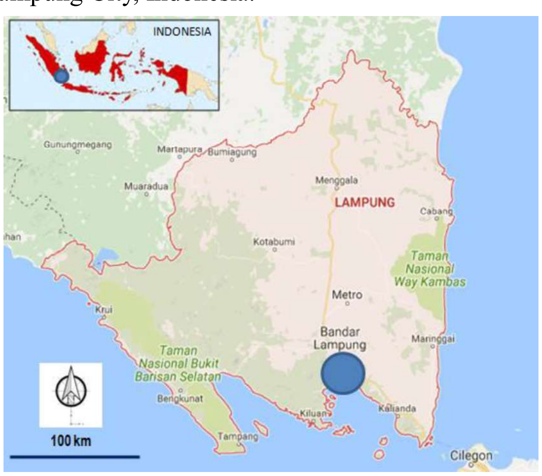

Fig.1. Location of the study

There are two ground tanks as rainwater harvesting facility developed in the area. Rainwater stored in the tanks is used to support sanitation facility in the department. Every ground tank serves for sanitation water supplier for about 600 people (students and staffs) for ordinary days, 200 people for Saturday and 10 people for Sunday.

Rainwater harvesting facility in this area consists of three components. They are:

- Rooftop as area for catching rainfall of about 65 m^2
- Gutter for collecting rainfall from the roof
- Conveying pipe with diameter of 6 inch
- Ground tank as rainwater storage with capacity of about 32 m^3
- Water pump
- Nylon filter with pores of 0.1 micron and activated carbon filter.
- Distribution pipe with diameter of 1.5 inch
- Overflow pipe.

Schematically, the system of rainwater harvesting facility in study area can be illustrated as follows:

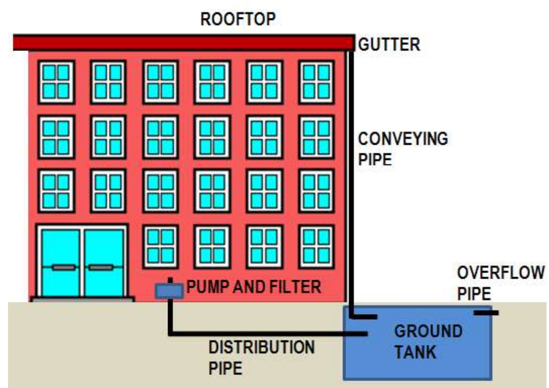

Fig.2. Schematic system of rainwater harvesting facility in study area

The photograph and dimension of the ground tank is presented in the appendix.

3. Effectiveness of the System

In order to test the effectiveness of the rainwater harvesting facility, water behavior in the ground tank is simulated. The simulation in this study is based on the philosophy of water balance models (Khastagir and Jayasuriya, 2010). The calculation is basically water balance in the storage simulation based on inflow and outflow (Kahinda et al., 2010). The equation is given as follows (Susilo et al., 2011):

$$S_t = S_{t-1} + I_t - O_t \quad for\ 0 < S_t < S_{max} \qquad (1)$$

where S_t is storage volume on day t (m^3), S_{t-1} is storage volume on day t -1 (m^3), I_t is total inflow on day t (m^3), O_t is total outflow on day t (m^3), and S_{max} is maximum storage capacity (m^3).

Total inflow for day t is calculated using the formula follows:

$$I_t = c.R_t.A.1000 \qquad (2)$$

where c is runoff coefficient for roofs which is assumed to be ranged of 0.8 – 1.0 (Fewkes, 1999), R_t is cummulative rainfall on day t (mm), and A is catchment or roof area (m^2).

Total outflow for day t (O_t) as a function of number of users in the building and water demand per person per day is calculated using formula as follows:

$$O_t = nD \qquad (3)$$

where n is number of users, and D is water demand per person per day, is assumed 5 l/day (Wulan, 2015).

4. Result and Discussions

Daily rainfall data of year 2012 is used for the simulation. The data is chosen with reason that year 2012 is normal year (not dry or wet year). The data was obtained from Mesuji – Sekampung River Management Organization (BBWS), Bandar Lampung with characteristics as follows:

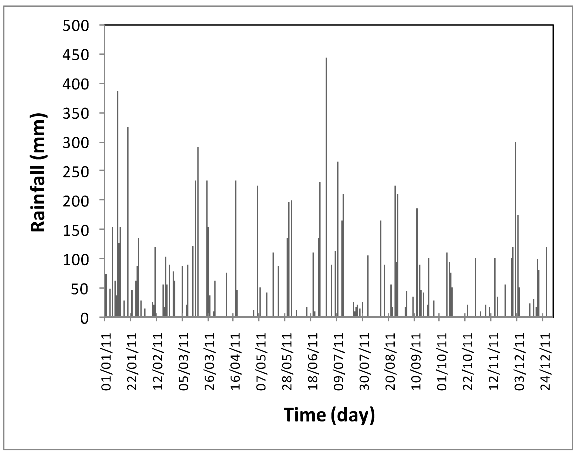

Fig.3. Rainfall data for simulation

Using the rainfall and other data, result of simulation is illustrated as the behavior of the water volume in the storage as follows:

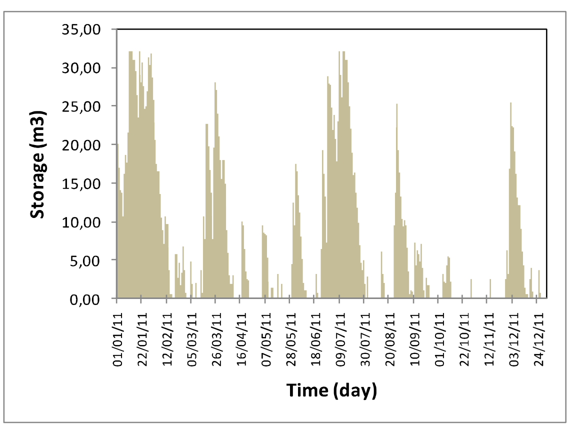

Fig.4. Result of simulation

The simulation stated that, with rainwater harvesting facility, the taking of groundwater for sanitation water supply can be reduced about 62%. This condition means that the application of rainwater harvesting facility can cover 225 days of 365 days of water sanitation demands in study area. For the other 140 days water sanitation demands in study area still have to be supported by groundwater. Supporting capacity of rainwater harvesting facility can fluctuate based on the condition of hydrological year. Previous research stated that the supporting capacity of rainwater harvesting can be dropped into only 20 – 30% if the year is influenced by strong El Nino.

The rainwater harvesting facility in the Civil Engineering Department, the University of Lampung, is still going on operation. Based on the research, rainwater stored also has good quality because the facility is completed by 0.1 micron nylon filter for catching micro debris and activated carbon filter for removing smell from the water. Physically, there is no taste, color, and smell from the water supplied by the facility. Based on this circumstance, the water is safe if used for sanitation water need in the department.

5. Conclusions

Applying rainwater harvesting as an alternative of freshwater source for public sanitation in Indonesian region is basically not a difficult task and promising good future for freshwater supply. Simulation result showed that in the normal year the facility of rainwater harvesting is able to reduce of groundwater uptake for about 62%. Saving of groundwater uptake for freshwater supply will be fluctuated in the dry or wet years. This research also showed that the application of rainwater harvesting can be good alternative of freshwater source for public sanitation on other communal places such as schools, office areas, and business areas in Indonesia.

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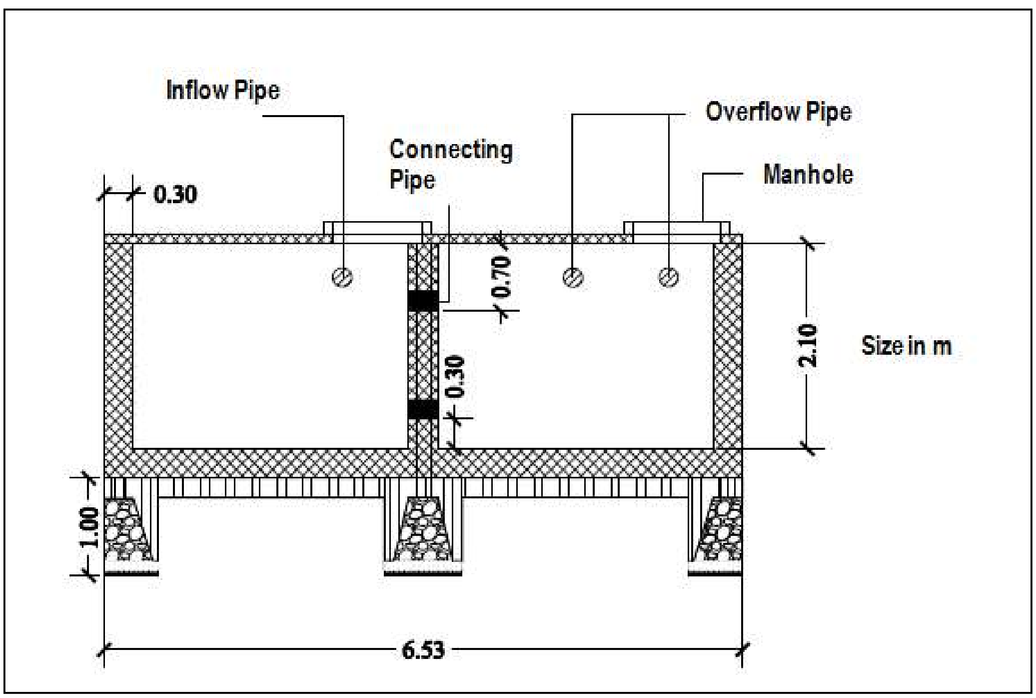
Appendix 1. Ground Tank in Water Harvesting Facility in the Area of Study



Appendix 2. Dimension of the Ground Tank