Utilization of rainwater harvesting installation to fulfil water needs in educational buildings

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Utilization of rainwater harvesting installation to fulfil water needs in educational buildings

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Abstract. The fulfillment of STT-PLN water needs to be supplied from ground water. This will be decreased soil and soil water discharge due to large quantities of consumption. Areas of Indonesia have a high rainfall, i.e. 2,000-4,000 mm/year, should not have to worry about the availability of clean water. The problem faced is that there is no adequate management of rainwater. Based on these problems, it is necessary to develop methods of managing rainwater, harvesting and utilizing rainwater to meet the needs of clean water and water conservation for the sustainability of the carrying capacity of the environment. By calculating using 15 years daily rainfall data and roofing area as a catchment area to obtain the volume of potential water. The aim of this research is to analyze the amount of rainwater volume that can be accommodated in the rainwater harvesting system and to be processed as a clean water consumption.

1. Introduction

Water is the main source of continuing human life. To fulfil in water supplied by a jet pump sourced from ground water. The process of pumping ground water continuously in large amounts will also damage the balance of ground water availability. For topographical conditions, the soil will also gradually decline and will endanger the building above. Another problem in the rainy season often occurs puddles due to drainage systems that cannot accommodate the intensity of high rainfall. The bad result is flooding in the rainy season. Therefore, it is necessary to plan the fulfilment of clean water through rainwater harvesting technology from the roofs of buildings. Rainwater harvesting planning is considered to be very important considering the increasing human awareness of the environment and the increasing application of the concept of green building as the effects of global warming are getting worse. According to the Minister of Environment regulation No. 12 of 2009 article 1 paragraph 1: Utilization of rainwater is a series of activities collecting, using and / or absorbing rainwater into the ground. Whereas Article 3 states, rainwater collection ponds are

ponds or containers used to collect rainwater that falls on the roof of buildings (houses, office buildings or industries) that are channelled through gutters.

2. Literature Review

2.1. Rainwater Harvesting

Rainwater harvesting (RWH) is a method or technology used to collect rainwater from building roofs, ground surfaces, roads or rocky hills and is used as a source of clean water supply (UNEP, 2001; Abdulla et al., 2009). Rainwater harvesting is a multipurpose way of supplying usable water to consumers during a crisis period, recharging the groundwater and finally reducing the runoff and water logging during the season of heavy rainfall. Traditional knowledge, skills, and materials can be used for this system. During the rainy season, an individual can collect water on his rooftop and manage it on his own. Reserved rainwater on rooftops can be used for self-purposes or domestic use (Sadia Rahman, 2014).

The oldest known rain harvest in Indonesian history is as a rainwater collector to obtain fresh water for daily life, especially for drinking. At first accommodated usual with improvised equipment. Then it is developed by harvesting from the roofs of the houses which are collected in reservoirs and used sparingly until the next rain comes. Such provision is commonly used in coastal areas and small islands, with surface water and brackish and salty ground water (Notodoharjo., 2006). In figure 1 shown Rainwater Harvesting system from the roof.

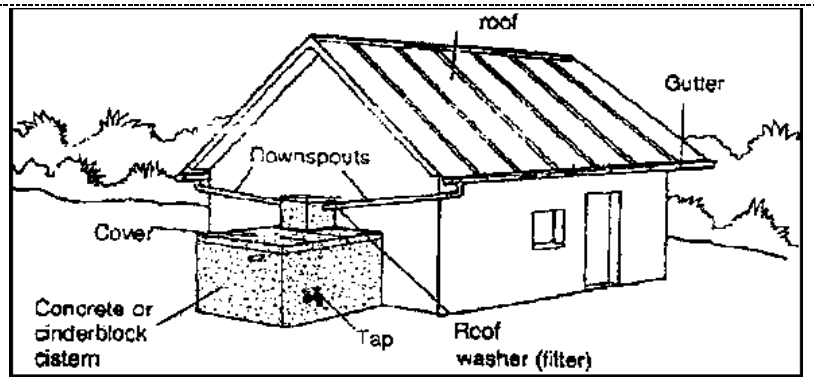

Figure 1. Rainwater harvesting system from roofing
(source: http://www.kelair.bppt.go.id)

2.2. Rainwater Harvesting Method

There are various techniques for applying rainwater harvesting that can be chosen according to local conditions. The way to harvest rain can be divided into two parts, the first is done by collecting rainwater on the roof of the building (roof catchment) and the second is done by collecting rainwater on the ground surface. PAHs can be built or placed above ground level (Figure 2) or under ground level (Figure 3) or under a building that is adjusted to the availability of land.

Figure 2. Rainwater harvesting under ground level (source: www.rainharvesting.com)

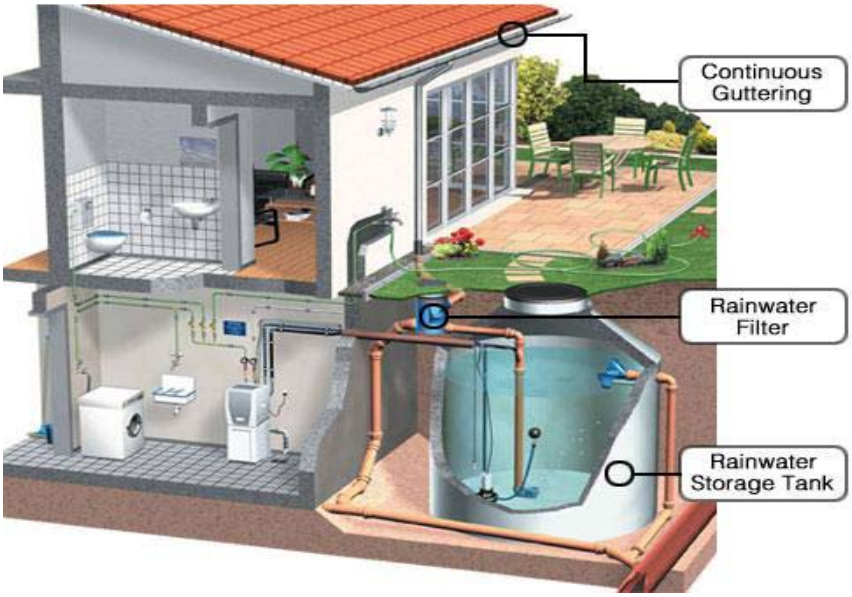

Figure 3. Rainwater harvesting under ground level (source: http://www.kelair.bppt.go.id)

2.3. Beneficial of Rainwater Harvesting

Rainwater harvesting is a simple and primary technique of collecting water from natural rainfall. The system is applicable for critical water crisis situation and normal situations. It is an environmentally friendly technique that includes efficient collection and storage that helps local people. The advantages of rainwater harvesting are:

- Runoff reduction, rainwater harvesting is one of Stormwater management system to reduce stormwater runoff from roof gutter not directly into the rivers body or city drainage;
- It can be used in case of an emergency (i.e., fire);
  it is solely cost effective as installation cost is low, and it can reduce expense that one has to pay for water bills;
- groundwater level is highly recharged during rainfall.

2.4 Quality of Rainwater Harvesting

The quality of harvested rainwater is an important issue, as it could be utilized for drinking purposes. The water quality of rainwater harvesting is very dependent on the characteristics of areas such as topography, weather conditions, type of rainwater catchment area, level of air pollution, type of holding tank and rainwater management According to Horn and Helmrich (2009), in suburban or suburban areas, most of the rainwater collected is very clean, but in any suburbs including industrial areas and dense transportation flows, rain air quality is very influential from exhaust gas emissions. In addition to industry and

transportation, the surface of rainwater catching material also affects the water quality. Laboratories test must be performed viability and applicability before using as drinking water.

3. Research Method

3.1. Research Location

The research was conducted at educational building in West Jakarta. The stages carried out in this study include a literature study that discusses research on the analysis of the application of rainwater harvesting at the building after that the determination of data needs is carried out.

One of many problems in urban area is the supply of raw water source but the ground water supply could not fulfil the demand of raw water supply. Extracting deep groundwater using pumping system in relatively large capacity cause disruption to availability and the balance of ground water. Therefore, need planning to carried out by implementing rainwater harvesting system in this area.

3.2. Data analysis

The rain data used with records from 14 years from January 2004 to December 2018. From the maximum rainfall data obtained a calculation of the average rainfall at this area is 95.13 mm. Table 1 is maximum rainfall in 14 years and figure 4 is chart of yearly precipitation amounts in research area.

Table 1. Maximum Rainfall Table.

Year	Rainfall (mm)
2004	87
2005	114
2006	57
2007	131
2008	54
2009	139
2010	75
2011	83
2012	54
2013	91
2014	105
2015	124
2016	120
2017	110
2018	83

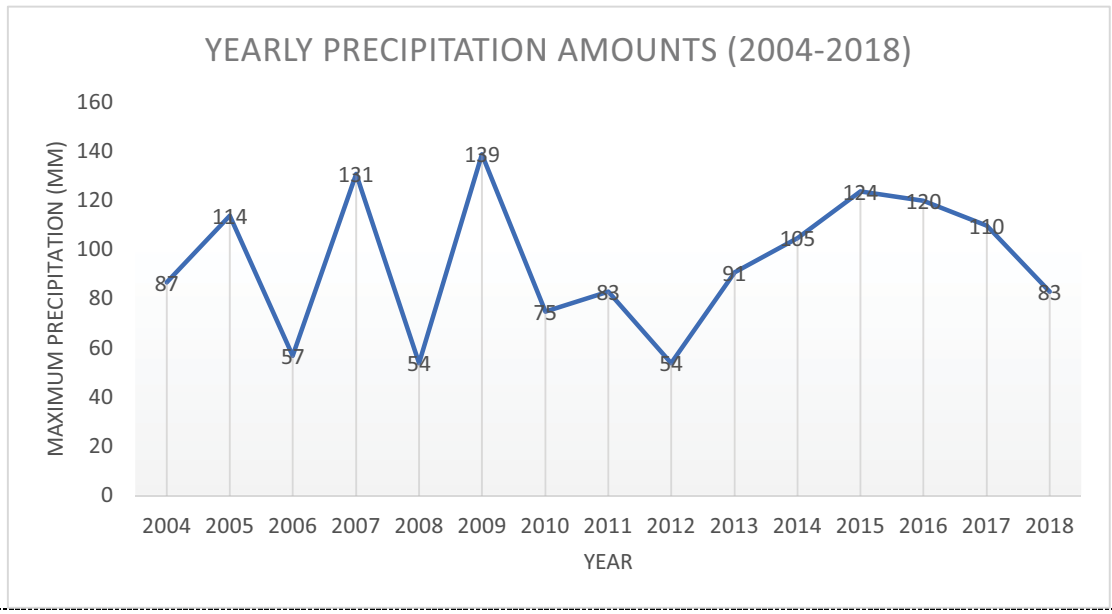

Figure 4. Line chart of yearly precipitation amounts
(source: Rainfall Data from BBWS Ciliwung Cisadane)

Tabel 2 is total roofing area in square meter.

Table 2. Total Roofing Area.

Location	Area (m^2)
Main Roof	256
Front Lobby Roof	192
Office Roof	443.87
Jumlah	891.87

4. Result and Discussion

4.1. Harvested rainwater volume

From the results of the calculation of the roof obtained and the calculation of the rainfall plan, it can be calculated the amount of rainwater volume that can be. Based on the average rainfall values obtained per day volume of 16.1428 m^3. Table 3 is the complete results of rainwater harvesting analysis.

Tabel 3. Rainwater Harvesting Analysis Results

Description	Value (mm)	Value (m)	Area (m^2)	Volume Per day (m^3)	Yearly Amount (m^3)
Average Rainfall	18,1	0,0181	891.87	16,143	2.066,273
Average Maximum Rainfall	95,1	0,0951	891,87	84,843	10.859,920
2 year	93,5	0,0935	891,87	83,365	10.670,710
5 year	119,4	0,1194	891,87	106,499	13.631,917
10 year	133,8	0,1338	891,87	119,323	15.273,395

(source: calculation results)

4.2. Storage Planning

Rainwater storage tanks harvested in this design are based on 10-year rainy volume periods. This is to anticipate if there is a rainfall period of 10 years, storage can accommodate the rain volume. So that runoff and puddles do not occur on the ground surface. The reservoir must also have a drain so that when it rains, the excessive volume of rainwater doesn't overflow in the reservoir area so that its caused surface inundation. The rainwater storages are made on underground. By utilizing the existing gutter pipe and made an additional channel that will flows rainwater from the existing gutter to the reservoir. Figure 5 shows the design of storage.

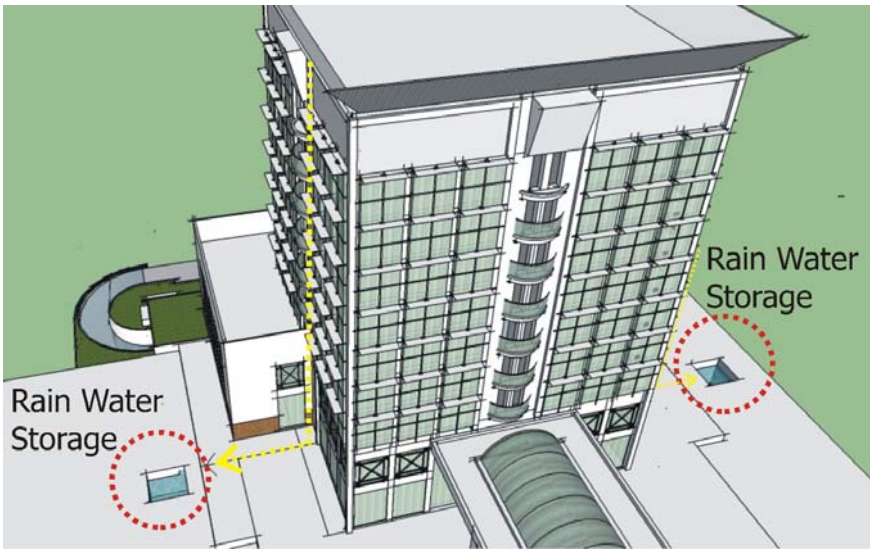

Figure 5. Rainwater storage on two sides of building

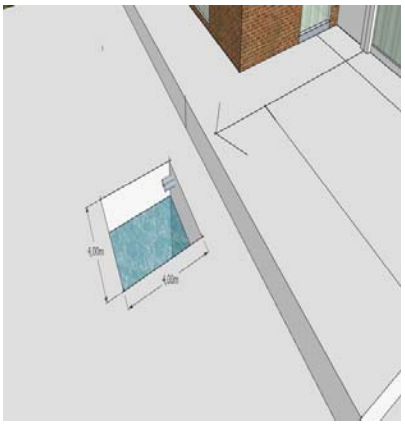

Figure 6. Rainwater storage

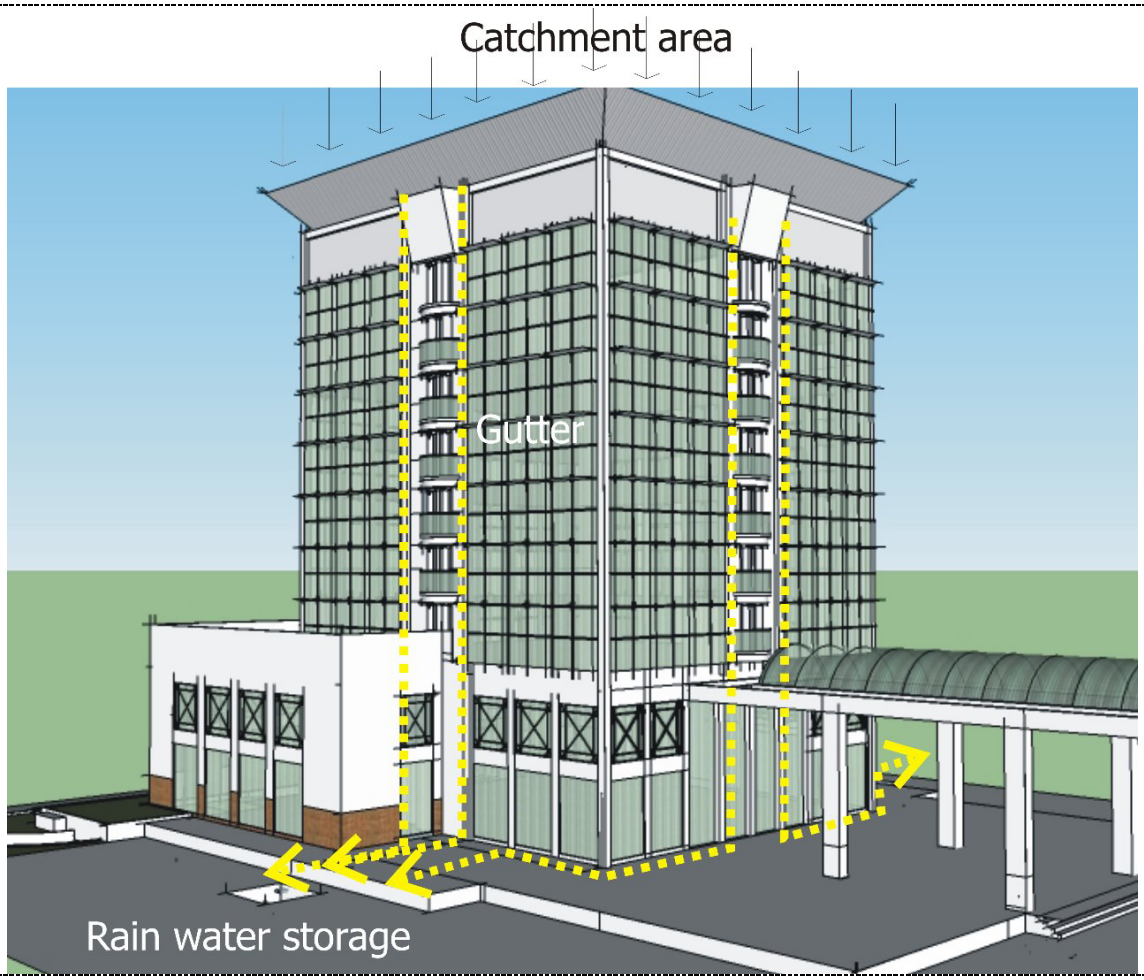

Figure 7. Rainwater harvesting system

From the results of the calculation analysis of the study based on the calculation of average rainfall, maximum average, 2-year period, 5-year period and 10-year period with a catchment area of 891.87 m^2. Rainwater harvesting is planned based on a 10-year rainy period with a storage volume of 119,3234 m^2. It is planned to build two water reservoirs with a storage volume of 64 m^3 each will be on underground with dimensions of 4m x 4m x 4m. The storage is placed on 2 sides of the building connecting to channels and makes it easier to distribute rainwater to reservoirs. Harvesting results will be used for supply public water needs at the educational area using jet pump to distribute to the building.
For further research should be reviewed calculation the entire roof area of all buildings, to harvest more rainwater. And primer rainfall data from more than one rainfall station for valid data.

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