The Study of Rainwater Harvesting for Vulnerable Households in Water Prone Area

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Research Article

The Study of Rainwater Harvesting for Vulnerable Households in Water Prone Areas (Case: Bekasi Regency, Indonesia)

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Abstract

Bekasi Regency is an area that consists of 23 sub-districts, located in West Java Province, Indonesia. There are 2 sub-districts, namely Bojongmangu District and Cibarusah District, which are considered as water prone areas. These two sub-districts are areas of drought and difficulty accessing piped water. Rainwater harvesting is a way to anticipate household water needs. Vulnerable household groups are groups of poor households who do not have access to water because they are in water prone areas and are unable to provide water independently. The research objective was to describe the harvesting capacity of rainwater for vulnerable families. The research method was carried out by collecting data on the size of the roofs of vulnerable family houses and then calculating the volume of rainwater that could be accommodated. The results of the study serve as directions for local governments to provide water harvesting facilities for vulnerable household groups.

Keywords

Bekasi-Indonesia, Rainwater-Harvesting, Vulnerable-Households, Water-Prone-Area

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Introduction

Water is the most important natural resource. Water is life. This statement refers to the value of water for individuals and life on this planet. Water is very important for humans (Kalvani, Sharaai, Abd Manaf, & Hamidian, 2019). The bond between humans and water is the important one and has a long history that includes ancient culture and today it forms the lifeline of any society. All known civilizations have developed with water sources as their base (Sadhu, Chaudhary, & Chakravarty, 2014). Water research provides meaning for human life.

The concept of household water insecurity or household water vulnerability is a way to better 'understand the interactions between various water characteristics and functions'. Domestic water insecurity, defined as the inability to access and benefit from adequate water (i.e., an sufficient amount of water for all household needs), reliable and safe water for well-being and healthy living, taking into account the various components of water by individuals and households (Young et al., 2019). Water insecurity issues can be grouped under three main headings: availability, access, and use (Webb & Iskandarani, 1998).

Domestic water insecurity is an urgent problem in developing countries (Webb & Iskandarani, 1998). Water insecurity in Indonesia occurs in most parts of its territory. Indonesia is not a country that lacks water, but environmental management, infrastructure and spatial use policies are not in line so that there are still many houses that are vulnerable to water (Asean Development Bank, 2016; Danielaini, Maheshwari, & Hagare, 2019). The problem of water insecurity in Indonesia occurs due to piped water services, lowering groundwater levels; decreasing water quality and climate-related disasters (Danielaini et al., 2019).

Based on data obtained from the Bekasi Regency Regional Planning and Development Agency in 2019, Bojongmangu and Cibarusah Districts are areas that have a high risk of drought. Drought disaster is a condition of water insecurity. For this reason, Bojongmangu and Cibarusah Districts are priority areas for this study activity.

The groups that vulnerable to water insecurity are the poor. The poor pay very high prices for water (Webb & Iskandarani, 1998). Data for the poor were obtained from data determined by the Bekasi District Statistics Agency. The poor community groups in Bojongmangu District are 3238 households and 4028 households in Cibarusah District. The poor groups in these two sub-districts were the research targets because they were vulnerable to meeting water needs.

Rainwater harvesting gives a long-term solution to providing access to safe water for residents and can present water security for households experiencing water scarcity. Rainwater harvesting offers an ideal solution in areas with sufficient rainfall but insufficient groundwater supply (quality and quantity) and inadequate or unsatisfactory surface water sources. Rainwater harvesting is very useful in remote and difficult terrain because it has the ability to operate independently. All processes are environmentally friendly (Sadhu et al., 2014). Rainwater harvesting is the collection, storage, delivery and use of rainwater for various purposes (Stec & Kordana, 2015). Rainwater Harvesting is a renewable source of clean water that is ideal for household use and small-scale agriculture and greater attractiveness of low-cost rainwater harvesting systems and simple accessibility and maintenance at the household level (Abdulla & Al-Shareef, 2009). Rainwater harvesting systems consist of three basic elements: collection areas, storage facilities, and transportation systems (Burszta-Adamiak & Spychalski, 2021). Water harvesting provides a solution to the water needs of people living in water-prone areas.

The Study on Rainwater Harvesting is a solution to anticipating water insecurity in Bekasi Regency. The relatively abundant rainfall can be used for water supply needs for vulnerable family groups, such as what happened in Bojongmangu and Cibarusah Sub-districts, Bekasi Regency. The objective of the study for the cases in the two districts is to describe the volume capacity of harvesting rainwater. Furthermore, it can describe the means of provision for harvesting rainwater. Rainwater harvesting research has been carried out such as: harvesting rainwater for domestic needs in India (Kumar, 2004), designing rainwater harvesting (Margeta & Fontane, 1990; Payne, Nakato, & Nabalango, 2008), construction of water storage tanks Gender-based rain in Uganda (Payne et al., 2008), Sustainability of rainwater harvesting development (Rahman, Dbais, & Imteaz, 2010), hydro-political mobilization of water harvesting (Arabindoo, 2011), rainwater harvesters in Morocco (Clus, Lekouch, Muselli, Milimouk-Melnytchouk, & Beysens, 2013), Harvesting water in Guatemala (Elgert, Austin, & Picchione, 2016), Harvesting rainwater as a reserve in Ethiopia (Feki et al., 2015), rainwater harvesting for household water safety (Kumar, 2004), Harvesting water in southern Iraq (Zakaria, Al-Ansari, Ezz-Aldeen, & Knutsson, 2012), Rainwater Harvesters for hotel

needs (Rukesh Reddy & Rastogi, 2008), Health Assessment for rainwater harvesting (Sadhu et al., 2014), Harvesting rainwater to reduce floods (Sepehri, Malekinezhad, Ilderomi, Talebi, & Hosseini, 2018), Evaluation of water harvesting in Iran (Toosi, Danesh, Tousi, & Doulabian, 2020), Perception of rainwater harvesting for households in Iran (Sheikh, 2020), research on rainwater harvesting was conducted in Cikarang Subdistrict, Bekasi Regency (Roekmi, Chua, & Baskaran, 2018) but did not focus on certain groups and more on assessing rainwater quality. Research on Rainwater Harvesting in Indonesia, especially for vulnerable households with locations in water prone areas it has never been done, to fill the gap in this problem this research was conducted.

Methods

Context of Study

The research location is in West Java Province, precisely in Bekasi Regency. Bekasi Regency is a location close to the capital city of Indonesia, namely the City of Jakarta. The research was conducted in rural areas in Cibarusah District and Bojongmangu District. These two sub-districts are areas experiencing water insecurity (Setyaningrum et al., 2020). Geographically, Cibarusah District is located at the end of the border with Bogor Regency and Bojongmangu District, Bekasi Regency. Cibarusah District has an area of 35.62 km² which is divided into 7 villages. Meanwhile, Bojongmangu District is geographically at the position of 6.4092º-6.4697º South Latitude and 107.1447º - 107.1919" East Longitude. Bojongmangu District has an area of 50.18 km² and is divided into 6 villages. For more details, see Figures 1 and 2 which explain the position of the study location.

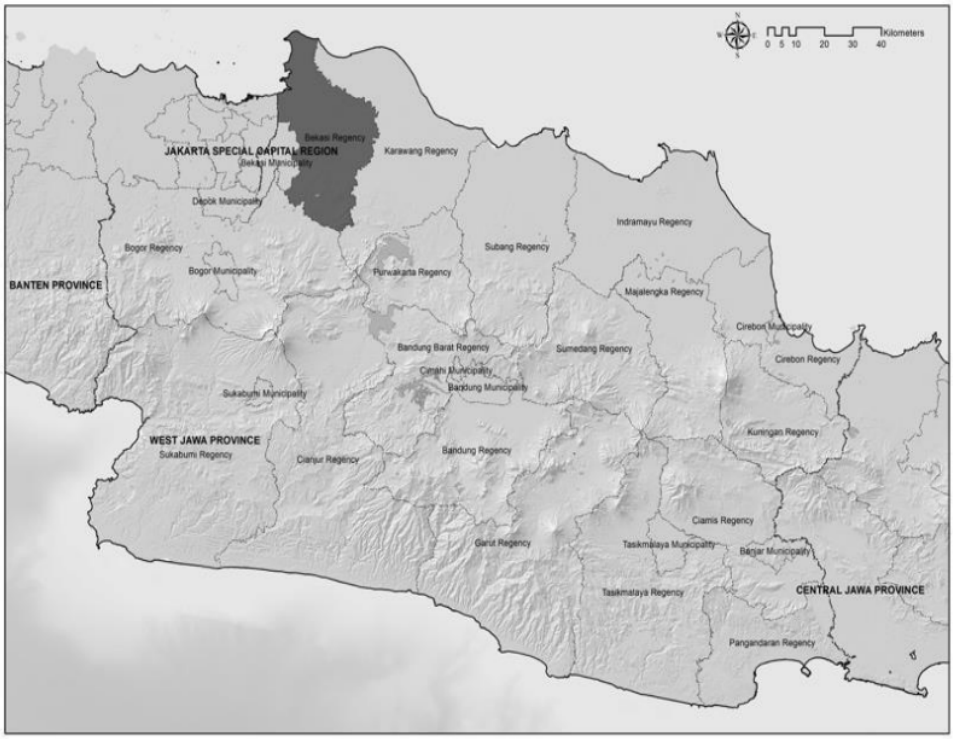

Figure 1. The Position of Bekasi Regency which is located in West Java Province
Source: Agustina, 2019

Figure2. The position of Cibarusah District and Bojongmangu District in Bekasi Regency
Source: Agustina, 2019

Data Collection Procedure

Data collection was carried out for 3 weeks with the assistance of 3 surveyor members. Data collection was held in October 2019. The survey was conducted from 08.00 to 17.00 Western Indonesian Time. First of all, the data of poor households located in Bojongmangu and Cibarusah Sub-districts was collected. This data has been obtained from the Bekasi District Development Planning Agency (Bappeda). The list was grouped into data for each village in the two sub-districts that are the research locations. The next stages were:

1. Conducted purposive sampling for each village located in the two sub-districts. The sampling was based on the criteria of vulnerable family homes.
2. Designated 6 houses from each village that are included in the list of vulnerable families
3. Measured the area of the roof of each house as the surface of the rainwater catchment.
4. Measured the number of residents in each house.
5. Took monthly rainfall data in Bekasi Regency obtained from the Meteorology, Climatology and Geophysics Agency (BMKG).

Data Analysis

The power analysis was carried out in the following stages:

1. Calculated the average rainwater catchment area. The catchment area is 0,5 X the area of the roof of the house
2. Calculated the volume of collected rainwater, namely by multiplying the volume of rain every month times the catchment area
3. Calculated the need for rainwater for each family using the rules set by the Ministry of Public

Works of the Republic of Indonesia (15-30 litres / per capita / day) multiplied by the average number of residents in each sampled house.
4. Calculated the excess and lack of rainwater in a monthly time period for one year.
5. Calculated the amount of rain water that can be accommodated from the calculation results of stage no.4 above
6. Determined the amount of rain water that can be accommodated

Result and Discussion

The Capture of Rainwater Volume

The study findings show the roofs of houses in the study area as shown in Figure 3. The volume of rainwater captured depends on the area of the catchment area. The catchment area used in the harvesting of household rainwater is the roof of the house. The roof of the house in the survey location varies, if you pay attention to the type of roof being observed, the area of the catchment used in the calculation is half (0.5 times) of the total roof area. In the following table it shows the area of the roof and the area of the observed rainwater catchment. The average rainwater catchment area for Bojongmangu and Cibarusah Districts is presented in table 1.

Figure 3. House Condition in The Study Location
Source: Agustina,2019.

Table 1
The Average of Rainwater Catchment Area

Village Name	Average Catchment Area (m2)
Desa Karang Mulya	65
Desa Karangindah	82
Desa Bojongmangu	90
Desa Sukabungah	57
Desa Sukamukti	64
Desa Medalkrisna	58
Desa Cibarusah Kota	43
Desa Cibarusah Jaya	39
Desa Ridogalih	66
Desa Ridomanah	74
Desa Sindangmulya	33
Desa Sirnajati	68
Desa Wibawamulya	43
	60
Total Average	

Source: Agustina, 2019

According to the table above, the average catchment area (roof) at the survey location is 60 m2. Furthermore, the volume of rain water that can be collected can be seen in table 2 below.

Table 2
Tappable Rainwater Volume

Month	Average Rain (mm)	Catchment Area (m2)	Tappable Rainwater Volume (litre)
January	283	60	16.973
February	378	60	22.679
March	162	60	9.702
April	140	60	8.370
May	90	60	5.389
June	50	60	3.013
July	35	60	2.089
August	25	60	1.497
September	37	60	2.216
October	83	60	4.966
November	121	60	7.289
December	178	60	10.652
Total	**1.581**		**94.835**

Source: Agustina, 2019

So, the potential for rain water that can be collected by each house is 94,835 litres per year.

Rainwater Storage Volume

The required rainwater storage volume is calculated based on the amount of rainwater that can be tapped and the amount of water required. The amount of water needed is influenced by the number of people served and the amount of water needs per capita. The per capita water requirement for rainwater storage uses a regulation stipulated by the Ministry of Public Works of the Republic of Indonesia, which is 15-30 litres / person / day. In this study, the water requirement per capita used in the calculation is 24 litres / person / day. This number is multiplied by the average number of family members in one house, which is 3 people (data from survey results). The results can be seen in table 3.

Table 3.
Data and Calculation of Rainwater Storage Capacity

Month	Days	Average rain (mm)	Roof Area (m2)	Collectible Rainwater (litre)	Water Requirements (litre)	Water Shortage (litre)	Excess Water (litre)
January	31	283	60	16.973	2.232	-	14741
February	28	378	60	22.679	2.016	-	20663
March	31	162	60	9.702	2.232	-	7470
April	30	140	60	8.370	2.160	-	6210
May	31	90	60	5.389	2.232	-	3157
June	30	50	60	3.013	2.160	-	853
July	31	35	60	2.089	2.232	-143	-
August	31	25	60	1.497	2.232	-735	-
September	30	37	60	2.216	2.160	-	56
October	31	83	60	4.966	2.232	-	2734
November	30	121	60	7.289	2.160	-	5129
December	31	178	60	10.652	2.232	-	8420
Total	**365**	**1.581**		**94.835**	**26.280**	**-878**	**69.433**

Sumber: Agustina, 2019

The calculation results show that the amount of water that can be stored is 94,835 litres / year. Water needs as much as 26,280 liters / year. The remaining water is 94,835 minus 26,280 which is 68,555 liters / year. The excess of water is as much as 69,433 liters / year. Meanwhile, the water shortage is as much as 878 liters / year. Thus, the water capacity collected is 878 liters or 0.878 m3. The results of the study focus on the amount of rainwater capacity that can be accommodated individually by vulnerable families. While the results of Roekmi's research, 2018, are more on the quality of rainwater in other sub-districts, Bekasi Regency. The results of his research show that the

quality of rainwater can be an alternative to meet family needs. This means that the capacity of the rainwater that is collected can be an alternative solution to fulfill water for these vulnerable families.

Conclusion

Based on the study results, the rainwater harvesting capacity that can be carried out in the study area is as much as 878 litres or 0.878 m3. This capacity measure can take advantage of the water catching facilities provided by the market. The tank capacity provided by the market is around 1050 litres. The Bekasi Regency Government can help provide rainwater storage tanks / tanks to vulnerable families by preparing these tanks. Therefore, the problem of household water needs in vulnerable family groups can be resolved and can also be a long-term solution.

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