Rainwater harvesting as social capital for urban water supply: mitigation of floods and droughts.

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Abstract. The Yogyakarta Urban Areas (YUA) has the highest population density in the Special Region of Yogyakarta. In its establishment as a city center, YUA is not only a residential area but also a commercial area which encourages land conversion. Changes in land use lead to a reduction in water catchment areas that have a major influence on the sustainability of groundwater reserves. This study aims to examine people's perceptions as social capital towards rainwater harvesting as an alternative to providing clean water. The research approach carried out in this study is based on empirical conditions found in the field. Data collection is done by questionnaire method while the data analysis used is descriptive qualitative to conduct studies on public perceptions. The results of the study show that people's perceptions are influenced by social environmental conditions. Most people do not want to harvest rain water, assuming that rainwater has worse quality compared to well water and water from PDAM sources. The need for efforts to raise awareness of the role of the community as social capital in providing reliable and sustainable clean water through rainwater harvesting

1. Introduction

The development of a city always involves changing land cover and use activities. Human activity is a driver of changes in land cover and use, with factors in it being the level of population growth, economic growth, and political policies taken [1]. The development of the city of Yogyakarta is quite rapid, with population growth reaching 0.29% [2] and commercial activities as supporters of the city of Yogyakarta as a tourism and cultural area.

Land conversion activities in the development of cities threaten the sustainability of water resources. Water resources occupy a special place among other natural resources. Water is the most widely spread substance on our planet [3]. Although in different amounts, it is available everywhere and plays an important role in both the environment and human life. The fulfillment of water needs in the Yogyakarta Urban Area is carried out by PDAMs and ground water in the form of water from individually owned wells. The impact of land conversion in the Yogyakarta Urban Area has begun to be felt in the city of Yogyakarta, in 2011 the decrease in groundwater level in the city of Yogyakarta reached 30 cm/year [4].
The sustainability of water resources is further exacerbated by the problems of climate change. Climate change has caused changes in weather in various parts of the world, one of its effects is a shift in rainfall patterns, rainfall intensity and uncertainty in the beginning of the rainy and dry season [5]. Furthermore, an abnormal global climate brings the potential for large and intense rainfall to produce flooding [6].

The problem of land conversion and climate change requires the existence of raw water sources as an alternative that can meet water needs, especially in the dry season. But the strategy depends on the community as consumers. Communities can respond to this threat through two different strategies, namely adaptation and mitigation [7]. The willingness of the community to participate in public activities is an important factor in the public's ability to influence local government and success in the application of new technologies, namely rainwater harvesting. This study aims to examine people's perceptions as social capital towards rainwater harvesting as an alternative to providing clean water.

2. Methods

The approach taken in this study is based on empirical conditions found in the field. Data collection is done by questionnaire method. The method of collecting data with a questionnaire is to submit a list of written questions to the community (household) or respondents with the aim of obtaining information with high reliability and validity. The data analysis used in this study is quantitative qualitative descriptive analysis. Qualitative research methods are used to examine a very micro situation that is one site, to a broad macro community that is complex. Analysis of data to assess public perceptions of rainwater harvesting includes ability to pay analysis (ATP) to determine the ability of the community in financing and willingness to pay analysis (WTP) to determine the willingness of the community in financing. According to the Ministry of Health (2000) the ability to pay the community can be done with a formula approach 5% of the total income of the community.

The number of respondents in this study was determined by the Slovin formula:

\[ N = \frac{N}{(1 + N \times e^2)} \]

Information:
N = Number of Samples
N = Total Population
e = Error Tolerance Limit (10%)

With the population in Yogyakarta Urban Area as many as 228,007 households, then the number of respondents is 100 families.
3. Results and Discussion

Based on the results of the survey and data reduction, the characteristics of the respondents can be described as follows;

1. Type of Job

This characteristic has the purpose of knowing the type of work of the respondent at this time, the type of work presented in Figure 1.

![Figure 1. Percentage of respondents based on type of work](image)

2. Monthly income

This characteristic has a close relationship with the amount of expenditure to pay for clean water needs. Monthly income of respondents can be seen in Figure 2.

![Figure 2. Percentage of respondents based on monthly income](image)
3. The type of source of drinking water used

This characteristic aims to find out the source of clean water currently used by respondents. The source of clean water can be seen in Figure 3.

![Figure 3](image)

**Figure 3.** Percentage of respondents based on the source of drinking water used

4. Costs incurred to pay to meet drinking water needs

This characteristic has a close relationship with the amount of expenditure to pay for clean water needs. Costs incurred for the cost of meeting clean water needs can be seen in Figure 4.

![Figure 4](image)

**Figure 4.** Percentage of respondents based on costs incurred to pay for clean water needs
5. Knowledge of rainwater harvesting technology

This characteristic has the purpose of knowing whether the respondent knows about rainwater harvesting technology. Knowledge of rainwater technology can be seen in Figure 5.

![Figure 5](image)

**Figure 5.** Percentage of respondents based on knowledge about rainwater harvesting technology

6. Willingness to use rain water for drinking water needs

This characteristic has the purpose of knowing whether the respondent wants to use rainwater as a source of raw water for drinking water. The willingness to use rainwater for drinking water needs can be seen in Figure 6.

![Figure 6](image)

**Figure 6.** Percentage of respondents based on willingness to use rain water for drinking water needs
7. The ability to pay the cost of drinking water from rainwater harvesting technology

This characteristic aims to determine the ability of respondents to pay the cost of drinking water from rainwater harvesting technology. The ability of respondents to pay the cost of drinking water from rainwater technology can be seen in Figure 7.

![Figure 7](image)

**Figure 7.** The percentage of respondents based on their ability to pay the cost of drinking water from rainwater harvesting technology

8. Public perception of rainwater as a source of raw water for drinking water

This characteristic has the purpose of knowing the public perception regarding rainwater as a source of raw water for drinking water. The public perception of rainwater as a source of raw water for drinking water can be seen in Figure 8.

![Figure 8](image)

**Figure 8.** Percentage of respondents based on perceptions of rainwater as a source of raw water for drinking water
Based on the results of the study, it can be seen if the population in the Yogyakarta Urban Area mostly works as private employees and workers as much as 27%, as many as 19% work as entrepreneurs, 15% work as farmers and 12% are civil servants. Most of the population in Yogyakarta Urban Area earns between Rp. 2,500,000 - Rp. 5,000,000. As many as 61% of respondents use well water as raw water for drinking water and as many as 39% of respondents use water from PDAM as raw water for drinking water. Most respondents pay for drinking water needs of Rp. 100,000 - Rp. 200,000/month. Most of the respondents were not willing to use rain water for drinking water needs on the grounds of poor rainwater quality. While the community's ability to pay the cost of drinking water from rainwater harvesting technology is Rp. <100,000. From the questionnaire data, the value of ATP and WTP produced can be seen in the following Table:

**Table 1. ATP and WTP values**

| No | Explanation                                      | Value  |
|----|--------------------------------------------------|--------|
| 1  | Average income of one month                      | 3,213,000 |
| 2  | Costs for meeting Average Drinking Water Needs   | 165,000 |
| 3  | ATP value (5% of average monthly income)         | 161,000 |
| 4  | Maximum ATP value (5% of maximum income)         | 250,000 |
| 5  | ATP value of drinks (5% of minimum income)       | 50,000  |
| 6  | WTP value                                        | 111,000 |

From the table above, it can be seen that the community's ability to pay the cost of drinking water is Rp. 165,000 per month. While the willingness of the community to pay the cost of drinking water is Rp. 111,000. Most people do not want to use rainwater for raw water for drinking with the assumption that rainwater has worse quality compared to well water and water from PDAM sources. So that efforts need to be made to increase awareness of the role of the community as social capital in providing reliable and sustainable clean water through rainwater harvesting. Efforts to increase public awareness can be done through socialization, a social engineering plan (social engineering). The process of implementing social engineering generally consists of one or a combination of activities as can be seen in the following figure:

**Figure 9. Process of Social Engineering**

The planning and implementation of social engineering is basically an effort to influence (change the behavior) of the community so that: "Interested, Moved, Invited" to act to participate in efforts to conserve groundwater and mitigate floods and drought. In general, the expected process of community change is as follows:
− Increased Awareness
− Increased interest (Interest)
− Demand
− There is participation and action (Action)

The implementation of socialization must be planned continuously so that the community change process can take place until the realization of broad community participation in supporting the realization of effective and efficient waste management.

4. Conclusion

The sustainability of groundwater availability is increasingly due to land conservation, another alternative is rainwater harvesting which is also a flood and drought mitigation effort. The application of rainwater harvesting technology will run if the community as a user has a positive perception. Public perception is influenced by social environmental conditions. Most people do not want to harvest rain water, assuming that rainwater has worse quality compared to well water and water from PDAM sources. The need for efforts to increase awareness of the role of the community as social capital in providing reliable and sustainable clean water through rainwater harvesting.

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