Risks of community-based groundwater users in the transition to West Semarang drinking water supply

M Rahdriawan1,2, W Pradoto1, F A Pratama1, M S Hanifah1 and S Muzdalifah1
1Department of Urban and Regional Planning, Faculty of Engineering, Diponegoro University, Jl. Prof. Sudarto, S.H., Tembalang Semarang, Indonesia.
2Corresponding author: mardwi.rahdriawan@pwk.undip.ac.id

Abstract. One of the phenomena of climate change is the reduction in groundwater resources, such as in Semarang. However, many people utilize this water source, whereas it can damage the environment and land subsidence. Therefore, the government-private partnership builds West Semarang Drinking Water Supply System, one of which functions to address groundwater use. This study aimed to determine community-based groundwater utilization characteristics that would switch to the municipality piping system. The research method used qualitative by reviewing documents and interviews community-based groundwater stakeholders and managers. The results showed that most people feel comfortable using water. They had long been less aware of the risks of groundwater exploitation. There were patterns and characteristics of the area, economy, and groundwater utilization by the community that affected their acceptance of switching to a new water supply system. In the future, there is a need for more intense socialization regarding the transition of drinking water supply by considering the characteristics of the current community-based water supply.

1. Introduction

Experts have often warned against the impact of climate change on groundwater conditions, either directly or indirectly. Examples of direct effects relate to groundwater replenishment, whereas indirect effects relate to changes in land-use, especially related to human activities in groundwater utilization [1]. Today, groundwater is still used in various places in the world to obtain a good quality of water when the area has not received piped drinking water service, which should be provided by the government. Groundwater utilization still occurs in the city of Semarang. This could damage the environment, for example, contaminating groundwater, lowering groundwater levels, and land subsidence [2]. Semarang's city is no exception, which is growing very rapidly; research related to the decrease in groundwater depth at shallow groundwater depth has the lowest decrease of -0.0108861 m and the highest is -3.67462 m. The changes in groundwater from 2014 to 2018 are the same every year. The depth of groundwater is obtained from seven observation stations with the lowest groundwater level of -37.054 m and the highest -1.6183 m, especially in densely populated areas [3]. Even though the settlements' environmental conditions have deteriorated, the community continues to live in that location.

This condition is very concerning when some people still use groundwater. Like the service in Semarang, two sources of drinking water are utilized by the community. The water provision from the Regional Drinking Water Company (PDAM) and well water, which mostly uses groundwater. Not all regions have received piping system services, a mere 173,612 customers in 2019 or 59.35%. Thus, more than 40% of people still use the non-piped system. They use artesian wells that have been built by
various government agencies, such as Semarang City Water Resources Management Office, Semarang City Community Empowerment Program, Semarang City Planning and Housing Office, and Central Java Province Energy and Mineral Resources Office. Wells has reached more than 500 units [4].

In fulfilling the availability of drinking water, the government seems to have not provided facilities and infrastructure, especially more decent drinking water. As far as West Semarang is concerned, some areas often experience a drinking water crisis during the dry season. Even raw water sources and groundwater are experiencing drought. Besides, the installation of drinking water channels from PDAMs in these areas requires expensive costs while the local budget is insufficient. Therefore, with various parties' support, the central and local governments will realize West Semarang Drinking Water Supply System (WSDWSS) program through the Public-Private Partnership (PPP). This program's target includes people who do not have access to drinking water and still use groundwater sources. The approach in PPP is an initiation process to foster initiative and stakeholder participation in deciding, planning, preparing, implementing, operating, and maintaining facilities that have been built, as well as continuing activities to improve health status in the community.

The funding requirement for constructing West Semarang DWSS building is 1.1 trillion rupiah, while the Semarang expenditure budget is limited. One of the efforts to overcome this problem requires the construction through PPP with the support of investors. The water system is targeted for completion in May 2021, with a capacity of 1,000 liters per second. West Semarang Water System will be able to meet the clean water needs of 65,000 families in West Semarang, Ngaliyan, and Tugu Sub-Regency.

The project undoubtedly received various responses from the community, especially residents of West Semarang, which consists of 3 sub-regency. Some are happy with the existence of West Semarang DWSS, especially the industries and the communities who can connect and pay to PDAM. However, many people are reluctant to switch to West Semarang piping because it is expensive, and they are not sure if the water will run smoothly. Besides, they consider that they can manage to have water through the use of groundwater. Based on the Interviews from the community's perspective, this transfer is not easy and has a high risk because it will change the community-based drinking water management into a pipeline network [5]. Therefore, this research needs to answer the following questions: how are community-based water management risks in in the transition groundwater to the West Semarang DWSS?

2. Method
This study used qualitative methods to explore community support or resistance in switching to the West Semarang DWSS network. Interviews were conducted with ten community-based groundwater local managers who understand the customer community's condition in their settlement. Primary data collection through interviews and direct observation in Tugu Sub-Regency. While secondary data collection, such as document review and literatures study [6]. The substance of the interview followed the flow of community-based water supply using groundwater. There were several issues related to this activity; the first is that the supply consists of the quality, quantity, and continuity of water sources [7]. The second is management, which includes: services capacity, customer complaints, service organization, and annual reporting. The third was related to the community's understanding of the West Semarang drinking water supply issues.

3. Result and discussion
3.1. Characteristics of non-piped drinking water supply system
From 2012 to 2020, the percentage of coverage of piped water services has not changed much, namely around 59% of the total population. Most of the areas with non-piped drinking water service levels include West Semarang, Ngaliyan, and Tugu Sub-Regency. Figure 1 shows the locations with non-piped drinking water supply. Non-piping systems in this area are not served by PDAM piping networks (Figure 1). It includes excavation or drilling for surface groundwater; limited deep groundwater drilling by considering environmental sustainability, rainwater utilization development, brackish water and
seawater treatment, and provision of water terminals for areas not yet served by piping networks. Table 1 shows several water supply programs that have been implemented to meet the regions' needs that have not been done by the local government.

The table 1 shows that there are non-piped sources that have been financed by various government agencies in the city of Semarang. However, some communities build independently. The description of the distribution of non-piped locations in the city is as follows in Figure 1.

The non-piped system means that the distribution of drinking water does not use a municipality piped network. The service unit uses public hydrants, water terminals, and tanks, generally, in the form of communal facilities that can be used by the community together, and there is no need for processing, as seen in Figures 2 and 3, which have different characteristic. The government-assisted water tanks are made of reinforced concrete, while the self-help water tanks are made of cheaper materials.

There were three characteristics. The first is that the community was ready to switch to West Semarang DWSS, characterized by their independent use of groundwater. Second, a balanced group of people changes to this system because they were good enough to get services from the community-based water supply, but if they switch to a new piping system, it would not be a problem. Third, the community groups who don’t need to change to this piping system. They have received excellent and low-cost drinking water services, the community’s characteristics were generally middle to lower class. In general, a great deal of community-based water supply was reluctant to switch to the new piping system because they can independently provide water for themselves.

**Table 1. Non-piped drinking water supply system**

| No | Sub District | Number of Wells | Provision of Community-Based Drinking Water and Sanitation | Special allocation funds | Expenditure Budget | Self-sub-system | Community Empowerment Program | City planning and housing services | Energy and mineral resources |
|----|--------------|----------------|----------------------------------------------------------|--------------------------|-------------------|-----------------|-------------------------------|-------------------------------|-------------------------------|
| 1. | Mijen        | 55             | 12            | 3             | 1                | 7               | 16              | 3                             | 13                            |
| 2. | Gunungpati   | 82             | 17            | 3             | 4                | 22              | 22              | 7                             | 7                             |
| 3. | Banyumanik   | 38             | 6             | 1             | 4                | 11              | 4               | 1                             | 11                            |
| 4. | Gajah Mungkur | 6              | 0             | 0             | 0                | 0               | 1               | 0                             | 5                             |
| 5. | South Semarang | 5             | 0             | 0             | 0                | 0               | 5               | 0                             | 0                             |
| 6. | Candisari    | 21             | 1             | 2             | 0                | 4               | 5               | 4                             | 5                             |
| 7. | Tembalang    | 67             | 7             | 2             | 2                | 24              | 19              | 2                             | 11                            |
| 8. | Pedurungan   | 24             | 8             | 2             | 1                | 5               | 0               | 0                             | 8                             |
| 9. | Genuk        | 31             | 8             | 0             | 1                | 1               | 5               | 7                             | 7                             |
| 10.| Gayamsari    | 6              | 2             | 0             | 1                | 1               | 0               | 0                             | 2                             |
| 11.| East Semarang | 2              | 0             | 0             | 0                | 0               | 2               | 0                             | 0                             |
| 12.| North Semarang | 8             | 0             | 1             | 0                | 1               | 3               | 0                             | 3                             |
| 13.| Central Semarang | 15           | 0             | 0             | 0                | 1               | 7               | 2                             | 0                             |
| 14.| West Semarang | 17             | 0             | 0             | 1                | 3               | 1               | 2                             | 10                            |
| 15.| Tugu         | 47             | 7             | 3             | 2                | 12              | 13              | 2                             | 8                             |
| 16.| Ngaliyan     | 98             | 7             | 8             | 4                | 31              | 12              | 12                            | 6                             |

522  74  28  18  127  117  27  130

Source: Bappeda (2013)[4]
Figure 1. Locations of non-piped drinking water supply system [4]  

Figure 2. Water supply Tank Tower assisted by the local government  

Figure 3. community-based self-contained water supply tank tower  

Community-based services are motivated by the government's inability or the existing institutions to meet the needs of their citizens or due to insufficient institutions that cannot adequately fulfill the governance of basic human needs [8]. This condition will cause environmental damage if the community takes massive and continuous groundwater extraction without improving the proper drinking water supply system. Therefore, the government builds a proper drinking water supply system is one of the efforts to protect the urban environment.
Table 2. Issues, description, and risks to groundwater

| No. | Issues                  | Description                                                                 | Risks to Groundwater |
|-----|-------------------------|-----------------------------------------------------------------------------|----------------------|
| 1.  | Water quality           | People feel that the water quality is good, even though it is only for meeting household needs. Several independent water management groups check water quality with the relevant authorities. | Moderate             |
| 2.  | Water quantity and continuity | Most people consider the quantity of water to be sufficient. The average flow of water is 12-24 hours. | High                 |
| 3.  | Domestic consumption    | The community uses groundwater for basic household activities.               | High                 |
| 4.  | Services capacity       | The local manager strives to fulfill the connection for new customers.       | High                 |
| 5.  | Complaints of problems  | The field officer carries out the completion process                         | Moderate             |
| 6.  | Benefit of management   | Managers have profit from water management that is used for the development of their neighborhood. | High                 |
| 7.  | Organizational form     | The organization’s operations are simple. There is a job description for the staff. | Low                  |
| 8.  | Annual report           | For community-based with large customer capacities, there are routine reports, but for small ones, there are often no reports | Moderate             |

3.2. Risks of community-based groundwater utilization

West Semarang DWSS is an alternative substitute for community-based drinking water supply. Of course, this system has been planned with attention to the environment and conservation of natural resources. The source of the water comes from the Jatibarang Dam water reservoir. This system pays close attention to environmental preservation so that the supply of drinking water is better. If the use of groundwater by community-based water providers continues, then there are risks, as shown in Table 2.

Table 2 shows that the sustainability of Community-Based Water Utilization is going well and tends not to switch to the West Semarang Drinking Water supply system because there are minor risks in this water management. 1) The daily needs are fulfilled since good water quality, good management at a low cost. The lack of awareness among managers and the community about the use of groundwater can damage the environment. 2) Even though the continuity of daily needs is more than 12 hours, the water quality is good, and clean water management does not cost much. 3) Moderate category, related to annual reports of technical problems in operation, finance, and community-based clean water supply. In general, the community don't have sufficient motivation to switch to the West Semarang DDWS. Most people are hesitant to pay for the installation of new connections offered by the water supply agency. At the same time, there are many risks to groundwater if the community uses it continuously.

The knowledge gaps related to climate change on groundwater occur in community groups that utilize groundwater. To minimize the risk of environmental damage due to groundwater extraction, social mitigation is needed to change people's views. This means learning with various media for groundwater users. Through behavior change by disseminating knowledge about climate, groundwater, and environmental change. This is done for rural communities when information gaps occur [9]. The groundwater extraction should be ready for changes to be reduced for the West Semarang drinking water supply, especially for the poor. The level of household connection is adjusted to the real conditions of the community. The collaboration with community-based water supply needs to be done, especially by utilizing water tank towers running for a long time. The last thing is that the local government can issue regulations restricting groundwater use by considering various parties’ interests [10].
4. Conclusion
Based on the analysis, many community-based water providers are reluctant to switch to West Semarang DWSS due to the drinking water needs appropriately met by utilizing groundwater. They are less aware that groundwater, which is continuous utilization, can cause environmental damage. They don't understand the impacts of climate change on groundwater because they do often not perceive significant differences in water quality and quantity. For the government, the shift from using groundwater to a piping system is essential. The social mitigation that needs to be done is how the community's efforts to switch to drinking water fulfillment. Through behavior change by spreading knowledge about climate, groundwater, and environmental change. The government needs to implement subsidies both for installation and monthly payments from providers for certain community groups. However, community-based local water supplies can be using groundwater in limited ways.

Acknowledgment
The authors would like to thank the water supply community-based groups in Tugu, Ngaliyan, and West Semarang Sub-Regency, and the Faculty of Engineering of Diponegoro University for supporting our strategic research in Semarang.

References
[1] Taylor, R G, B Scanlon, P Döll, M Rodell, R van Beek, Y Wada, et al, 2012. Groundwater and climate change. Nature Climate Change, vol. 3. p 322-329.
[2] Gutama, M S and Warnso, H, 2018. Implementasi Kebijakan Perda Nomor 03 Tahun 2018 Tentang Pengelolaan Air Tanah di Dinas ESDM (Energi Sumber Daya Mineral) Provinsi Jateng (Semarang: Diponegoro).
[3] Simarsoit, Y, Prasetyo, Y, and Suprayogi, A, 2019. Analisis Korelasi Perkembangan Kota Semarang Terhadap Perubahan Penggunaan Air Tanah. Jurnal Geodesi Undip.
[4] Bappeda, 2013. Penyusunan Rencana Induk Sistem Penyediaan Air Minum (RISPAM) Kota Semarang (Semarang: CV. Rekayasa Jati Mandiri).
[5] Hatmoko, J U D and Susanti, R, 2016. Risk Management of West Semarang Water Supply PPP Project: Public Sector Perspective The 2nd International Conference on Civil Engineering Research (ICCER).
[6] Muhadjir, N, 1996. Metodologi penelitian Kualitatif (Yogyakarta: PT. Bayu Indra Grafika).
Merriam, S B, 2002. Qualitative Research in Practice: Examples for Discussion and Analysis (New York: Jossey-Bass A Wiley Company).
[7] Rana, M M P and Piracha, A, 2018. Supplying water to the urban poor: Processes and challenges of community-based water governance in Dhaka city Management of Environmental Quality: An International Journal, vol 29. p 608-622.
[8] Tesoriero, F, 2010. Community development: community-based alternatives in an age of globalization 4th ed (New South Wales: Frenchs Forest).
[9] Stočes, M, Masner, J and Jarolímek, J, 2015. Mitigation of Social Exclusion in Regions and Rural Areas - E-learning with Focus on Content Creation and Evaluation Agris on-line Papers in Economics and Informatics, vol 7. p 143-150.
Cheung, C K and Leung, K K, 2011. Social Mitigation of the Impact of Urban Renewal on Residents' Morale," Social Indicators Research, vol 106. p 523-543.
[10] Rahmi, Y K, Wirutomo, P, Kusnoputran, H and Moersidik S S, 2017. Citizen engagement to sustaining community-based rural water supply in Indonesia International Journal of Development Issues, vol 16. p 276-288.