www.bircu-journal.com/index.php/birci
Budapest International Research and Critics Institute-Journal (BIRCI-Journal)
Humanities and Social Sciences
ISSN 2615-3076 Online)
ISSN 2615-1715 (Print)

Analysis of Smart Tank Clean Water Supply Infrastructure Development

Shiddiq Waluyo[1], M Yanuar J Purwanto[2], Bambang Pramudya[3], Ernan Rustiadi[4], Moh Hasan[5]
[1,2,3,4]*Institut Pertanian Bogor, Indonesia*
[5]*Anggota Komisi Pembimbing, Dirjen SDA, Jakarta, Indonesia*
shiddiqwaluyo123@gmail.com, yanuar.tta@gmail.com, bpramudya@yahoo.com, /ernan@indo.net.id, mohasan53@yahoo.co.id

Abstract

This study aims to develop an appropriate clean water supply infrastructure, to increase the need for clean water infrastructure, especially smart tanks following the development of the city and society. Quantitative descriptive analysis is used to identify the existing clean water supply infrastructure. The results of quantitative descriptive analysis show that the existing service area of the Piping SPAM Cibinong urban settlement area is an area that is used as the center of urban activities with an existing service level of 17.26%. The existing raw water source used by PDAM Cibinong District is the Ciliwung River with a water discharge rate of 643.360 l/sec. PDAM Tirta Kahuripan in 2018 was only able to produce clean water of 643,360 l/second, so that there was a shortage of clean water in Cibinong sub-district in 2038 of 748 l/second, therefore we had to look for alternative sources of raw water. To be able to realize the fulfillment of clean water supply infrastructure in urban areas precisely in accordance with urban development, the construction of a water supply system is immediately carried out by developing clean water supply infrastructure, in this case the smart tank design. The development of clean water supply infrastructure is expected to be able to overcome the shortage of water supply infrastructure and clean water.

Keywords
clean water; infrastructure; development; urban; smart tank

I. Introduction

The Cibinong urban settlement area is one of the sub-districts in Bogor Regency, an area that is developing in the fields of agriculture, trade, services, and tourism. The increase in population will affect the increase in the need for drinking water (Hasibuan 2013). Developments in the Cibinong urban settlement area cannot be separated from the addition of supporting facilities, including clean water infrastructure and facilities.

Most of the clean water needs of the Cibinong urban settlement area with a population of 447,052 people are served by the Regional Drinking Water Company (PDAM) Tirta Kahuripan with a percentage of water service distribution of 17.36% by operating 3 units of Water Treatment Plants (IPA) as the production of raw water sources. namely IPA Cibinong, IPA Kedung Halang, and MA Ciburian.

These various problems have caused the management of clean water services in this area to not be optimal in achieving its intended goals. The management of clean water infrastructure in the Cibinong urban settlement area is intended to achieve service targets in

DOI: https://doi.org/10.33258/birci.v4i4.3228

accordance with the United Nations agreement written in the 2015 MDGs (Millennium Development Goals) that by 2015, it is targeted that the distribution of drinking water services must reach 80% for urban areas and 60% for rural areas. The unavailability of proper distribution of clean water services is the main cause of death in developed countries due to the development of water-borne diseases (Sudarmadji et al. 2014).

The central government implements policies that form the basis for good distribution of drinking water services so that the objectives of the Drinking Water Supply System (Permen PUPR No. 27 of 2016) can be achieved. Bogor Regency is following up on these national and regional policies by directing development to the development of clean water supply, which is prioritized for densely populated areas and residential centers. The development plan is strengthened by the current condition of the SPAM service level which is under the provisions issued by the Supporting Agency for the Development of Drinking Water Supply Systems on Guidelines for Reducing Non-Revenue Water (NRW) or Non-Revenue Water (ATR) (BPPSPAM. 2013).

Development is a systematic and continuous effort made to realize something that is aspired. Development is a change towards improvement. Changes towards improvement require the mobilization of all human resources and reason to realize what is aspired. In addition, development is also very dependent on the availability of natural resource wealth. The availability of natural resources is one of the keys to economic growth in an area. (Shah, M. et al. 2020)

The rapid development in several sectors in Cibinong is closely related to the high need to utilize space, including the development of clean water supply infrastructure. Every space utilization activity should refer to the RTRW document that has been determined. Based on Rustiadi (2018), the RTRW is a formal reference for spatial use, but the facts on the ground indicate the occurrence of the Master Plan Syndrome because the implementation of spatial planning is currently only able to be realized to the extent of a plan document but is difficult to implement. This is because the planning document has not been effective as an instrument for controlling space utilization and resource management, including clean water supply infrastructure.

Controlling the use of space is one of three processes in the use of space, namely spatial planning, space utilization, and controlling space utilization (Kemendagri RI 2017). Law No. 115 of 2017 concerning the mechanism for controlling the use of space states that controlling the use of space in an effort to realize spatial order, which includes zoning regulations, permits, incentives, and disincentives, as well as sanctions. Utilization of space that is not in accordance with the spatial plan, whether equipped with a permit or without a permit, is subject to administrative sanctions, imprisonment, and criminal penalties.

Controlling the use of space is a function that must be carried out by the government in its responsibility to improve community welfare, achieve justice, reduce conflicts and the negative impacts of spatial planning and ensure that development is efficient, effective, and in accordance with the function and consistent with the spatial plan (Kurnianti 2015). According to Sitorus et al. (2012), the spatial plan is realized by utilizing space in an area, where the complexity of the problems in the development and development of an area is the cause of the storage of space utilization in the RTRW. In the era of regional autonomy, initiatives to improve people's welfare tend to be implemented to meet short-term needs without paying attention to environmental sustainability and long-term development sustainability. With the increasing trend of urbanization, attention to spatial planning needs special attention, for example through the application of zoning regulations, incentive, and disincentive mechanisms, and so on (Talen et al. 2016).

Based on this explanation, in the Cibinong urban settlement area, it is necessary to develop physical infrastructure for a clean water supply smart tank. A smart tank is a clean water reservoir designed in such a way that it has the ability to distribute water, both to user pipelines and public hydrants. To distribute the water, it is assisted by a distribution reservoir which is built adjacent to the smart tank. The physical infrastructure for the supply of clean water-smart tanks is designed in the form and functions as a Water Sensitive City (WSC). The distribution of water comes from the use of rainwater harvesting (PAH) in the Cibinong urban residential area. In the next stage, the WSC will be used as a reference for physical development activities (Brown et al. 2013).

This Cibinong urban residential area has an area of 43.29 Km2 or 10.88% of the area of Bogor Regency and consists of 13 villages, namely: Karadenan, Nanggewer, Nanggewer Mekar, Cibinong, Pakansari, Sukahati, Tengah, Pondok Rajeg, Harapan Jaya, Pabuaran , Cirimekar, Ciriung, Pabuaran Bloom. (Cibinong District BPS in 2019 figures). This study aims to develop a clean water supply infrastructure (Smart Tank) in the Cibinong urban settlement area.

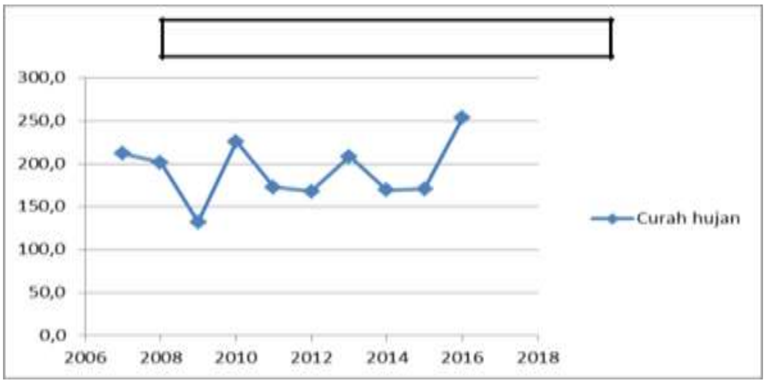
II. Research Method

This research was conducted in three stages, starting with the collection of secondary data, primary data, and data analysis. This type of research is a quantitative descriptive study to determine the need for clean water for the service area of PDAM Tirta Kahuripan, Cibinong District, Bogor Regency, and the potential availability of water in the Cibinong urban settlement area.

III. Result and Discussion

3.1. Rainfall

According to the Meteorology and Geophysics Agency (BMKG 2018) explains that rainfall (mm) is the height of rainwater collected in a rain gauge on a flat, non-absorbent, non-absorbent, and non-flowing place. According to Triatmodjo (2013), the rain gauge station only provides the depth of rain at the point where the station is located, so that the rainfall in an area must be estimated from that measurement point. If in an area there is more than one measurement station placed scattered, the rainfall recorded at each station may not be the same. In the hydrological analysis needed to determine the average rain in the area, the annual rainfall in the Cibinong urban settlement area can be seen in Figure 1.



Tahun	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
rainfall/ Month	239,0	198,5	166,3	218,7	170,0	171,6	246,1	424,7	362,0	169,1

Source : Cibinong's BMKG, 2018

Figure 1. *Cibinong Annual Rainfall Graph (2009-2018)*

3.2. Planned Rainfall Analysis

Amount of the planned discharge in a water supply infrastructure plan, more precisely the rainwater harvesting system, is determined using hydrological analysis. In this plan, frequency analysis requires rainfall data, namely maximum rainfall. In calculating the planned rainfall using the Gumbel distribution method (Subramanya 2013). The analysis of the calculation of the average daily maximum rain data in an area must be carried out properly and correctly, because the results obtained will affect subsequent analyzes, such as the analysis of the frequency of rain data.

Table 1. Maximum Daily Rainfall

No	Years	Average rain Annual (mm)	(R-r)	(R-r)^2
1	2009	239,0	6,22	39
2	2010	198,5	38,52	1484
3	2011	166,3	70,72	5001
4	2012	218,7	26,62	709
5	2013	170,0	46,02	2118
6	2014	171,6	65,42	4280
7	2015	246,1	-9,08	82
8	2016	424,7	-187,68	35224
9	2017	362,0	-124,68	15545
10	2018	169,1	67,92	4613
Average		2184		69095
amount		228,4		691

Source : the calculation results, 2019

Calculate the average rain

$$\bar{X} = \frac{2184}{10} = 218,4 \qquad (1)$$

Calculate standard deviation

$$SD = \sqrt{\frac{69095}{10-1}} = 87,62 \qquad (2)$$

Calculate Frequency (K), Plan Rain (X_T)

Amont (n) = 10

The Sn value can be taken from the attachment:

Sn = 0,9497; Yn = 0,4952

Table 2. Return Period, Yt Value is taken attachment

Return Period T (Year)	Y_t
2	0,3065
5	1,4999
20	2,9702
50	3,9019
100	4,6001

Source : the calculation results, 2019

Then calculate the planned rainfall for the return period of 2 (two) years, 5, 20, 50, and 100 years with Yt for each return period and the calculation results are listed in Table 3.

Table 3. Rainfall analysis wih Gumbel probability distribution

Return Period T (Year)	Y_t	K (Frequency factor) $K = \frac{Y_t - Y_n}{S_n}$	Plan rain (mm) $X_T = \overline{X} + (S \times K)$
2	0,3065	-0,1986	99,79
5	1,4999	1,0579	968,03
20	2,9702	2,6060	2037,77
50	3,9019	3,5871	2715,71
100	4,6001	4,3223	3223,73

Source : the calculating results, 2019

Table 4. Rainy return period (PUH)

PUH	Yt	Yn	Sn	K	R	SD	XT
2	0,3665	0,4952	0,9497	-0,1986	237,02	691	143,38
5	1,4999	0,4952	0,9497	1,0579	237,02	691	968,04
20	2,2502	0,4952	0,9497	2,6060	237,02	691	1513,95
50	3,1985	0,4952	0,9497	3,5871	237,02	691	2203,94
100	3,9019	0,4952	0,9497	4,3223	237,02	691	2715,73
			Average				7401,66
			Amount				1850,41

Source : The calculating results, 2019

Determine Yn and Sn (seen from the table)
Yn = 0,4952
Sn = 0,9487
Determine Yt
Yt = - [Ln x Ln T/T-1]
Yt = - [Ln x Ln 2/2-1]
Yt = 0.3665
Calculate Xt
Xt = X + {(SD/Sn) (Yt – Yn)}
Xt = 237,02 + (691/0,9497) (0.3665 - 0,4952)
Xt = 143,38

3.3. Rainfall Intensity Analysis

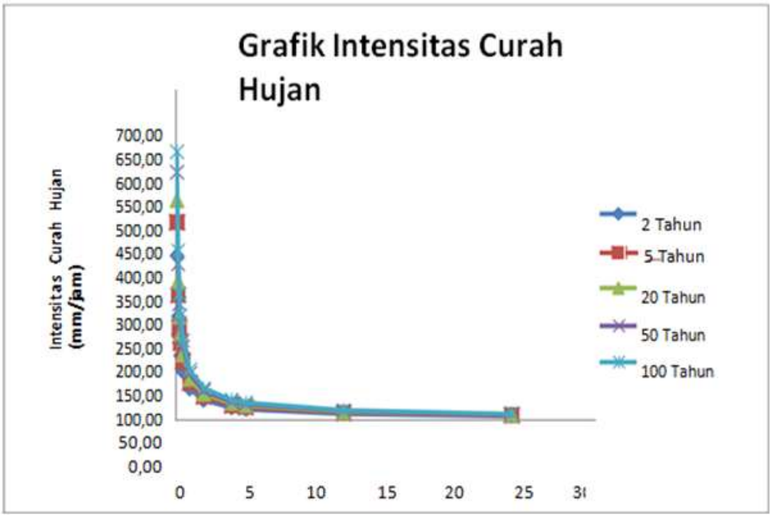
Ratio of the total amount of rain (rain depth) and expressed in units of depth per unit time is called the rainfall intensity, and is usually expressed as mm per hour (mm/hour). The amount of rain intensity caused by the long duration of rainfall. To get the intensity of rain for a certain duration can use the Mononobe method (Handayani at al. 2013).

Table 5. Mononobe Planned Rainfall Intensity (mm/hour)

Duration	Maximum Rainfall 24 hours (R24) (mm/24 Jam)				
	2 Years	5 Years	20 Years	50 Years	100 Years
	143,38	968,04	1513,95	2203,94	2715,73
0,08	267,73	1807,41	2826,93	4114,94	5070,49
0,16	168,66	1138,66	1780,78	2592,38	3194,38
0,25	125,25	845,82	1322,81	1925,69	2372,87
0,33	104,09	702,64	1098,87	1599,69	1971,17
0,5	78,9	532,82	833,3	1213,08	1494,78
1	49,71	335,6	524,84	764,03	941,45
2	31,31	211,35	330,64	481,33	592,93
4	19,73	133,18	208,17	303,04	373,41
5	16,99	114,77	179,5	261,3	325,54
12	9,48	64,01	100,11	145,35	179,58
24	5,97	40,33	63,08	91,83	113,15

Source : The Calculating Results, 2019

From Table 5 above and Figure 2 below, the rain intensity values for various rain durations using the Mononobe method. The intensity of the rain, the longer the duration of the rain, the value of the intensity of the rain will be smaller, in this case it shows that the shorter the period of rainfall, the greater the intensity of the rainfall, because the rain is not always continuous. To analyze the planning using the Mononobe formula for Rainy Return Period (PUH) 5 (five), assuming a rain duration of 2 hours, the result is a rainfall intensity of 211.35 mm/hour.



Source: Primary Data 2018

***Figure 2.** Rainfall intensity of the Mononobe Method*

$$I = \frac{R24}{24}\frac{(24)^{2/3}}{t} \quad (3)$$

$$I = \frac{968,04}{24}\frac{(24)^{2/3}}{2} \quad (4)$$

$I = 211,35$

3.4. Rainwater Volume in Residential

Areas The Cibinong urban settlement area is in a housing zone that has medium density land capability with a maximum building coefficient of 50% (Regent Regulation no. 92 of 2018). Cibinong City has a catchment area that has the potential to generate rainwater volume. The volume of rainwater that can be accommodated in the residential zone.

Calculate debit (Q)

$$Q=0,00278.C.I.A \quad (5)$$

Q = 0,00278 x 0.95 x 211,35 mm/jam x 1,5400 x 50% Ha

Q = 0.430 m^3/detik

The average rain in the Cibinong urban settlement area lasts at least 20 minutes or 1200 seconds in a day (Daulay, 2016). So the volume of rainwater runoff that can be accommodated is:

Calculating Volume (V)

$$V = Q \times 1200 \text{ detik} \quad (6)$$

V = 0,430 m^3/detik x 1200 detik

V = 516 m^3

Calculation of rainwater discharge using the rational method. From Table 6.5 it can be seen that the *volume* of rainwater that can be accommodated from buildings in Cibinong housing is 880288 liters or 880.288 m^3. Rainwater that can be accommodated will be distributed to each housing block and can be seen in Table 5

Table 5. Rainwater Volume in Cibinong Urban Residential Area

	Building Name	Code	Roof Area (A) m	KDB (%)	Rainfall Intensity (I) mm/Jam	Roof Coefficient (C) 0,95	Debit (Q) m/det	Storage Volume (V) m3	Volume (Liter)
1	Housing	PR	15400	50	211,35	0,95	0,430	516,00	516000
2	Education	PD	1171,08	50	211,35	0,95	0,048	57,00	57000
3	worship	PB	379,518	40	211,35	0,95	0,0085	10,168	10168
4	Offices	PK	240,960	60	211,35	0,95	0,0081	9,72	9720
5	Shops	PT	361,450	60	211,35	0,95	0,012	14,40	14400
6	Health	KS	346,990	60	211,35	0,95	0,012	14,40	14400
7	Markets	PS	3000	50	211,35	0,95	0,084	100,80	100800
8	Hostels	PN	1600	50	211,35	0,95	0,045	54,00	54000
9	TNI/Pol	AS	3850	40	211,35	0,95	0,086	103,20	103200
	Total		26,367,998				0,7336	880,288	880.288,00

Source : the Calcuting Results, 2019

3.5. Analysis of Clean Water Treatment Systems

Quality of rainwater raw water must meet the standards as raw water and drinking water for both physical and chemical characteristics. The results of the quality of rainwater above are the quality of water when it is not raining and visually in terms of the color of the water is clear, but when it rains the color of the water is a little cloudy. The turbidity is caused by environmental conditions in the upstream of the river experiencing changes in land use so that it supports fluctuations in water turbidity between the rainy and dry seasons. Therefore, it is very necessary to carry out a treatment process before the water is distributed to customers. To obtain water quality in accordance with the required standards, it is necessary to carry out a treatment process using a pre-sedimentation unit, a Quick Sand Filter (SPC) unit, and a disinfection unit. The water treatment plant is built in 1 (one) stage for a capacity of 16 l/second.

a. Pre-sedimentationsedimentation

The pre-tank is planned to consist of 2 (two) tanks with a capacity of 16 liters/second each. Following are the dimensions for 1 (one) unit of the pre-sedimentation tank:

1) settling basin
2) Mud Room
3) system *Inlet*
4) system *Outlet*

b. Rapid Sand Filter (SPC)

The rapid sand filter unit (rapid sand filter) is a filtration process capable of filtering raw water with a low degree of turbidity below 15 mg/l. The tub unit used is a filtration tub which is planned to consist of 2 tubs with a capacity of each tub of 16 l/s. Sand and gravel buffer media (consisting of 4 layers), are filter media used in the filtration process. To carry out the process of filtering raw water, it can be started from the operation of the filtration unit being washed (backwash) with a duration of 1 (one) time every day. The source of water in thefiltration process backwash comes from water that is stored in the reservoir. The reservoir unit discharges water to be pumped into the filtration unit through apipe backwash connected to the manifold pipe. The dimensions of the disinfection unit are as follows.

1) Body dimensions
2) Inlets
3) orifice
4) Underdrain
5) Outlets
6) Filtration media and buffers
7) Overflow channel
8) Pump

c. Disinfection

The disinfection process is carried out to reduce or eliminate pathogenic micro-organisms by using chlorine/calcium hypochlorite ($Ca(OCl)2$) which is inserted into the pipeline before entering the reservoir unit. The chlorine element used in the disinfection process is at a market level of 70%. The manufacture of the solution requires a chlorine content of 0.4 kg with a frequency of making 2 times a day (every 12 hours).

d. DistributionThe distribution

The system is a gravity system, which will serve the entire Cibinong urban settlement area according to the density of the population. The main distribution system and the flow pattern intended for service areas are very decisive in a plan. In order for the water distribution process to run smoothly, the distribution reservoir unit is designed to be close to the WTP, besides that the distribution system will make its operation and maintenance easier.

e. Distribution Reservoir

Construction of Phase 1 The distribution reservoir will be used to store water with a capacity of 277m3. The distribution reservoir unit consists of 2 equal parts and is equipped with several piping accessories including inlet pipe, outlet, channel drain, overflow. The water meter is a parameter used to measure the amount of water that will flow to the distribution network (consumers).

f. Distribution Piping Network

The distribution pipeline network calculation is done manually using the Darcy-Weisbach equation. The distribution pipeline network uses several alternative routes because most of them are located in service areas (settlements). The distribution line uses several branch patterns and has 2 main distribution pipes. The surface condition of the research area has different elevations, flat, up, and down.

3.4. Water Service Design and Infrastructure Development

a. Water Needs and Availability

Total demand for clean water in the Cibinong Urban Settlement in the service area is up to 2038 the average clean water need is 1508,943 l/sec. The availability of water discharge based on the calculation results is 643.360 l/sec, and the average population discharge is 1508.943 l/sec, able to serve 100% of the population's needs with 20% water loss. So that the available water debit is able to meet the clean water needs of the Cibinong urban population until 2038.

The water shortage in 2019 was 84 l/s, in 2024 it was 226 l/s, in 2029 it was 388 l/s, in 2034 of 575 l/sec, and in 2038 748 l/s can be anticipated by increasing the water supply from water reservoirs in the form of water reservoirs, water tanks called rainwater harvesting (smart tanks). The availability of existing water in the Cibinong urban settlement area can be seen in Table 7.

Table 6. Availability of existing water in the urban settlement area of Cibinong

Zone	Needs (l/det)
PublicHousing	372,543
Hydrant	41,394
Education	9,045
Worship Mosque and Mushollah	15,730
Offices	9,588
Shops	0,589
Health Centers and Hospitals	0,292
Market	18,627
Lodging	0,003
TNI/Polri Dormitory	0,003
Small Industry	175,546
Total	643,360

Source : Primary data, 2018

Based on table 6, it can be seen that the need for clean water in the Cibinong sub-district in 2018 was used for housing, public hydrants, education, worship, mosques and prayer rooms), offices, shops, health centers and hospitals, markets, lodging, TNI/Polri dormitories, Small industry, this indicates that the need for clean water in the Cibinong sub-district is very high. Which are scattered in the city center and in villages that are on the outskirts of the city. Furthermore, a picture of the PDAM pipeline network in Cibinong district can be seen in Figure 3.

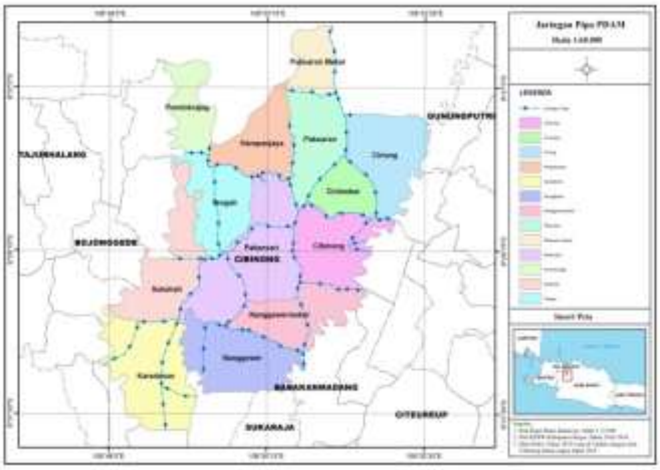


Figure 3. *PDAM pipeline network in Cibinong district*

From the picture above, it can be seen that most of the villages/kelurahan in the Cibinong sub-district are already served by the clean water network from the PDAM, but the network only reaches residential areas that are close to arterial and collector roads, this is because the PDAM pipeline network follows the road, so there are still rural areas that have not been reached by PDAM.

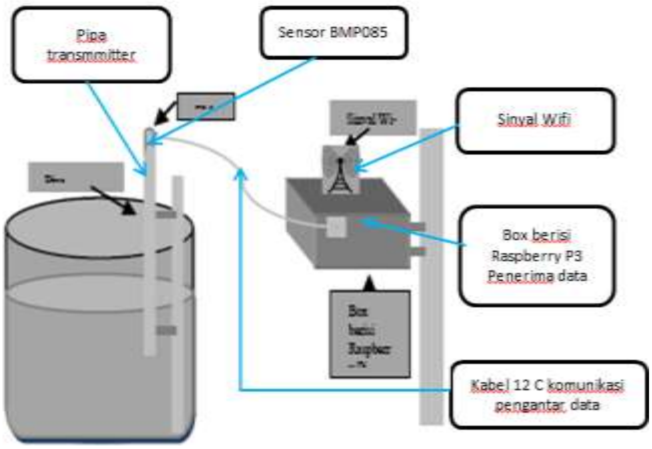
a. Prediction of Water Availability

Scenario for the clean water supply system in the Cibinong urban settlement area is planned by developingclean water supply infrastructure smart tank a modifiedin the form of WSC. Rainwater harvesting (PAH) is an alternative water source for community needs. The stages of the smart tank development design.

b. Design of Clean Water Infrastructure Development Services

Design of piped water infrastructure in the Cibinong urban settlement area which is planned for 20 years starting from 2019 to 2038. The smart tank design was designed based on the Bogor Regency Drinking Water Supply Master Plan (RISPAM) in 2014 and the Regional Spatial Plan Bogor Regency which has been approved. The mainstay rainfall is 80%, while the basic building coefficient (KDB) is used at 50% in order to meet the needs of public infrastructure and facilities (PSU).

According to Bogor Regency Regional Regulation No. 5 of 2014, the Master Plan for the Provision of Drinking Water (RISPAM) for Bogor Regency in 2014 and the RTRW for Bogor Regency are the main references for the direction of expanding the SPAM service area in the Cibinong urban settlement area in the future. Based on the structure of the function of the region in the future, the direction of developing the concentration of activities and social services on a sub-district scale is in the Cibinong urban settlement area.



Source: Adu at al. 2017
Figure 4. *Design Smart Tank*

Figure 4 above is an example of adesign smart tank that is used to detect water levels and regulate the distribution of clean water using a microcontroller. Thework system smart tank starts from reading the BMP085 sensor which is planted at the inner end of the transmitter pipe between the water level and the air. Then the BMP085 sensor sends data via a 2 C cable to the Raspberry P3 forwarded to the Web Server. The measurement results of the data collected on the Web Server then send notifications in the form of an email to the user.

c. Land use planning stages in the development of Smart Tanks in the Cibinong urban area
Land useis any form of human intervention on land resources, either permanent (permanent) or(cyclicalcyclical) which aims to meet their needs, both material and psychological. (spiritual) or both (Sitorus 2016). Land use is the result of continuous human efforts in meeting their needs for available land resources. Therefore, land use is dynamic, following the development of human life and culture (Sitorus 2012).

Classification of land use that is commonly used is based on aspects of land use for agriculture and non-agriculture. The land use can be grouped into two groups, namely:

1) The use of agricultural land is differentiated based on the supply of water and the commodities that are cultivated, utilized or on the types of plants or plants found on the land, such as moor, rice fields, gardens, meadows, forests and so on;
2) Use of non-agricultural land such as land use for urban or urban settlements, industry, recreation, mining and so on (Hapsari et al. 2015). As a form of human activity, in the field it is often found that land uses are either single (one use) or a combination of two or more land uses.

The physical resources of an area such as soil, water, climate, topography, and geology greatly determine the potential of an area for various types of use (Kurnianti 2015). If the use of land for rice fields turns into residential or industrial, the change in land use is permanent and cannot be returned (irreversible). Sulikawati et al. (2016) defines land use change as a process of change from previous land use to other land uses which can be permanent or temporary, and is a logical consequence of the growth and transformation of changes in the socio-economic structure of developing communities. Changes in land use in the implementation of development cannot be avoided. These changes occur because of the need to meet the needs of an increasing population and are related to the increasing demands for a better quality of life. For example, the increasing need for living space, transportation, recreation areas and clean water will encourage changes in land use (Mayasary 2015).

(1) First

Phase The first phase ofdevelopment smart tank in the Cibinong urban settlement area in the period 2019 to 2024 will be designed smart tanks in order to meet the water needs of the community. The development of smart tanks will be adjusted to the level of clean water needs for the community. The focus of thedevelopment location smart tank in the Cibinong urban area is based on village or urban administration. At this stage the villages that are the focus of handling are villages that are not served by the PDAM's clean water network. The distribution of villages or Ward that are the focus of the development smart tank for the first stage can be seen in Figure 5.

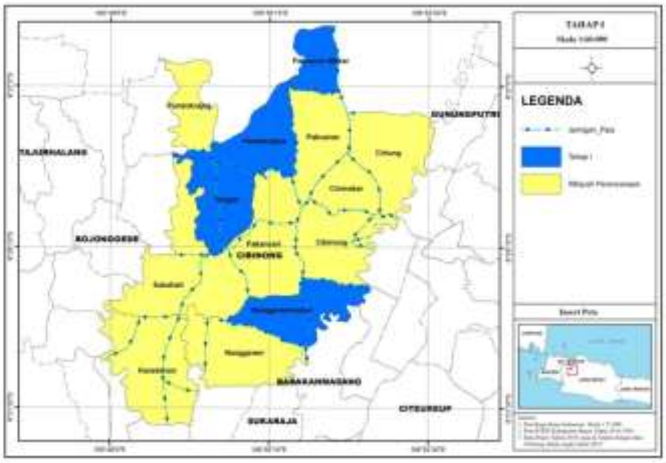


Figure 5. *Distribution Map of development Villages/Villages Smart Tank 2019-2024*

From Figure 5 above, you can see a map of the distribution of villages/Ward that became the focus of the development smart tank in the Cibinong area in the first year of 2019 – 2024, namely Harapan Jaya, Pabuaran Mekar, Tengah, and Nanggewer Mekar villages. In the future, it is hoped that with this smart tank, people who are not served by PDAM can enjoy clean water.

(2) Second

Phase The first phase of the development of *smart tanks* in the Cibinong urban residential area in the period 2024 to 2029 will be designed *smart tanks* in order to meet the water needs of the community. The development of *smart tanks* will be adjusted to the level of clean water needs for the community. The focus of the smart tank development location in the Cibinong urban area is based on the village or urban administration. At this stage, the villages that are the focus of handling are villages that are the development areas of urban settlement areas which are villages with locations far from the reach of PDAM pipes. The distribution of villages or Ward that are the focus of the development of *smart tank* for the first phase can be seen in Figure 6

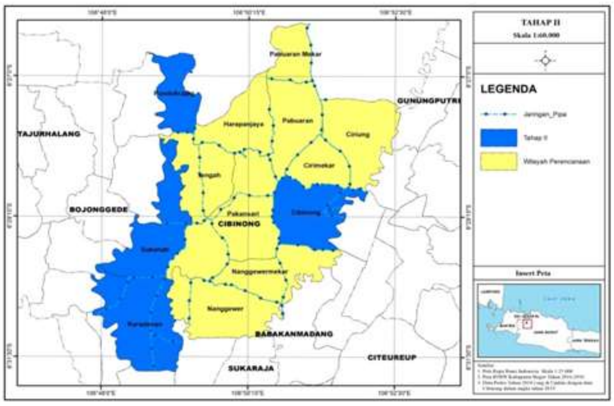


Figure 6. *Distribution Map of development Villages/Villages Smart Tank 2024-2029*

From Figure 6 above, it can be seen that the distribution map of the villages/Ward that became the focus of the development *smart tank* in the Cibinong area in the first year 2024–2029 were the villages of Cibinong, Karadenan, Sukahati, and Pondok Rajeg. This area is a development area for the Cibonong urban area, it is hoped that with this *smart tank*, people who are in the development area not served by PDAM can enjoy a clean water-smart *tank*.

(3) Third

Phase The first phase of development of smart tanks in the Cibinong urban settlement area in the period 2029 to 2034 will be designed smart tanks in order to meet the water needs of the community. The development of smart tanks will be adjusted to the level of clean water needs for the community. The focus of the development location smart tank in the Cibinong urban area is based on the village or urban administration. At this stage, the villages that are the focus of handling are villages that have been served by the PDAM's clean water network, but the water supply from the PDAM has not been sufficient. The distribution of villages or Ward that are the focus of development smart tank for the first stage can be seen in Figure 7

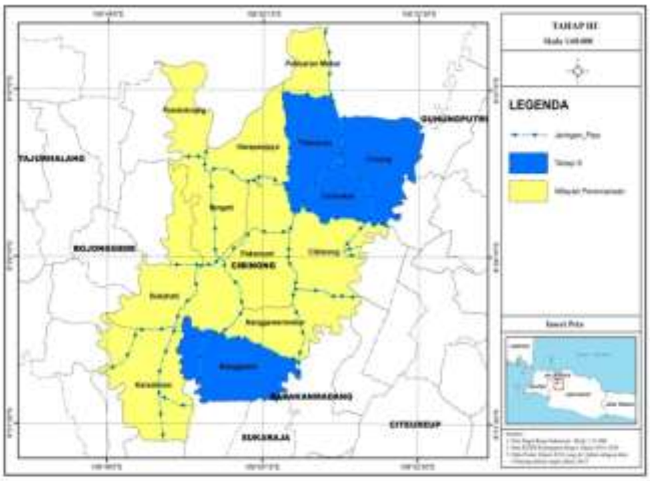


Figure 7. *Distribution Map of PemanganVillages/Sub-districts Smart Tank 2029-2034*

From Figure 7 above, it can be seen that the distribution map of villages/Ward that became the focus of the development smart tank in the Cibinong area in the first year 2029–2034 were the villages of Nanggewer, Pabuaran, Cirimekar, and Ciriung. This area is a development area for the Cibonong urban area, it is hoped that with this smart tank the people in this area can meet the needs of clean water from smart tanks if the water supply from the PDAM is not sufficient.

(4) Fourth

Stage The first stage of development smart tank in the Cibinong urban settlement area in the period 2034 to 2038 will be designed smart tanks in order to meet the water needs of the community. The development of smart tanks will be adjusted to the level of clean water needs for the community. The focus of the development location smart tank in the Cibinong urban area is based on the village or urban administration. At this stage, the villages that are the focus of handling are villages that have been served by the PDAM's clean water network, but the development of smart tanks in this location is directed as a clean water reserve if at any time the water supply from the PDAM is disturbed. The distribution of villages or Ward that are the focus of development smart tank for the first stage can be seen in Figure 8

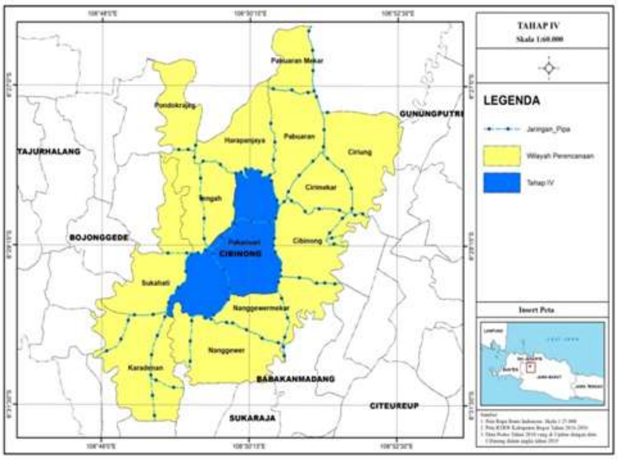


Figure 8. *Distribution Map of development Villages/Villages Smart Tank 2034-2038*

From Figure 8 above, it can be seen that the distribution map of the villages/Ward that became the focus of the development smart tank in the Cibinong area in the first year 2034 – 2038 was Pakansari village. This area is a development area for the Cibonong urban area, it is hoped that with this smart tank the people in this area can meet the needs of clean water from smart tanks if the water supply from the PDAM is not disturbed. The development of this smart tank in this area is expected to maintain a clean water supply because this area is a center for trade and services, government, public services, and settlements.

IV. Conclusion

a. The existing service area of the Piping SPAM Cibinong urban settlement area is an area that is used as the center of urban activities with an existing service level of 17.26%. The existing raw water source used by PDAM Cibinong District is the Ciliwung River with a water discharge rate of 643.360 l/sec. PDAM Tirta Kahuripan in 2018 was only able to produce clean water of 643,360 l/second, so the amount of water distributed did not meet the needs of the community.

b. The shortage of clean water in the Cibinong sub-district in 2038 is 748 l/second, therefore we have to look for new alternative sources of raw water.
c. The construction of a water supply system will be implemented immediately by developing a clean water supply infrastructure, in this case, the design *smart tank.*

References

Badan Pendukung Pengembangan Sistem Penyediaan Air Minum (BPPSPAM). 2013. Pedoman Penurunan Non Revenue Water (NRW) atau Air Tak Berekening (ATR). Jakarta: Kementerian Pekerjaan Umum dan Perumahan Rakyat

Badan Pertanahan Nasional. (2013). Tata Cara Kerja Penyusunan Neraca Penatagunaan Tanah. Jakarta: BPN.

Badan Pusat Statistik (BPS) Bogor. (2019). Kecamatan Cibinong dalam angka 2019. Kabupaten Bogor: Pemerintah Kabupaten Bogor.

BMKG, Badan Meteorologi, Klimatologi, dan Geofosika, [Online]. Available: https://inatews.bmkg.go.id/new/tentang_tsunami.php. [Accessed 12 Maret 2018]

Brown RR, Wong THF, Alien R, Deletic A, Gangadharan L, Gernjak W, Jakob C, Johnstone P, Reeder M, Tapper N, Vietz G, Waish CJ. 2013. Blueprint 2013: Stormwater Management in a Water Sensitive City. Melbourne (AU): Cooperative Research Centre for Water Sensitive Cities.

Handayani, Y. L., Hendri, A., & Aditya, A. (2013). Analisa Hujan Rancangan Partial Series Dengan Berbagai Perpanjangan Data Dan Kala Ulang Hujan . Jurnal Teknik Sipil Volume 12, No.3 , 221-223.

Hapsari A, Ritohardoyo S. 2015. Keselarasan Perubahan Penggunaan Lahan dengan Rencana Detail Tata Ruang (RDTR) di Wilayah Peri-urban Kasus: Kecamatan Godean Tahun 2009-2014. Jurnal Bumi Indonesia. 4(4):1-10

Hasibuan DAF. 2013. Analisis kebutuhan dan ketersediaan air baku di Kabupaten Tangerang [skripsi]. Bogor(ID): Institut Pertanian Bogor

K. S. Adu-Manu, C. Tapparello, W. Heinzelman, F. A. Katsriku, and J. D. Abdulai, “Water quality monitoring using wireless sensor networks: Current trends and future research directions,” ACM Trans. Sens. Networks, vol. 13, no. 1, 2017.

Kang H.M. and Yusof F., 2013.Determination of Best-fit Distribution and Rainfall Events in Damansara and Kelantan, Malaysia.Matematika. Hal: 43-52.

Kurnianti D N. 2015. Proyeksi Penggunaan Lahan untuk Konsistensi Tata Ruang di Kawasan Jabodetabek [Tesis]. Bogor (ID): Institut Pertanian Bogor.

Mayasary D S. 2015. Analisis Perubahan Penggunaan Lahan, Pola Ruang dan Tingkat Perkembangan Wilayah di Kota Bogor [Skripsi] . Bogor (ID): Institut Pertanian Bogor

Nurjannah dan Purwandari. 2012. Alih Fungsi Lahan: Potensi Pemicu Transformasi Desa-Kota (Studi Kasus Pembangunan Terminal Tipe A “Kertawangunan”). JSEP. Vol. 6/3, pp. 53-68.

Peraturan Bupati no. 92 tahun 2018 tentang Petunjuk Teknis Ketentuan Umum Peraturan Zonasi Pemanfaatan Ruang di Kabupaten Bogor

Peraturan Menteri Dalam Negeri RI No. 115 Tahun 2017 tentang Mekanisme Pengendalian Pemanfaatan Ruang

Peraturan Menteri Pekerjaan Umum dan Perumahan Rakyat. (2016). Peraturan Menteri Pekerjaan Umum dan Perumahan Rakyat Nomor 27 Tahun 2016 tentang Penyelenggaraan Pengembangan Sistem Penyediaan Air Minum. Jakarta: Peraturan Menteri Pekerjaan Umum dan Perumahan Rakyat.

Peraturan Pemerintah Republik Indonesia Nomor 21 Tahun 2021 Bab I Pasal 1 Tentang Penyelenggaraan Penataan Ruang

Rustiadi, E. (2018). Perencanaan dan Pengembangan Wilayah. Jakarta:Yayasan Pustaka Obor Indonesia.

Shah, M. et al. (2020). The Development Impact of PT. Medco E & P Malaka on Economic Aspects in East Aceh Regency. Budapest International Research and Critics Institute-Journal (BIRCI-Journal). P. 276-286.

Sitorus SRP, Leonataris C, Panuju DR. 2012. Analisis Pola Perubahan Penggunaan Lahan dan Perkembangan Wilayah di Kota Bekasi, Provinsi Jawa Barat. Jurnal Tanah dan Lingkungan 14(1):21–28.

Sitorus. 2016. Perencanaan Penggunaan Lahan (Cetakan Pertama). Bogor (ID): IPB Pres

Sri Harto. (2013). Analisis Hidrologi.Jakarta:Gramedia Pustaka Utama.

Subramanya, 2013. Engineering Hydrology. New Delhi: McGrawHill.

Sudarmadji, Hadi, P. & Widyastuti (2014). Pengelolaan Sumberdaya Air Terpadu. Pertama. Yogyakarta: Gadjah Mada University Press.

Sulikawati, Jupri, L. S. (2016) 'Dampak alih fungsi lahan pertanian menjadi permukiman terhadap perubahan nilai lahan di Kecamatan Bogor Utara Kota Bogor', 4, pp. 1–12.

Talen, E., Anselin, L., Lee, S., & Koschinsky, J. (2016). Looking for Logic: The Zoning—Land Use Mismatch. Landscape and Urban Planning, 152, 27-38. doi:https://doi.org/10.1016/j.landurbplan. 2016.04.002

Triatmodjo, B. (2013). Hidrologi Terapan. Yogyakarta: Beta Offset Yogyakarta

WHO. Millennium Development Goals (MDG's). (2015). Jakarta: United Nation; 2015.

.