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SUSTAINABLE DEVELOPMENT FOR WATER SUPPLY CASE STUDY: INDONESIAN COASTAL CITY

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ABSTRACT

Increasing need of clean water will affect the needs to get proper and equitable water distribution services throughout the region. City X is a strategic city for the eastern part of Indonesia. Existing water supply is very bad because the water needs are still not achieved. Therefore, sustainable development planning is needed for the water supply system so it can meet the needs of clean water that fulfill three aspects of service, namely quantity, quality and continuity. The method used in this research are compilation of general plans, preparation of programs and development activities, preparation of criteria and service standards, analyze potential sources and allocation of raw water. Based on the projected population density and the planned development of the City X, the service area is divided into six distribution zones, by considering the availability of existing drinking water supply systems, priority of underserved areas, population density and direction of City X. At the end of this plan (in 2036) the achievement of piped drinking water services is around 79%. From the volume aspect, the water balance shows excess of water supply. In this development, a plan is prepared by considers possibilities in the implementation of water supply system development.

KEYWORDS: Clean Water, Sustainable Development, Water Supply System.

1. INTRODUCTION

The clean water supply system has been established since 1983 by the Directorate General of Human Settlements and managed by the Drinking Water Management Agency (BPAM). The supply of clean water / drinking water in City X was carried out by a business entity substituting the Regional Drinking Water Company since 2005. City X's drinking water supply system currently has two units of installation with an average water production capacity (in 2011-2015) from both water treatment plant (WTP) is 146 liter/day. The percentage of water loss rates decreased from 2009 (61%) to 2015 to 49%. Problems with the drinking water supply system can be seen from the technical and non-technical aspects. Both aspects will be related to each other. In May 2016, the production of clean water decreased around 40% from the previous year's production as the effect of decreasing the quality of raw water sources used. This is one of the factors decreasing City X's water production. As for other clean water sources, special studies need to be carried out so that the potential of water resources can be known and can be managed optimally. Therefore, sustainable development planning is needed for the water supply system so that it can meet the needs of clean water for residents of City X who can fulfill three aspects of service, namely quantity, quality and continuity.

2. METHODS

Population growth is one of the factors that must be considered in planning drinking water supply system. The increasing rate of population growth in a city give impact to addition of infrastructure facilities that support population needs such as the drinking water supply system. Based on population data from 2006-2016, City X has an average population growth of 7,22% per year. Based on the results of testing the three projection methods, the arithmetic method was chosen to be used because it provides better projection results and represents an increase in population which is closer to the condition of the real population.

In conducting the projected number of house connections (HC) done by considering how much amount of water that able to be supplied. When this plan is drawn up, the supply of drinking water is managed by a private sector that gets the right to manage drinking water services by the City Government of X City. In addition, there will be an additional supply of drinking water from the City Regional Drinking Water System and District X which

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is assistance from the Central Government (Directorate of CiptaKarya) in 2018. For the management of City Regional Drinking Water System, a Regional Level Service Unit was formed in 2014. The method used in the sustainable development planning of the city X drinking water supply system includes:

- Compilation of general plans,
- Preparation of programs and development activities
- Preparation of criteria and service standards, and
- Analyze potential sources and allocation of raw water.

3. RESULTS AND DISCUSSION

Based on the projected population density and the planned development of the City X, the service area is divided into six distribution zones by considering the availability of existing drinking water supply systems, priority of underserved areas, population density and improvement direction of City X.

Some districts combined into one zone generally almost have the same density and have a close location. With consideration of the design, it is expected that drinking water supply for City X will be on target in line with the growth of City X in the future. Based on the results of zoning, it is known that zone 1 has the largest water requirement, which is 641,08 liters/second, followed by Zone 3 of 613,63 liters/second. Zone 1 has the largest needs due to the existence of alarge residential area.

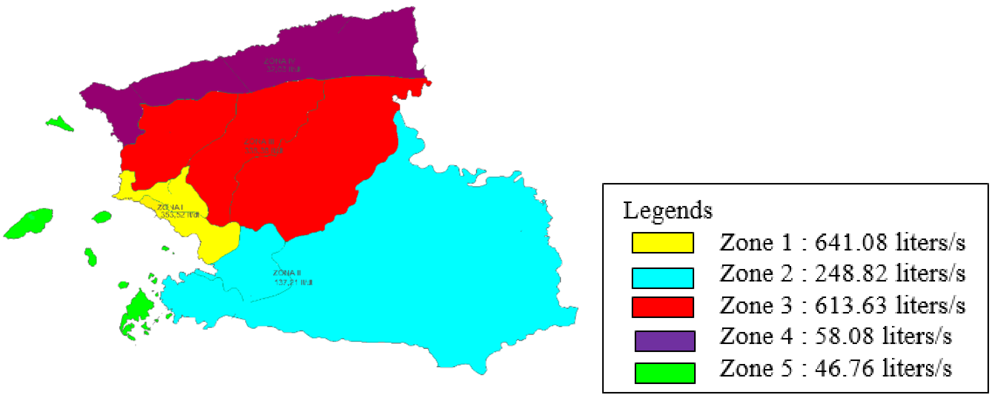

Fig 1: Zoning map of the water needs of City X in 2036

Based on City X population data for 10 years, population projections were calculated for 20 years. By considering all of possibilities that might be happened during the implementation, the scenario about water supply system needs to be conduct by all of stakeholders. In this scenario, City Regional Drinking Water System operates in 2018 and the development plan is in accordance with the planned water supply of 500 l/s until 2024. Assuming delay in the development pipeline so that the City Regional Drinking Water System's plan can be realized in 2031, so the target of adding HC will be 50% of the annual target that had been planned. In 2018, the private sector that previously supplied water to City X will has completed contract with the Sorong City Government and the management of the existing water supply is returned to the Sorong City Government.

Water supply revitalization from WTP managed by private sector (110 liter/day) is carried out so that it can increase supply capacity by 20 liter/day (according to what is required in the City Regional Drinking Water System Pre-FS Study) in 2012 and then assumed that the supply will be increase by 20 liter/day in 2027 so that the total discharge of the water supply from the WTP becomes 150 liter/day. The sustainable development for water supply that planned for the City X is an improvement of City Regional Drinking Water System after 2031 to increase 100% piped water service in 2031 (5 year delay). At the end of this plan (in 2036) the achievement of piped drinking water services is around 79%. Assuming the growth in the number of customer connections is 12% / year from the number of customers. With this assumption, the addition of HC ranges from 16-26 HC/day (reference from City Regional Drinking Water System to increase HC after 2020 is 17 HC / day). The following are the scenarios applied in planning drinking water supply:

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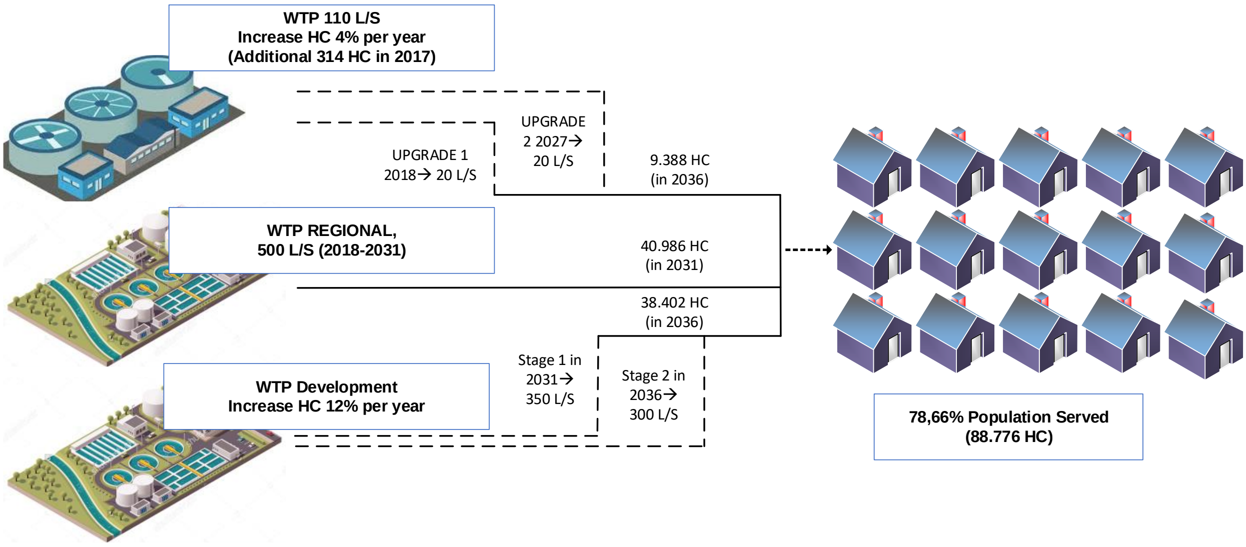

Fig 2: Scheme for Increasing House Connections

From the volume aspect, the water balance shows excess of water supply. For this reason, planning is made in the scheme of service targets reaching 100% for City X until 2036. Drinking water services will run according to the "business as usual" with a plan to increase capacity by 2 times to reach a production capacity of 150 l/s. Regional WTP runs according to the target number of customers (40.986 HC) and the allocation of drinking water supply of 500 l/s which has been set by the end of 2024. Furthermore, the development of the service starts in 2025 so that at the end of the planning year (2036), water drink can reach 100%. This development is in the form of adding WTP units and developing distribution networks to increase the number of customers.

In general, the potential of surface water that can be used as a water source can be classified as river, lake, spring, swamp and coastal, temporary rain / reservoir reserves. Water sources that can be used as raw water sources for drinking water for City X include rivers and lakes. Some rivers are surveyed to see the potential quantity and quality of water that meets the criteria as a source of raw water. In conducting river selection as a raw water source, several aspects that must be considered are quantity, quality and continuity of the river. The river used for the distribution of the watershed is a large river which has the potential to be extracted by considering the current size and current continuity. From the analysis it is known that the rivers that pass through or are in Sorong rely on rainfall as the main filler thus be strongly influenced by the seasons. Small rivers will dry out during the dry season so they cannot fulfill the quantity and continuity aspects in the supply of raw water for drinking water.

The river which is currently used as a source of raw water has not fulfilled the requirements due to changes in the characteristics of the river which are strongly influenced by the season. In addition, the water withdrawal discharge has also exceeded 10% of the river's capacity so that it is not possible if the withdrawal discharge increased. River A is very potential to be used as an alternative source of raw water for drinking water considering the river discharge (especially the estuary part) which is affected by tides so that the water debit is always abundant and the influence of the season is quite small. But despite fulfilling the quantity and continuity aspects, the characteristics of brackish river water with high salinity levels require different water treatment methods than conventional water treatment. Water treatment with high salinity is generally carried out with desalination units that require both investment and operational costs and maintenance that is greater than conventional processing for fresh water. Therefore, the quality and financial aspects become constraints for River A as a source of raw water for drinking water.

River B is the best alternative when compared to other rivers. Even though the debit plan for river B is smaller than the watershed that is currently used as raw water, the discharge plan for the B river flow area will actually be much greater if part of the river B stream in the Regency X region is included in calculation. In the calculation, the planned discharge of river B is calculated only in watershed areas in City X only. This is the reason why the planned discharge of river B is smaller than the discharge of other watershed plans. In addition,

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there are already intakes, plans to develop transmission and IPA pipelines for Regional SPAM make River B very potential as a source of raw water for drinking water for the development of City X SPAM. City X SPAM can later be integrated with Regional SPAM so that it is easier in planning, operation and monitoring.

In addition to the river, an analysis of the potential of the lake in the form of a water reservoir in the city X is in the form of an irrigation pond located at km 13 from the main road of city X. The embung has been constructed with construction of retaining walls that are still under construction. The channel for irrigation from this dam has been completed but has not been operated. Pump houses for pipeline drainage have also been available but have not been used.

Fig 3: Description of Embung Water Condition

For potential springs, the springs that the researchers examined were Y waterfalls which have a height ranging from 3-4 meters with organoleptic water quality that is quite clear. The surrounding soil and bottom of the waterfall are clay soils. Access to the Y waterfall is quite difficult to reach and is in a protected forest area. The condition of the waterfall and its small storage are not possible if used as a source of raw water.

The potential for groundwater extraction in city X as potential for raw water is not recommended. This is based on the Decree of the President of the Republic of Indonesia No. 26 of 2011 concerning Determination of Groundwater Basin, which states that the extent of groundwater basins included in the city of X cannot be identified. In addition, based on the Presidential Regulation of the Republic of Indonesia No. 57 of 2014 concerning Spatial Planning, it is stated that it is necessary to control the exploitation of groundwater in groundwater basins which are located adjacent to the sea to avoid land subsidence and sea water intrusion.

The potential of rainwater in city X cannot be determined precisely because there is only one rainfall measurement station. Therefore, the potential of rainfall in the city of X can be applied to households by making individual rain pools. The potential of rainfall storage is considered important to consider especially the City X Islands District which is directed to use a non-piping system in meeting drinking water needs.

The plan to develop a drinking water supply system includes plans to develop raw water sources and intakes, production units, distribution units and service units. Development of raw water sources and intakes is carried out in the form of protection of raw water sources, maintenance of raw water units, and monitoring and evaluation of raw water units, while in City Regional Drinking Water System for City X is in the form of operation of intake buildings with raw water transmission networks. As for City Regional Drinking Water System Cıty X, the development is in the form of planning the intake building and transmission network. Development of production units carried out on Existing water supply system includes WTP maintenance, rehabilitation, as well as monitoring and evaluation, while in City Regional Drinking Water System Cıty X in the form of planning for drinking water production units.

Development of the distribution unit includes the addition of distribution reservoir capacity and expansion of the primary distribution pipeline network, as well as the development of the District Meter Area (DMA). The addition of distribution reservoir capacity aims to maintain equilibrium between supply and consumption along with the increase in water demand of City X. The expansion of the primary distribution network to be carried out is divided into two expansions, namely expansion of existing primary networks and expansion of new networks. The expansion of the existing primary network is carried out by enlarging the existing primary pipe that will distribute water sourced from the existing water supply system and City Regional Drinking Water

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System Cıty X. The expansion of the new network is an expansion of the scope of services achieved by creating a new network that will drain water sourced from the development of the City X water supply.

The development planned for service unit is by adding home connections as an effort to reach the targeted level of service. The development of this service unit is also carried out by ensuring the availability of drinking water services that fulfill three aspects, namely quantity, quality and continuity. By ensuring these three aspects, the customer will feel satisfied and will continue to subscribe.

Plans for reducing leakage in the form of handling commercial water losses and decreasing physical water losses. Handling commercial water losses is planned through efforts based on the causes of commercial water losses themselves, such as meter inaccuracies, data reading and handling errors, unauthorized consumption, and increasing collection efforts to deal with unpaid or overdue customer bills. The reduction in physical water loss is planned through the installation of DMA in the existing service area and replacement of distribution pipes, especially old pipes.

4. CONCLUSION

Sustainable development planning is needed for the water supply system by concern with quantity, quality and continuity. The service area divided by considering the availability of existing drinking water supply systems, priority of underserved areas, population density and direction development. In this research, WTP operates in 2018 and the development plan is in accordance with the planned water supply of 500 l/s until 2024. At the end of this plan (in 2036) the achievement of piped drinking water services is around 79%. Customer connections will increase up to 12%/year. In this development, a plan is prepared that considers various possibilities in the implementation of water supply system development until 2036. The plan to develop a drinking water supply system includes plans to develop raw water sources and intakes, production units, distribution units and service units. Through this research, it is known that the potential of raw water that can be used as an alternative for future water needs in City X is on river B. However, the use of river B as a raw water source also requires further study regarding the future river management plan.

References

1. *Heidecke, Claudia. (2006). Development and evaluation of a regional water poverty index for Benin. EPT Discussion Paper 145. IFPRI.*
2. *Meigh, J.R., McKenzie, A.A. and Sene, K.J. (1999). A grid-based approach to water scarcity estimates for eastern and southern Africa. Water Resources Management 13: 85–115.*
3. *Ohlsson, L. (1999). Water conflicts and social resource scarcity. Paper prepared for the European Geophysical Society. Den Haag. April: 12-23.*
4. *Steven D. M. Mlote, Caroline Sullivan and Jeremy Meigh. (2002). Water Poverty Index: a Tool for Integrated Water Management. Paper presented at 3rd WaterNet/Warfsa Symposium 'Water Demand Management for Sustainable Development', Dar es Salaam.*
5. *UN. (2002). United Nations's Report of the World Summit on Sustainable Development. 15 A/CONF.199/20: 15-21.*