Study on Development of Water Supply System in Penukal Abab Lematang Ilir Regency

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Abstract. PALI is one of Regencies in South Sumatera Province which previously belonged to Muara Enim Regency. Water treatment plants in this regency are owned and operated by Muara Enim Government. The water supply serves 60.51 % of the total population which is less than national target (100 %) by 2019. The objective of this research is to study the deficit of water supply by 2037. The method used in this research was estimating water demand based on the projected population by 2037 and compared with water availability in the region. It is concluded that PALI can serves 24.88 % in 2019. Whereas to reach the national target of piping water service is 35 % in 2019, the strategy has to construct a new Water Treatment Plant (WTP) as 100 L/sec for serving Talang Ubi District that using water resource in Teluk Lubuk District or nearest WTP from Talang Ubi.

1. Introduction

Clean water is a basic need that is indispensable for sustainable human life in order to improve the degree of public health. To fulfill these basic needs, drinking water supply system is needed, healthy, efficient and effective, integrated with other sectors, especially sanitation so that people can live healthy and productive.

Penukal Abab Lematang Ilir (PALI) Regency is one of the new autonomous regions that was belonged to Muara Enim Government, South Sumatra Province, its areas 1,877.8 Km². Administratively, PALI Regency consists of five districts, that is Talang Ubi District, Tanah Abang District, Penukal Utara District, Penukal District, Abab District. Those District consist of 65 villages and 6 kelurahan. Based on the projected population used linear model in PALI Regency in 2022, 2027, 2032 and 2037 were numbered 197,445 people, 212,096 people, 226,744 people, dan 241,393 people. The highest population density is in Tanah Abang District which density in 2037 amounts 224.1 people/Km², while the lowest ones is amount 64.5 people/Km² [1].

Water supply system for PALI Regency is still conducted by Muara Enim Regency through PDAM Lematang Enim, Muara Enim Regency. To fulfill water supply in Muara Enim regency, PDAM Lematang Enim, Muara Enim Regency has Water Treatment Plant (WTP) which is managed by 3 (three) branches, namely Muara Enim Branch, Tanjung Enim Branch and Teluk Lubuk Branch. Of the 3 units of PDAM Lematang Enim, branch that serves the region of PALI Regency is the Teluk Lubuk Branch Unit. In juridical terms, the clean water company of PALI Regency has been established since
October 13, 2017 in accordance with the issuance of Regional Regulation of Penukal Abab Lematang Ilir Number 6 Year 2017 on the Establishment of Regional Water Company Tirta PALI Anugerah Penukal Abab Lematang Ilir. However, clean water management is still in the process of handing over the assets with Muara Enim Regency Government, so that clean water management is still done by PDAM Lematang Enim, Muara Enim.

The fulfillment of clean water needs in PALI Regency is served by pipeline network through PDAM Lematang Enim and not pipeline network through protected water source ie digging well, and river water. The coverage of piped water service is 18.11% (32,995 people), while non-piped water service is 42.41% (77,272 people) [2]. PDAM Lematang Enim through Teluk Lubuk Branch Unit has 4 (four) units of WTP, those are Tanah Abang WTP, Tempirai WTP, Simpang Babat WTP and Air Itam WTP while the capital of PALI, Talang Ubi District, Pendopo served by the WTP located in Teluk Lubuk, Muara Enim Regency. Total number of PALI Regency subscribers up to 2017 is 6,599 units of house connection. The installed capacity of PALI Regency water management system is 190 L/s. (operating conditions both 160 L/s) with a production capacity of 160 L/s. Assuming that 1 L/s. can serve 80 house connection and 5% for public hydrant, it can be calculated that the service capacity of water supply system with piped water network by 12,800 house connection and 640 public hydrant. This shows the existence of idle SR is 6,201 house connection, which means also idle capacity that can be utilized again.

Since the establishment of PALI Regency in 2013, the trend of increasing coverage of piped water services in PALI Regency is as follows: 14.21% (2014); 15.67% (2015); 17.10% (2016) and 17.03% (2017) [3]. The realization of piped water service coverage is still very far when compared with national achievement so it needs study in fulfillment of clean water requirement for PALI community. By 2017, the coverage of clean water service in PALI reaches 60.51%, while the national achievement is 72.04%. The target of national water service coverage is 100%, indicating an imbalance in the number of very remote targets, requiring an assessment of achieving logical and realistic targets in accordance with regional capability and national support.

Thus, can be formulated problems as follows:

a. What strategy should be done to fulfill clean water service in PALI Regency independently (not dependent on Muara Enim District)?

b. What kind of system development assessment should be done to meet the target of 100% water service achievement by 2019?

Based on the existing problems, this study aims to:

a. Identify the projected amount of clean water demand in the regency of Penukal Abab Lematang Ilir until 2037 (20 years).

b. Identify the capability of piped water service until it can be utilized optimally.

c. Analyze the strategy of developing the right water supply system so that the coverage of clean water service of the population in PALI Regency reaches 100%.

The objective of this research is to study the deficit of water supply by 2037. The method used in this research was estimating water demand based on the projected population by 2037 and compared with water availability in the region.

2. Literature Studies

Population growth is one aspect of resources that needs to be taken into account in the development of water supply systems. This is because the population is the subject of clean water users. The population of PALI Regency based on PALI In Figures 2017 is 182,219 people. The result of projection of population by using linear model in 2022, 2027, 2032 until 2037 amounted to 197,448 people, 212,096 people, 226,744 people, and 241,393 people as table 1. Until 2037, the estimated population of most
PALI regency is Talang Ubi District as many as 110,421 people, while the lowest estimated population is in Penukal District of 29,428 people [4].

PALI is crossed by 2 (two) watersheds (DAS) which is big enough, that is DAS Musi and DAS Lematang. Musi River in the north and Lematang River in the southern part of the regency, these two rivers have a very large discharge and potential as a source of raw water. Lematang River is one of the longest rivers in South Sumatera Province, the length of Lematang River 244 Km with 6,990 Km² of Watershed (DAS), average monthly debit of 315.8 m³/s [5]. Lematang River passes three regencies namely, Lahat regency, Muara Enim regency including PALI regency and Musi Banyuasin regency, empties into the Musi River. Musi River is located on the northern part of PALI Regency with a length of 640 Km and has a total area of 7.745 Km² River Flow, average monthly debit of 103.9 m³/s [6].

### Table 1. Population Projection of Penukal Abab Lematang Ilir Regency

| District    | Population Projection (People) | 2022  | 2027  | 2032  | 2037  |
|-------------|--------------------------------|-------|-------|-------|-------|
| Talang Ubi  |                                | 84,897| 93,405| 101,913| 110,421|
| Tanah Abang |                                | 30,352| 31,713| 33,073| 34,433|
| Penukal Utara|                               | 24,594| 26,206| 27,817| 29,428|
| Penukal     |                                | 29,143| 30,074| 31,004| 31,935|
| Abab        |                                | 28,459| 30,698| 32,937| 35,176|
| **Total**   |                                | **197,445**| **212,096**| **226,744**| **241,393**|

Source: PALI Regency RTRW 2017 - 2037

The availability of water is the amount of water (debit) estimated to be continuously present in one location (weir or other water building) in the river for a certain amount and within a certain period. Available water can be used for various purposes such as raw water covering domestic water and non-domestic water (trade, offices) and industry, river maintenance, livestock, fishery, irrigation and hydroelectric power plants [7].

A clean water network system is a system for delivering clean water from raw water collection, to reaching customers as clean water that meets clean water standards [8].

Water demand is determined by population projection, water consumption and water availability. The need of clean water is generally divided into two groups namely:

a. Domestik water demand, that is calculated based on the number of people who need clean water for daily purposes. This need is served by house connection and public hydrant.

Domestic water requirements can be calculated by the equation:

\[
\text{water needs} = \text{percentage of water services} \times a \times b
\]

where:

- \(a\) = total water use (liters/person/day)
- \(b\) = population of service area (people)

b. Non-domestic water demand, that is the water requirement for the identified facilities and infrastructures that exist or will be in accordance with the spatial plan of the territory. The determination of non-domestic water demand is based on the number of supporting population and the number of facility unit. Urban facilities include public, industrial and commercial facilities. The calculation of non-domestic water demand is assumed to be 15% - 20%.
The water supply system in PALI Regency is served by the Teluk Lubuk Branch Unit, PDAM Lematang Enim. Teluk Lubuk Branch Unit oversees the management of 4 (four) units of WTP that located in PALI and 1 (one) WTP Teluk Lubuk-Pendopo in Muara Enim. Water supply system in PALI Regency can be seen in table 2.

| IPAB                  | Capacity (L/s) | Service Capability (SR) | Idle Home Connection (SR) | The Number of Home Connection (SR) | The Number of People Served (SR) | Percentage of Piping Services (%) |
|-----------------------|---------------|-------------------------|---------------------------|------------------------------------|---------------------------------|----------------------------------|
| IPAB Tanah Abang      | 30            | 2,400                   | 1,269                     | 1,131                              | 5,655                           | 3.10%                            |
| IPAB Simpang Babat    | 10            | 800                     | 477                       | 323                                | 1,615                           | 0.89%                            |
| IPAB Air Itam         | 30            | 2,400                   | 2,046                     | 354                                | 1,770                           | 0.97%                            |
| IPAB Tempirai         | 30            | 2,400                   | 1,118                     | 1,282                              | 6,410                           | 3.52%                            |
| IPA Teluk Lubuk*      | 60*           | 4,800                   | 1,291                     | 3,509                              | 17,545                          | 9.63%                            |

* WTP Location in Muara Enim Regency that serves Talang Ubi district

2.1. Previous Studies

The research that aims to develop a strategy the increasing of the clean water service capacity in Bangko Municipality of Merangin Regency [10]. The capacity development strategy of clean water service is considering area aspect with its indicator of area topography, raw water source, raw water quantity, raw water quality, environmental pollution and forest destruction), social economic aspect and development with indicator of population growth, community economy, and regional development, PDAM service aspect with indicator of quantity and quality of water produced, service coverage, flow continuity, age of pipeline network, availability of supporting facilities and infrastructure, as well as regulatory and policy aspects with indicators in the form of support of authority and responsibility of water resources management, consumer protection and support of executive and legislative institutions. The results obtained are the determination of strategies undertaken to improve the capacity of clean water services in Bangko City adjusted to the characteristics of each region by using SWOT analysis.

According to the research that is motivated by the limited raw water resources in Gunungkidul Regency [11], it used Technical Guidance and Manual of Urban Drinking Water System as well as calculations done in research in PALI Regency.

The research that aimed to analyze drinking water supply strategy for the people in Kupang City and surrounding areas which are included in the semi-arid region of Indonesia in 2015-2035 [12]. The research method is done through data collection, formal documentation on related data equipped with field survey results to find out the real condition of availability and management of drinking water in the study area. Stages of analysis in this study by calculating the projected population based on arithmetic method, least square, geometric and linear regression and taken the data with the smallest standard deviation. Furthermore, also calculated the projected rate of drinking water needs by taking into account the domestic water needs, non-domestic water needs, urban needs, and water loss, average water demand, maximum water demand, and last peak hour water needs by using the standard provisions of urban facilities from Ministry of Public Works. This is done also on the analysis of research data for PALI Regency. The targeting of the achievement of clean water service in this study used the MDGs target in 2015 and in accordance with the direction of development policy in the drinking water sector in 2019.
3. Methodology
This research is descriptive research with quantitative approach. The implementation of this method is done by conducting surveys, case studies, comparative studies, and data analysis.

3.1 Source of Data
Data needed in this research is primary data and secondary data. Primary data is data related to the fulfillment needs of clean water service, that is data from survey results of Clean Water Treatment Plant in 4 (four) WTP in PALI and 1 (one) WTP unit in Muara Enim, and raw water availability data and information from interview result with related parties. Secondary data are supporting data needed for the study of development of water supply system in PALI Regency, among others: population data, piped water customer data, and service achievement data.

3.2 Data Collection
Primary data were obtained from interviews with related parties such as PDAM and collection of information by conducting surveys to water supply system location in 5 PALI District. This is done to determine the installed capacity and production capacity of each available WTP and the service that has been done by PDAM Lematang Enim.

Secondary data was collected by collecting data from the literature study which supported the study of water supply system development in PALI Regency.

3.3 Data Analysis
Data analysis is done as a follow-up of data collection to obtain the expected output. In the study of development of clean water system required data projection of population growth. The projected population growth is derived from the PALI Regency RTRW data 2017 - 2037 which is calculated by regression method. Population data is required to find out the projection of clean water needs up to the planning year. Projected data on clean water needs is used to answer the fulfillment of the national target of 100% coverage of water services by 2019, that consists of 35 % for piped water service and 65 % for non-piped water service.

The study of water supply system development in PALI Regency is done by optimizing raw water source scenarios and increasing capacity of existing WTP, and new WTP development scenario to fulfill clean water requirement independently if managed by PDAM Tirta Pali Anugerah.

4. Results and Discussion
As mandated by Peraturan Presiden Republik Indonesia Number 2 of 2015 on the National Medium-Term Development Plan 2015-2019, Indonesia targets 100% secure access to clean water services by 2019 with a service access target scheme with piped water service is 35% and a nonpiped water service is 65%. The coverage of PALI clean water service in 2017 only reaches 60.51%, consisting of 18.11% piped water service coverage and 42.40% non-piped water service coverage.

The clean water service in PALI still serves by PDAM Lematang Enim, Muara Enim Regency which has 6,599 home connection. Through the calculation of one home connection is assumed 5 (five) people, so the population that is served by piped water service, is 32,995 people or 18.11% of the total population of 182,219 people. While the coverage of the population that is served by non piped water service is 42.41% (77,272 people).

The WTP capacity in PALI currently reaches 160 L/s., it can be assumed serving 12,800 home connection and 640 public hydrant. Nowadays, PDAM Lematang Enim serves the area of PALI Regency 6,599 home connection. This shows the existence of idle capacity in fulfilling the piped water service. As explained earlier that the WTP in PALI is located in five districts. Tanah Abang WTP serves Tanah Abang District which has capacity 30 L/s and raw water source from Lematang River. Currently serving 1,131 home connections (5,655 people) or 3.10% of Tanah Abang District. IPAB Tanah Abang
still has idle 1,269 home connections which can be optimized for improvement of Tanah Abang District service. Simpang Babat WTP serves the Penukal District has an WTP with an installed capacity of 10 L/s and production capacity of 10 L/s. Currently serving 323 home connections (1,615 people) or 0.89% of people of Penukal District and still have idle of 477 home connections. Air Itam WTP serves the people of Abab District having WTP with installed capacity of 30 L/s and production capacity of 30 L/s with raw water source from Penukal River (Musi River). Currently serving 354 home connections (1,770 people) or 0.97% of the population of Abab District and still has idle 2,046 home connections. Tempirai WTP serves the people of Penukal Utara District having WTP with installed capacity of 30 L/s and production capacity of 30 L/s. The number of home connections currently reaches 1,282 (6,410 people) or serves 3.52% of the population of Penukal Utara District. Tempirai WTP still has idle 1,118 home connections.

By using equation 1 to know the domestic demand, PALI water supply needs up to 2037 can be calculate as table 3.

| Description                                      | Unit  | 2022  | 2027  | 2032  | 2037  |
|--------------------------------------------------|-------|-------|-------|-------|-------|
| Number of Population                             | People| 197,445| 212,096| 226,744| 241,393|
| Domestic Water Demand                            | L/s   | 229   | 245   | 293   | 313   |
| Non-Domestic Water Demand                       | L/s   | 19.65 | 21.62 | 29.72 | 32.21 |
| Domestic Water Demand and Non-Domestic Water Demand | L/s   | 248.18| 267.10| 322.83| 344.82|
| Loss Water                                       | %     | 20    | 20    | 20    | 20    |
| Average Water Demand                             | L/s   | 297.81| 320.52| 387.39| 413.79|
| Maximum Water Demand                             | Factor| 1.10  | 1.10  | 1.10  | 1.10  |
| Fire extinguisher                                | L/s   | 327.59| 352.58| 426.13| 455.17|
| Totally Water Needs                              | L/s   | 360.35| 387.83| 468.75| 500.69|
| Peak Water Needs                                 | Factor| 1.5   | 1.5   | 1.5   | 1.5   |
|                                                  | L/s   | 540.53| 581.75| 703.12| 751.03|

Furthermore, Teluk Lubuk – Pendopo WTP serves Talang Ubi District where the population is the highest. The WTP has an installed capacity of 60 L/s and the production capacity of 60 L/s has served 3,509 home connections (17,545 people) or 9.63% of the residents of Talang Ubi District. Teluk Lubuk-Pendopo WTP is located in Muara Enim Regency, so it can be a problem if the assets not clear yet. So, if PDAM Tirta PALI Anugerah will be operated to require alternative solution of water supply by building new WTP or increasing the nearest WTP capacity, unlike WTP location in 4 other districts located in regency PALI.

By using the target of increasing the achievement of clean water service 3 - 4% per year in accordance with the financial capability of PALI regency, it can be seen that the achievement of new water service reaches 24.88% in 2019 whereas the national target in 2019 is 35%. It can be seen in table 4.

The WTP capacity building strategy in the study considers the following:

a. Availability of raw water resources

The raw water source of piped water supply in PALI Regency comes from Lematang River and Musi River, the mainstay discharge of Lematang River at 56.510 L/s and the discharge mainstay of the
Susi River at 81.290 L/s. This figure indicates the potential for the availability of large raw water to meet the needs of clean water.

b. Population growth rate
Based on the calculation of population projection, it is found that the average percentage of population growth of PALI district is 3.43%. Population growth has an effect on the increasing need of clean water, where the water service by pipeline network is currently only 18.11% or 32,995 people are served.

c. Existing condition of WTP
PALI Regency is currently served by 5 (five) WTP with a total production capacity of 160 L/s. WTP location in 4 sub-districts within PALI District and 1 unit of WTP serving the district capital located in Muara Enim Regency.

d. Targeted coverage of clean water services
The target of clean water service coverage has been determined by the PALI District Government of 3% - 4% per year taking into account the regional financial capacity in developing the water supply system. While the national target under the Strategic Plan of the Public Works Ministry 2015-2019 coverage of piped water services by 35% in 2019, and nonpiped 65%.

e. Regional Financial Capability
The regional financial capability and the Government's commitment in providing clean water facilities and infrastructure is critical to achieving the targeted coverage of clean water services.

Table 4. Coverage Plan of Piped Clean Water Service in PALI Regency

| NO | IPAB            | Population Services by Piped Water (People) |
|----|----------------|--------------------------------------------|
|    |                 | 2018 | 2019 | 2020 | 2021 | 2022 | 2027 | 2032 | 2037 |
| 1  | IPAB TELUK LUBUK - PENDOPO | 20,801 | 24,095 | 27,423 | 30,781 | 36,509 | 58,848 | 79,496 | 102,695 |
| 2  | IPAB TANAH ABANG    | 9,078 | 10,903 | 12,743 | 14,597 | 16,358 | 26,256 | 33,637 | 41,476 |
| 3  | IPAB TEMPIRAI       | 7,453 | 8,509 | 9,578 | 10,657 | 11,484 | 17,477 | 22,724 | 28,455 |
| 4  | IPAB AIR ITAM       | 2,617 | 3,486 | 4,373 | 5,277 | 6,148 | 11,236 | 16,996 | 23,428 |
|    | Total (People)     | 39,949 | 46,993 | 54,117 | 61,312 | 70,498 | 113,818 | 152,853 | 196,054 |

Projected Population (People)

|               | 2017-2037 |
|---------------|-----------|
| 187,159       | 188,859   |
| 190,412       | 191,843   |
| 197,445       | 212,096   |
| 226,744       | 241,393   |

Percentage of Services (%)

|               |          |
|---------------|----------|
| 21.34         | 24.88    |
| (35)          | (35)     |
| 28.42         | 31.96    |
| 35.70         | 53.66    |
| 67.41         | 81.22    |

*National target

5. Conclusion
From the discussion, some conclusions can be drawn:

a. Projected population of PALI regency until 2037 is obtained from projection of population per five year at PALI Regency RTRW 2017-2037. The average percentage of population increase of PALI Regency is 3.43%. Projected population of PALI regency until 2037 based on PALI 2017 -2037 RTRW of 241.393 people.

b. The current production capacity of the piped water supply system is 160 L/s. With the calculation of capacity building plan to fulfill the clean water requirement of piping every WTP by using the target set of master plan of water supply system development of PALI Regency can be seen that in the next 20 years require the addition of capacity of 520 L/s with clean water service coverage
81.22% in 2037. However, to meet the national target in 2019 by 35%, PALI Regency has only 24.88% service capability and will surpass the national target by 2022.

c. Scenario of development of WTP show target of service achievement equal to 39% in 2021 and better be done at Lubuk Teluk because source of nearest raw water and still adequate. To fulfill the water requirement from 2022-2037, the scenario of WTP development in Tanah Abang district is 300 L/sec through Tanah Abang WTP. The development of new WTP in Teluk Lubuk is no longer possible because it is not part of PALI Regency so that the development of new WTP that is nearest to the source of raw water for serving Talang Ubi is located in Tanah Abang. The piped water service scenario in Talang Ubi District is targeted at 93% until 2037, because Talang Ubi district is the administrative center of PALI Regency and the center of strategic activities. The rest is assumed to be served through non-piped networks.

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