Projection Of Water Availability And Needs In The Watershed Of Sungai Bolong Of Border Zone Indonesia-Malaysia

Maria Menung Migo[1], Yoseph Yoseph[2]

Urban Infrastructure Civil Engineering, Politeknik Negeri Nunukan, Nunukan Indonesia
mariaboleng1@gmail.com[1], yoseph.stnnk@gmail.com[2]

Abstract: Provision of raw water for community needs is a direct effort in improving community welfare as the main key of regional economic development. Embung Bolong is a place to supply raw water which is managed by PDAM Nunukan through IPA Nursery and IPA Pasir Putih to meet the needs of the community in Border Zone Indonesia- Malaysia, especially Nunukan City. The purpose of this study was to analyze the availability of water in the Bolong reservoir on water adequacy. The method of this research is quantitative analysis in case of analyzing of water availability with Penman modification standardized by BSN in SNI 7745 in 2012 to get the value of Evapotranspiration and Mock model for getting the average monthly water discharge value of the Bolong river or called Sei. Bolong. The water needs analysis is using domestic and non-domestic water needs analysis in 2020. This analysis based on population, number of public facilities served by Bolong reservoirs and projecting domestic water needs in 2021–2035 based on water planning criteria by the Director General of Human Settlements, Public Works Agency in 2000. Water balance analysis based on the availability of water in the reservoir with the water needs for the people of Nunukan. The results obtained in this analysis are the clean water needs of the Nunukan population in 2020 amounting to 46.08 liters per second and after being projected until 2035 is the normal need 96.51 liters per second, the maximum day water needs are 110.99 liters per second and the peak hour requirement is 168.89 liters per second.

KEYWORDS : Water Availability, Water Needs, Water Balance.

1 Introduction

The provision of raw water for the needs of the community is a direct effort to improve the welfare of the community as the key to the economic development of the region. On Nunukan Island, meeting clean water needs is still a problem, the availability of raw water is still below the level of raw water needs due to significant population growth and the condition of limited raw water has become more critical due to massive land clearing for plantation, agricultural and settlement activities which results in a low discharge of the mainstay of the rivers on Nunukan Island. The condition of the Bolong Watershed (DAS) has a decrease in the carrying capacity of water resources on Nunukan Island, causing limited availability of raw water to meet the needs of clean water for the people on Nunukan sland.

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2 Research Methodology

The study location analyzes the availability and needs of water in the Bolong River Basin located in Nunukan Regency with a watershed area of 1,206 km2. Nunukan Island has a flat to hilly topography, with hilly shapes extending from northwest to southeast. The peaks of the hills located in the central part of the island, have an altitude of 150-185 m above sea level (asl). The method used in this study is Quantitative by using Penman Modification standardized by BSN in SNI 7745 of 2012 to obtain evapotranspiration value and Mock model to obtain the average water discharge value of Bolong river.

Identifying the condition of the Bolong embung, the Bolong watershed, the capacity of the embung, climate and rainfall data, land use in the embung area as a source of water infiltration that can help the availability of water in the embung and the number of residents and general facilities served by the Bolong embung. Analysis of Water Availability and Needs in the Bolong Watershed was carried out by comparing the availability of water in Embung with water needs for the community in Nunukan City with the variables used are:

1. Water availability variables with indicators: Average algebra of rainfall, Climate, Embung capacity, Land use, Bolong Watershed and Dew Condition.
2. Variable Water needs with indicators: Population, Service map and Schematic of drinking water supply system and water needs according to clean water planning criteria.

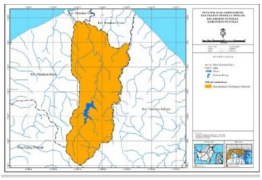

Fig 1. Administrative map of Nunukan Tengah village Source: Bappeda and R&D of Nunukan Regency, 2021.

Spatial data analysis is carried out using GIS-based software, while nonspatial data is analyzed using software that has calculation capabilities by making graphs. Nonspatial data management is carried out using quantitative analysis research methods to calculate water availability, namely the discharge of water available in the Bolong embung, projections of population, water needs in 2020, projections of water needs in 2021-2035 and water balance to the availability and needs of water in Nunukan City.

3 Data Analysis

1. Rainfall and climate Based on observations from the Nunukan Airport Meteorology, Climatology and Geophysics Agency (BMKG) in 2020, Nunukan experienced a hot climate with an average air temperature of 27.8°C and the lowest average rainfall in 2011-2020 in February was 113.71mm and the highest occurred in August at 317.21mm.
2. Land Use Land Use Embung Bolong catchment area there is a change in land function change, in 2013 it was still dominated by shrubs and forests of 452 ha and 420 ha of the total land area of 1,264 ha, but in 2021 it was dominated by settlements of 544 ha and mixed gardens of 360 ha of the same land area of 1,264 ha. The condition of the land is shown on the following map:

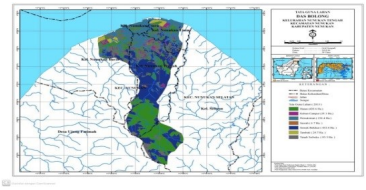

Fig 2. Land use map of Embung Bolong in 2013, The condition of the forest is still dense. **Source**: Research Analysis, 2023.

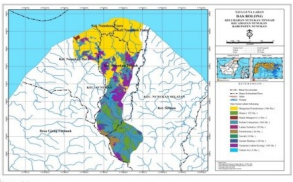

Fig 3. Land use map of Embung Bolong in 2023, Forest conditions have been reduced. **Source**: Research Analysis, 2023.

3. The Bolong Watershed and the Broad Capacity of The Bolong Embung 81,541.9 m2 with a depth of ± 5 meters, the capacity of the Bolong Embung ± 407,709.5 m3 (PDAM Nunukan data in 2020), the capacity of the carrying capacity always decreases along with sedimentation coming from the catchment area making silting at the bottom of the embung which reduces the capacity of the embung. For the catchment area in Embung Bolong suffered severe damage, in addition to cases of illegal logging, damage was also caused by forest looting or settlements and oil palm plantations. Bolong Watershed (DAS).

4 Discussion Of Research Results

4.1 Analysis of Water availability

The results of the calculation of monthly evapotranspiration of the Bolong embung area based on data on air temperature, air humidity, solar irradiation and wind speed using the Penman modification method with the largest calculation results occurring in February of 239.132 mm and the lowest occurred in October 131.57 as shown in this figure:

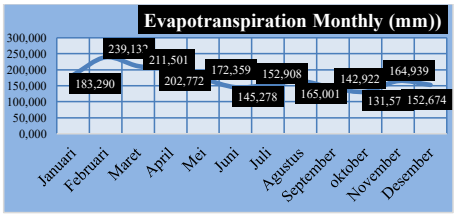

Fig 4. Source : Analysis results, 2023.

The results of the calculation of the monthly water discharge of the Bolong river from 2011 to 2020 using the Dr. F.J. Mock method are displayed in the form of a graph as below, The largest water discharge occurred in September at 0.1645 m3/s and the lowest in February at 0.0062m3/s :

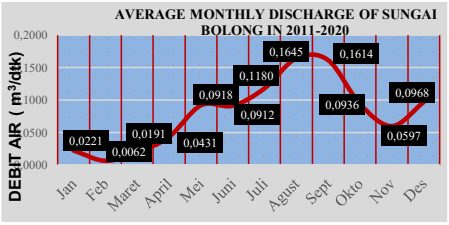

Fig 5. Source : Analysis results, 2023.

4.2 Water Needs Analysis

The analysis of domestic water needs is a very important aspect in determining the need for future water supply which is carried out on the basis of population growth analysis in the research area. Water requirements domestic for cities is divided into several categories and clean water planning criteria for each category have been set by the Director General of Cipta Karya PU, Year 2000.

Population Growth Projections
The number of residents of Nunukan Island served by Embung Bolong in 2020 is 5,513 SR (33,078 inhabitants), thus the projected population growth of Nunukan Island served by the Bolong embung until 2021 to 2035 is shown in the figure.

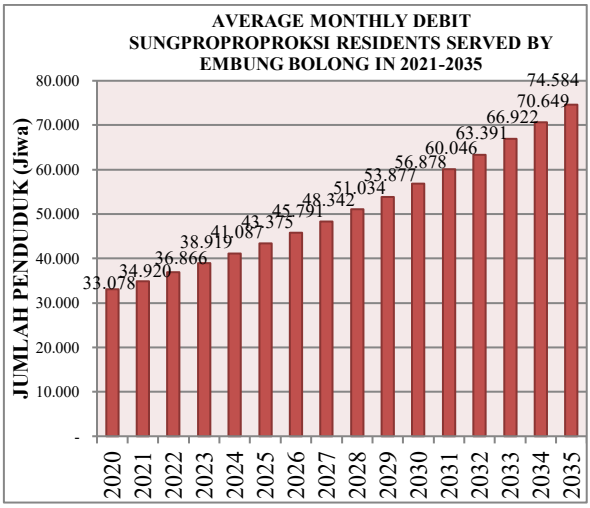

Fig 6. Source : Analysis Results, 2023

The results of the projection of Nunukan population served by Embung Bolong in 2035 are 74,584 people, then Nunukan is included in the category of small cities with a population of 20,000 to 100,000 people, based on clean water planning criteria for the category of Director General of Copyright works of the PU Office, in 2000. Water needs consist of total domestic and non-domestic water needs in 2020 and projected domestic water needs from 2021 to 2035 served by Embung Bolong by taking into account the amount of water loss, which is 30% of the total water needs.

The water balance analysis was obtained by comparing the average monthly discharge of the Bolong river and water demand in 2020 and the 2035 projection results shown in the table below:

Table 1. Source : Analysis Results, 2022.

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Month	Average Monthly Discharge (Q) (liters/s)	Water Requirement (liters/second)	Water Balance (liters/sec)
January	22,1	96,51	-74,41
February	6,2	96,51	-90,31
March	19,1	96,51	-77,41
April	43,1	96,51	-53,41
May	91,8	96,51	-4,71
June	91,2	96,51	-5,31
July	118	96,51	21,49
August	164,5	96,51	67,99
September	161,4	96,51	64,89
October	93,6	96,51	-2,91
November	59,7	96,51	-36,81
December	96,8	96,51	0,29

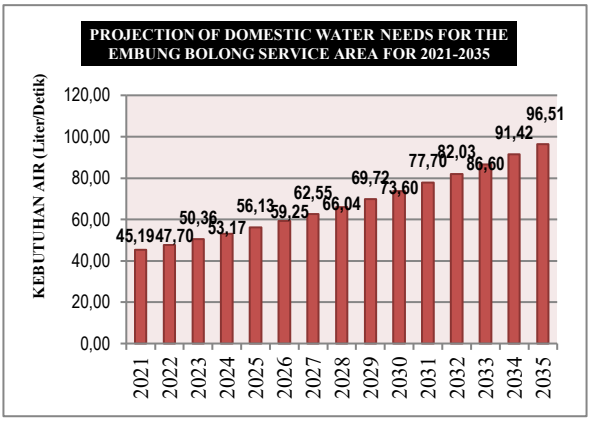

Fig 7. Source : Analysis Results, 2023.

Domestic water needs for house connections per person in accordance with the planning criteria of the Director General of Cipta Karya Dinas PU, in 2000 was 110 liters / soul / day (small city category), with the average amount of water discharge available in the

embung and the amount of water needs domestic per person then can be determined the number of residents who are able to be served by the Bolong embung in 2021-2035, as shown in the table below:

Table 2. Source : Analysis Results, 2023**.**

Month	Average Monthly Discharge (Q) (liters/s)	Water Requirement (liters/second)	Number of served (souls)
January	22,1	0,00127	17.402
February	6,2	0,00127	4.882
March	19,1	0,00127	15.039
April	43,1	0,00127	33.937
May	91,8	0,00127	72.283
June	91,2	0,00127	71.811

July	118	0,00127	92.913
August	164,5	0,00127	129.528
September	161,4	0,00127	127.087
October	93,6	0,00127	73.701
November	59,7	0,00127	47.008
December	96,8	0,00127	76.220
Rata-rata			**63.484**

5 Conclusions

Based on the results of research and discussions on the analysis of water availability in Embung Bolong on water adequacy on Nunukan Island, several conclusions were obtained as follows:

1. The clean water needs of nunukan residents in 2020 were 46.08 liters per second and after projections until 2035 were the normal needs of 96.51 liters per second, the total need for clean water on a maximum day of 110.99 liters per second and peak hours of 168.89 liters per second. The average monthly discharge of Sungai Bolong ranges from between 6.2 – 164.5 liters per second, where the lowest discharge occurred in January, February, March, and April at 22.1 liters per second, 6.2 literpers per second, 19.1 liters per second and 43.1 liters per second and the highest occurred in August;

2. From the results of the calculation of water balance on the availability and needs of water in 2020, it was obtained that water availability in January, February, March and April could not meet the needs of the community because the amount of water availability was below the total water needs of 46.08 liters per second and in 2035 the availability of water in the embung was only able to serve the community in July, August and September while in other months it cannot meet the needs of the community because the amount of water availability is below the amount of water needs, which is 96.51 liters per second. For the development of the Nunukan Island area in improving community welfare towards clean water as the key to regional economic development, the Bolong embung can only serve the Nunukan population of 63,484 people and does not include non-domestic needs.

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REFERENCES

1 Asdak C. Hydrology and Watershed Management. UGM – Press, Yogyakarta.(2007)
2 Asdak C. Hydrology and Watershed Management. Gadjah Mada University Press, Yogyakarta.(1995)
3 National Standardization Agency, SNI 7745:2012 : Procedure for Calculating Evapotranspiration of reference plants using the Penman-Monteith method. Indonesian National Standardization Agency, Jakarta.(2012)
4 Regional Environmental Impact Control Agency, Environmental Impact Analysis of Sungai Bolong Dam (2007)
5 Nunukan Regency.Badan Pusat Statistik Kabupaten Nunukan, Kabupaten Nunukan Dalam Angka.(2020)
6 C.D. Soemarto, Engineering Hydrology, Erlangga Publishers, Jakarta(1999)
7 Directorate General of Copyright of the Ministry of Public Works. Criteria for Clean Water Supply.(2000)
8 Mock, F.J Land Capability Appraisal Indonesia Water Availibility Appraisal, Food and Agriculture Organization of the United Nation, Bogor. . (1973)
9 Putuhena. Availability and Need for Water. 35-40 p. P.E., Haryani, Gadis Sri., Pawitan, Hidayat. (ed). Transformation of Water Resources Management Policy, LIPI Press, Jakarta. (2004)
10 RTRW Nunukan Regency,(2013-2023).