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Analysis of Raw Water Availability in the Kacang Pedang Pond, Pangkal Pinang City, Bangka Belitung Province

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Abstract
This study aims to analyzes the availability of raw water in Kacang Pedang pond, Pangkal Pinang City, Bangka Belitung Province, which was formed from a former tin mine excavation. The availability of raw water is very important considering that Pangkal Pinang City, as the provincial capital, is experiencing continuous population growth, which has an impact on increasing raw water needs. Kolong Kacang Pedang is the only main water source utilized to meet these needs. This study aims to analyze water availability and raw water utilization in the kolong, as well as projecting the raw water needs of Pangkal Pinang City for the next 10 years. This analysis is also expected to be an alternative solution if the existing water sources are no longer able to meet the community's needs. The benefits of this study are to meet raw water needs evenly and sustainably, and function as flood control. The methodology used includes hydrological analysis, water availability analysis using the NRECA method, raw water demand analysis with population projections, and water balance analysis to balance water availability and demand. The data used in this study are rainfall data for 10 years (2015-2024), population data, and kolong inventory data. This analysis is expected to illustrate water availability and determine the reliable discharge that can be used to meet domestic water needs, as well as evaluate whether these water resources will remain relevant to population growth in the next 10 years.

Keywords: *Kacang Pedang pond, Water balance, NRECA*

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I. INTRODUCTION

As the capital of the Bangka Belitung Islands Province, Pangkal pinang City is located on the east coast of Bangka Island. Pangkal pinang City is one of seven regencies/cities within the administrative area of the Bangka Belitung Islands Province. As the provincial capital, it is a center of activity and has a high level of activity, which, in turn, contributes to the increasing demand for raw water. Pangkal pinang City itself relies solely on the primary source of sword bean pits. These pits, formed from abandoned tin mines, are used as a raw water source. The pits that can be used as a raw water source and for daily needs are those that are 20-30 years old, or those with a pH between 5.5 and 8. If these requirements are met, the pits can be used as a raw water source (Cynthia Henny, 2011). According to Yusuf's (2011) research, water from older pits is used by residents to meet domestic water needs, including those from the Regional Drinking Water Company (PDAM). With the increasing development of all aspects of life as a result of increasing population growth and development, the need for and demand for water services will also increase. On the other hand, there is a tendency for water availability to become increasingly limited, even scarce, primarily due to environmental degradation and pollution. Water allocation is expected to ensure fairer, more transparent, and more accountable distribution of water for various purposes.

If this situation is not addressed, it is feared that it could lead to tensions and even conflict due to clashing interests when demand is no longer balanced with the availability of water resources to meet it (supply). Therefore, proportional and balanced efforts are needed between the development, conservation, and utilization of water resources, both from a technical and legal perspective. Water resource management is a complex issue that involves all parties, including users, beneficiaries, and managers.

Given these conditions, it is necessary to conduct a study on water allocation in Pangkalpinang City to provide an overview of water availability, both now and in the future, taking into account the city's population, facilities, and economic development. This study can hopefully provide alternatives and solutions if the condition of Pangkal pinang city's water sources cannot meet the needs of the local community. Problem Formulation

In addition to rainfall data, surface runoff is one of the important factors in the transport system of various materials that will be carried into river flow. If the intensity of rainfall exceeds the infiltration rate, then excess water begins to accumulate as surface reserves. If the surface reserve capacity is exceeded, then surface runoff begins as a thin layer flow. Surface runoff is the part of the runoff that passes above the land surface towards the river channel. (Achmad Syarifudin, 2018).

Another term for surface runoff that is often used by some experts is runoff on land or runoff water. The duration of rain, intensity and distribution of rain affect the rate and volume of surface runoff. The total surface runoff for a rain is directly related to the duration of rain for a certain rainfall intensity. Rain with the same intensity and for a longer time will produce greater surface runoff. Rain intensity will affect the rate and volume of surface runoff. (Achmad Syarifudin, 2018)

In high intensity rain, the total volume of surface runoff will be greater than with low intensity even though the total rainfall received is the same. Topographic forms such as land slope will affect surface runoff. Watersheds with high slopes will produce greater surface runoff. The presence of vegetation can increase the amount of water retained on the surface, thereby reducing the rate of surface runoff. (Achmad Syarifudin, 2018).

II. MATERIAL AND METHODS

This research is located is in Kolong Kacang, precisely on Senopati Street, Kacang Pedang Village, Gerunggang District, Pangkal Pinang City, Bangka Belitung Islands Province with coordinates of 2° 07' 51.30" South and 106° 05' 46.77" East as shown in Figure 1.

Figure 1: Research location

2.1. Research Data Collection

Data collection to obtain the information needed to achieve the research objectives. The data used in this study consists of three main aspects, namely: hydrological and climatological data, population data and its growth projections for the next 10 years (2024-2033), and data on the inventory of the underpasses and the use of underpasses as water resources, including location maps and the RTRW.

2.2. Data Analysis

a. Hydrological Analysis

By analyzing rainfall data to calculate the average monthly rainfall.

b. Water Availability Analysis

Water availability analysis was conducted using hydrological and climatological data, calculating 10 years of rainfall data using the NRECA method based on the characteristics of the dam, which then obtained discharge data.

c. Water Demand Analysis

The next stage was a water demand analysis using population data and growth projections to analyze water needs using mathematical methods, resulting in a projection of domestic raw water needs for the next 10 years (2024-2033).

d. Study of pond Conditions and Problems

The conditions and problems in the pond were assessed quantitatively and qualitatively.

e. Optimization and Simulation of Dam Operations

Damage Dam operation simulations were calculated based on water demand and evaporation (outflow), as well as water availability (inflow), using a Linear Program for operations within the projected period (10 years). The results of the calculations were used to analyze and evaluate the dam's performance. Based on the analysis of raw water availability and demand, the water availability and demand conditions in the Kolong benefit area can be assessed.

f. Projected raw water needs for 2024–2033

By analyzing the optimum discharge at the Kacang Pedang Kolong to meet the domestic water needs of Pangkalpinang residents according to the projected plan.

III. RESULTS AND DISCUSSION

3.1 Data Processing

To determine water needs and availability in Pangkalpinang City, specifically the Kacang Pedang River water source, we used available secondary data. Several calculations were analyzed to obtain monthly rainfall data, evaporation data for the three water sources, potential evapotranspiration using the Modified Penman method, determine the dependable discharge and the size of the available water sources using NRECA, generate discharge data using the Markov method, and simulate the storage capacity of the three water sources for raw water needs over the next 10 years.

3.2 Rainfall Data

The analysis of the Kacang Pedang River water source was conducted based on available climatological data from the Pangkalpinang Meteorological Station. Rainfall and climatological data can be found in Appendix A. A summary of annual rainfall can be seen in Table V.1. and the highest rainfall in 10 years from 2015-2024 occurred in 2021, with a rainfall value of 3211.3 mm/year, while the lowest rainfall occurred in 2023 with a rainfall value of 1868.4 mm/year and an average (Ra) rainfall of 10 years of 214.9 mm/year.

Table 2: Recapitulation of rainfall in 2015-2024

No	tahun	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Aug	Sep	Otk	Nov	Des	JUMLAH	Rata-Rata
		Satuan : (mm)													
1	2015	178	70	146	309	215	129	20	220	250	32	109	230	1906,9	158,9
2	2016	235	602	407	261	253	171	86	159	414	273	184	155	3199,3	266,6
3	2017	405	228	220	252	231	48	185	139	71	211	259	358	2606,5	217,2
4	2018	66	175	284	261	261	158	32	64	173	88	206	319	2088,1	174,0
5	2019	161	474	270	221	214	102	65	169	20	53	41	365	2155,0	179,6
6	2020	180	137	176	292	413	259	189	223	168	462	221	357	3076,7	256,4
7	2021	207	58	392	284	328	91	272	277	209	206	553	336	3211,3	267,6
8	2022	235	172	315	245	139	228	136	283	216	378	390	238	2976,5	248,0
9	2023	233	165	261	147	314	128	146	25	10	17	203	219	1868,4	155,7
10	2024	385	411	321	368	306	316	66	33	70	70	225	132	2702,3	225,2
	AVERAGE	228,53	249,24	279,14	264,045	267,41	162,96	119,69	159,015	160,235	179,04	238,95	270,84		

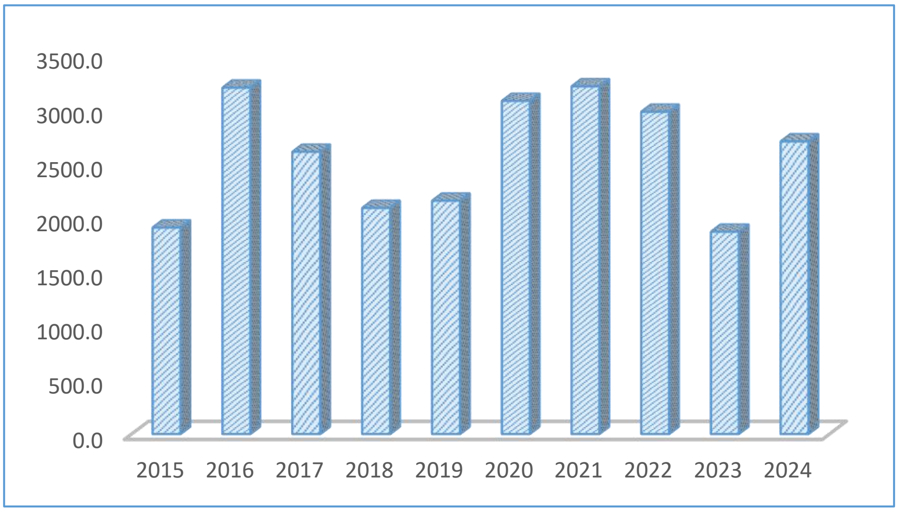

Figure 2: Rainfall graph for 2015-2024

3.3 Water Availability Analysis

Determining water availability in a region is essential to determine the extent of water availability for daily use. In this study, the authors analyzed water availability from three sources to meet the needs of the city of Pangkal pinang, commonly known as "kolong" (underwater basin), namely "Kacang Pedang". The NRECA method was used in this study to determine water availability in Pangkal pinang. The final result is a flow rate in cubic meters per second.

The NRECA model used climatological data for 10 years (2015-2024) to determine water availability in "kolong Kacang Pedang" (underwater basin). An example of the NRECA discharge calculation results for January 2015 is as follows:

Table 2: Recapitulation of rainfall in 2015-2024

Month	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
January	178	235	405	66	161	180	207	235	233	385
February	70	602	228	175	474	137	58	172	165	411
Mart	146	407	220	284	270	176	392	315	261	321
April	309	261	252	261	221	292	284	245	147	368
May	215	253	231	261	214	413	328	139	314	306
June	129	171	48	158	102	259	91	228	128	316
July	20	86	185	32	65	189	272	136	146	66
August	220	159	139	64	169	223	277	283	25	33
September	250	414	71	173	20	168	209	216	10	70
October	32	273	211	88	53	462	206	378	17	70
November	109	184	259	206	41	221	553	390	203	225
December	230	155	358	319	365	357	336	238	219	132
Average	1907	3200	2607	2088	2155	3077	3211	2977	1868	2702

3.3 Kacang Pedang Pond

To analyze water availability under the Kacang Pedang River, the parameters are as follows:

• Watershed area: 14.23 km²
• Annual rainfall: 2435 mm
• Nominal C: 0.2
• PSUB: 0.5 (Normal/regular catchment area)
• GWF: 0.5 (Normal/regular catchment area)

Therefore, the discharge for the Kacang Pedang pond is:

Table 3: NRECA discharge under Kacang Pedang Pond

	Tahun	Jan	Feb	Mar	Apr	Mei	Juni	Juli	Agustus	September	Oktober	Nov	Des	Satuan
		Satuan : (m3/dt)												(m3/dt)
	2015	1,454	0,869	1,009	1,351	0,688	0,684	0,489	0,598	0,622	0,510	1,172	1,179	(m3/dt)
	2016	0,968	0,380	1,548	0,675	1,136	0,774	0,810	0,496	0,183	0,437	0,838	0,961	(m3/dt)
	2017	1,123	2,242	1,613	1,671	0,928	1,026	0,802	1,900	1,216	1,439	1,829	1,744	(m3/dt)
	2018	0,983	1,513	1,166	1,692	1,565	1,481	0,710	0,398	0,483	1,298	1,682	1,402	(m3/dt)
	2019	0,721	2,142	1,361	0,859	0,806	0,876	0,959	0,231	0,159	0,228	0,923	0,935	(m3/dt)
	2020	0,691	1,570	1,284	1,054	1,271	0,779	0,871	0,546	1,120	0,999	1,599	1,701	(m3/dt)
	2021	0,988	0,424	0,420	1,549	0,964	0,597	0,727	0,681	0,508	0,277	0,632	1,262	(m3/dt)
	2022	0,688	0,416	0,658	1,387	1,100	0,786	0,282	0,147	1,062	0,302	0,545	1,016	(m3/dt)
	2023	0,913	2,769	2,052	1,559	1,398	1,059	0,619	0,811	1,875	1,429	1,105	0,615	(m3/dt)
	2024	1,579	1,266	1,127	1,297	1,197	0,484	0,889	0,738	0,471	0,954	1,247	1,665	(m3/dt)
NRECA	Jumlah	10,107	13,590	12,239	13,093	11,053	8,545	7,157	6,546	7,699	7,873	11,570	12,480	(m3/dt)
	Rata2	1,011	1,359	1,224	1,309	1,105	0,855	0,716	0,655	0,770	0,787	1,157	1,248	
	Max	1,359	Feb											
	Min	0,655	Agustus											

Table 4: Q80 NRECA for raw water standards for Kacang Pedang River

Data Diurut Dari Besar Ke Kecil, Berdasarkan Data Jumlah Tahunan													
P=m/(n+1)	m	Jan	Feb	Mar	Apr	Mei	Juni	Juli	Agustus	September	Oktober	Nov	Des
		Satuan (m3/dt)											
9,09	1	1,579	2,769	2,052	1,692	1,565	1,481	0,959	1,900	1,875	1,439	1,829	1,744
18,18	2	1,454	2,242	1,613	1,671	1,398	1,059	0,889	0,811	1,216	1,429	1,682	1,701
27,27	3	1,123	2,142	1,548	1,559	1,271	1,026	0,871	0,738	1,120	1,298	1,599	1,665
36,36	4	0,988	1,570	1,361	1,549	1,197	0,876	0,810	0,681	1,062	0,999	1,247	1,402
45,45	5	0,983	1,513	1,284	1,387	1,136	0,786	0,802	0,598	0,622	0,954	1,172	1,262
54,55	6	0,968	1,266	1,166	1,351	1,100	0,779	0,727	0,546	0,508	0,510	1,105	1,179
63,64	7	0,913	0,869	1,127	1,297	0,964	0,774	0,710	0,496	0,483	0,437	0,923	1,016
72,73	8	0,721	0,424	1,009	1,054	0,928	0,684	0,619	0,398	0,471	0,302	0,838	0,961
81,82	9	0,691	0,416	0,658	0,859	0,806	0,597	0,489	0,231	0,183	0,277	0,632	0,935
90,91	10	0,688	0,380	0,420	0,675	0,688	0,484	0,282	0,147	0,159	0,228	0,545	0,615
50%		0,98	1,39	1,23	1,37	1,12	0,78	0,76	0,57	0,57	0,73	1,14	1,22
80%		0,697	0,418	0,728	0,898	0,830	0,614	0,515	0,264	0,241	0,282	0,673	0,940
90%		0,688	0,383	0,444	0,693	0,700	0,495	0,302	0,155	0,161	0,233	0,554	0,647
Catatan : P (Peluang, Probabilitas)% ; n = Jumlah Data ; m = nomor urut data ke ..1,2,3,sd.n													

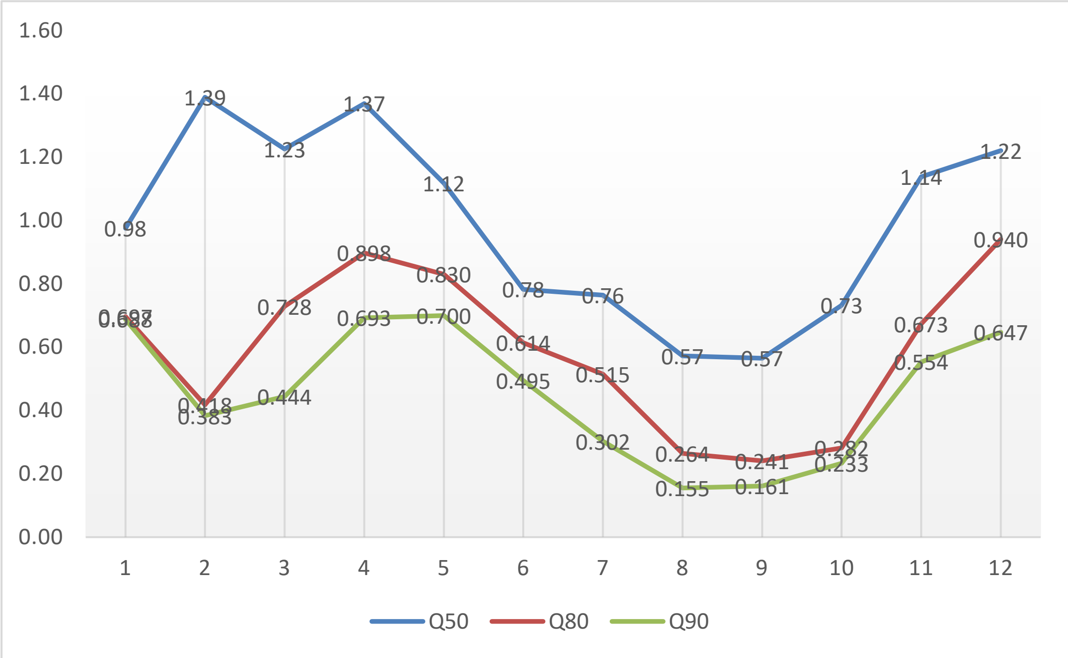

Figure 3: The mainstay discharget in the Kacang Pedang River

IV. CONCLUSION

Based on the results and discussions, the following can be concluded:

1. The analysis results at Kolong Kacang Pedang indicate that it does not fully meet the water requirement of 110 liters per person per day.
2. Population growth is projected to reach 23,3368 people by 2033.
3. The raw water supply from Kolong Kacang Pedang is insufficient to meet 100% of the service requirement in Pangkal Pinang City, necessitating further development.

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