International Research Journal of Engineering, IT & Scientific Research
Available online at https://sloap.org/journals/index.php/irjeis/
Vol. 9 No. 2, March 2023, pages: 57-64
ISSN: 2454-2261
https://doi.org/10.21744/irjeis.v9n2.2286

Analysis of Integrated Clean Water Services for West Bali Region

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Article history:

Submitted: 27 Dec 2022
Revised: 18 Jan 2023
Accepted: 09 Feb 2023

Keywords:

clean water;
integrated;
management;
need;
supply;

Abstract

The area of Jembrana Regency is 841.80 km2, has five sub-districts. The total population in 2021 is 281,289 people, covering the Melaya District 54,032 people, State District 85,349 people, Jembrana District 56,061 people, Mendoyo District 58,909 people, Pekutatan District 26,938 people. Gerokgak District is part of the western part of Bulelelng Regency. The population of Grokgak Subdistrict in 2021 is 86,421 people. The integration of clean water supply in the western part of Bali is very important, because the community is a collection of individuals who have socio-cultural, occupying different areas and environments, but have a common interest, for the fulfillment of water as a source of human life. Differences in interests in the use of water include, domestic and non-domestic interests, industry, irrigation and conservation. To find out the potential of Tukad Unda downstream in providing clean water, an analysis of its water The provision of clean water in the western part of Bali will be studied in this study, in line with efforts to improve clean water management in Jembrana Regency and Buleleng Regency. To determine the water balance in providing clean water, an analysis of water availability and water needs is carried out. Analysis of the availability and demand for clean water is the goal of the study, so that an integrated clean water supply system pattern is obtained in the West Bali region, covering Jembrana Regency, and Gerokgak District in Buleleng Regency. The current availability of clean water in the West Bali Region is 336.82 l/sec. The need for clean water in the West Bali area until 2040 is 930.61/sec, there is a water deficit in 2040 of 593.79 l/sec. The total development of water resources until 2040 is 660 l/sec. The development of a clean water supply system in western Bali will be able to meet clean water needs until 2040, resulting in a clean water surplus of 66.21 l/sec.

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1 Introduction

The integration of clean water supply in the western part of Bali is very important, because the community is a collection of individuals who have socio-cultural, occupying different areas and environments, but have a common interest in fulfilling water as a source of human life. Differences in interests in the use of water include, domestic and non-domestic interests, industry, irrigation and conservation. Jembrana Regency as an area of West Bali Province, is a district that has great potential as an industrial center with the existence of Gilimanuk Port as a commercial area. Clean Water as the main means in developing this area must be immediately pursued, so that the development of Jembrana Regency can be sustainable. Surface water sources owned by Jembrana Regency are supported by infrastructure including Benel Reservoir and Palasari Reservoir. Gerokgak District in Buleleng Regency is also part of the western region of Bali Province, which is a developing tourist area, with Gerokgak Reservoir, Titab Reservoir as infrastructure that has been built. Differences in administrative areas and socio-cultural conditions of different communities like this, it is very necessary to strive for the unification of the clean water management system in this area (Kodoatie & Sjarief, 2005; Soemarto, 1999).

The development of drinking water treatment is currently being carried out to meet the needs of the community, especially water-prone areas and rural areas, however, the provision of drinking water treatment facilities still has several main problems, among others, the existence of drinking water treatment facilities that are not functioning properly. optimal, due to the lack of local community involvement in planning, construction, operation and maintenance; water is still considered something that can be obtained for free, so that people do not care about the problem of financing for operational activities and maintenance of drinking water facilities (Bambang, 2017).

Problem Formulation

The formulation of the problem from this research is:

1. How much is the availability of clean water in the West Bali Region
2. What is the need for clean water in the West Bali Region?
3. How is the clean water supply system integrated in the West Bali Region?

Purpose

The purpose of this research:

1. Calculating water availability in the West Bali Region
2. Calculating current and projected water needs in the future
3. Develop an integrated clean water supply system in the West Bali Region.

Literature review
Sustainable Water Resources Management

Sustainable water development has three dimensions which include: economic development, preserving ecology, justice in accommodating and fulfilling the wishes of all parties. So to be able to achieve this, there are at least five aspects that must be covered, among others, institutional aspects, economic aspects, social aspects, biological aspects, and physical aspects. Sustainability can be interpreted as efforts and activities to provide drinking water and environmental sanitation that are carried out to be able to provide benefits and services to the user community continuously (Kamulya & Slamet, 2017). A water supply system is said to be sustainable when: the system is functioning and used, the system is able to provide a level of benefits appropriate (quality, quantity, regularity, availability, efficiency, equity, reliability and health), runs for a long time without adversely affecting the environment, all operational and maintenance costs are met, there is an institution that manages it, and gets proper support from outsiders (Linsley & Franzini, 1995).

Water Potential

Water potential is the amount of water contained in water bodies, both as surface water and as underground water. In the analysis of the amount of water potential, it can be obtained through data series from recording weir discharge, river or it could be based on the mainstay discharge analysis by using several methods of diverting the variance of rain associated with the conditions of the existing watershed. The method commonly used is the FJ Mock method or the Nreca method (National Development Planning Agency, 2003).

Strategy Management

Strategic management is defined as a way to guide companies to achieve a number of goals, including corporate responsibilities, managerial capabilities, to administrative systems related to strategic decision making, and operations.Strategic management is a series of fundamental decisions and actions from the highest management, which are applied by all members of an organization, for the realization of organizational goals (Satmoko, 2005).

Population

The calculation of the population is important, because knowing the population of an area will be the basis for making population policies at a certain time. The province of Bali, which includes nine regencies and cities, has a relatively varied population. Population development in the province of Bali has not been evenly distributed. As a result of the uneven development of the region, especially related to the development of the tourism industry sector, community social centers, and government, which are still in the district capital. Calculation of the population using arithmetic, geometric and least square formulas. To determine the method used in each sub-district, the smallest standard deviation value of the three approaches will be determined (Minister of Public Works Regulation 2007).

Clean Water Development System

Part of a clean water distribution network system, are the components that exist in a series of clean water distribution network systems. These parts consist of pipes and their connections, valves, pumps, reservoirs, all of which must work properly. Based on the instructions of the Integrated City Infrastructure Development Program regarding Guidelines for Planning and Technical Design for the drinking water sector, it is stated that the raw water sources that can be treated are springs, namely water sources that are above the ground surface, shallow wells, namely water sources resulting from excavations or drilling depths. less than 40 meters deep, deep wells, namely water sources from excavation or drilling with a depth of more than 40 meters, rivers, namely water drainage channels formed from upstream to empties into the sea or lakes, lakes and water reservoirs, namely deep water storage units a certain amount of which the water comes from streams or rainwater reservoirs (Chung et al., 2012; Teo et al., 2022).

2 Methodology

Scope of Research

The scope of the Integrated Clean Water Service Analysis in the West Bali Region, is:

1. Conducting a literature study or review of relevant studies related to the clean water supply system in Jembrana Regency and Gerokgak District
2. Conduct a survey of the current condition of the clean water supply system
3. Analyze the availability and needs of clean water today and future projections.

Data Source

Sources of data to be taken are as follows:

1. Demographic data on population, socio-cultural facilities and infrastructure, tourism, industry, from the BPS Bali province and Jembrana and Buleleng regencies
2. Clean water supply system data, from the Jembrana Regency and Buleleng Regency PDAM agencies
3. Clean water source data which is the current availability in Jembrana and Buleleng Regencies
4. Clean water quality and quantity dataClean water supply system data

Measurement With Current Meter

The tool used to measure the flow velocity is a current measuring instrument, which is commonly referred to as a current meter. The main equipment commonly used in measuring flow is a flow meter, including all its accessories, namely a timer and a rotation counter, a depth gauge, a width gauge, assembly equipment and some additional tools. The selection of the use of equipment and equipment must be adjusted to the physical condition of the river being measured (Field & Samadpour, 2007; Bouwer, 2000).

Analysis of clean water availability

In calculating the mainstay discharge using the basic year planning method. The planning base year is a reliable debit pattern where the debit pattern has actually happened in previous years. The mainstay discharge calculation is intended to find the quantitative value of the available discharge throughout the year, in the dry season and in the rainy season (Savenije & Van der Zaag, 2008; Thomas & Durham, 2003).

Population Analysis

Calculation of the population using arithmetic, geometric and least square formulas. To determine the method used in each sub-district, the smallest standard deviation value of the three approaches will be determined (Minister of Public Works Regulation 2007).

Clean Water Needs Analysis

The Directorate General of Human Settlements has set the water usage standard for metropolitan cities of 190 liters/person/day, standard waterrequirements for large cities at 170 liters/person/day, medium cities at 150 liters/person/day, and small cities at 130 liters people. /day (Swastomo & Iskandar, 2020).

Water Balance

The water balance is intended to determine how much potential is available each month, as well as how much water is needed. The Water Balance will know the months of surfing as well as the months that are in deficit. Mathematically, the calculation method for obtaining the residual water discharge in this water balance analysis is the mainstay discharge minus the demand discharge (Chowdhury et al., 2016; Miller, 2006).

Clean Water Supply System

The clean water supply system strategy is carried out by means of a literature study, with the development of the concept of sustainable water source management, based on the condition of the current system that has been running, taking into account the sustainability of clean water supply in the future. Inventory of existing clean water sources and clean water sources that are in the process of being built (Ghaffour et al., 2013; Smith et al., 2011).

3 Results and Discussions

Water Potential
River

Jembrana Regency has 17 rivers that have the potential to be utilized. The river that has the lowest capacity is the Bajra River with a capacity of 17.04 liters/second. The river that has the largest capacity is the Yeh Sumbul River with a capacity of 2,716.69 liters/second. Surface water in Buleleng Regency includes water from rivers, with a total of 51 rivers, with a total flow rate of 637 million m^3 every year (Farfán et al., 2019; Sukarasa & Paramarta, 2020).

Springs

Jembrana Regency also has the potential of springs that have been utilized by PDAN at this time. The total capacity utilized by PDAM Jembrana Regency from springs as a raw water source is 17 liters/second. In addition to the three springs that have been used, there is also the Pulo Sae Spring with a capacity of 50 liters/second. Buleleng Regency has the potential of 277 springs around 69.06 million m^3, but which is a potential and effective water source is estimated at 48.34 million m^3.

Lakes and Reservoirs

Buleleng Regency has 2 lakes, namely Lake Tamblingan and Lake Buyan. The two natural lakes are closed lakes, meaning that the incoming and outgoing water is balanced. The lake's water potential is 143.25 million m3/year. Buyan Lake 116.25 million m3/year and from Tamblingan Lake 27.00 million m3/year. Other surface water sources are Palasari Dam and Benel Dam in Jembrana Regency, Grokgak Dam, and Titab Dam in Buleleng Regency.

Populations

Calculation of population using arithmetic, geometric and least square formulas. Determination of the method used in each sub-district will be determined with the smallest standard deviation value of the three approaches (Ratnayaka et al., 2009).

Table 4.1
Population West Bali Region, 2020-2040

Districts	Projected population (person)				
	2020	2025	2030	2035	2040
Melaya	53.720	55.281	56.842	58.403	59.964
Negara	84.700	87.944	91.189	94.433	97.678
Jembrana	55.680	57.586	59.491	61.397	63.302
Mendoyo	58.680	59.824	60.969	62.113	63.258
Pekutatan	26.820	27.409	27.998	28.587	29.176
Grokgak	85.730	89.239	92.892	96.695	100.653
Total	365.330	377.283	389.381	401.628	414.031

Water Demand Projection

The area's domestic water needs are determined based on the population, where the level of service will increase every year. Meanwhile, non-domestic needs are 20% of domestic needs. The total water demand is the sum of domestic, non-domestic, and water leaks, where water leakage is 20% of the total domestic and non-domestic needs.

Table 4.2.
Average Water Demand Capacity (liter/second)

Districts	Average Water Demand Capacity (liter/second				
	2020	2025	2030	2035	2040
Melaya	58,2	89,83	123,16	126,54	129,92
Negara	91,76	142,91	197,58	204,61	211,64
Jembrana	54,29	87,34	122,45	133,03	137,15
Mendoyo	57,21	90,73	125,49	134,58	137,06
Pekutatan	17,43	32,66	48,53	61,94	63,21
Grokgak	92,87	145,01	201,27	209,51	251,63
Total	371,76	588,48	818,48	870,21	930,61

Water Balance

Jembrana Regency and Grokgak District as a clean water management unit that regulates the availability and needs of clean water. The need for clean water to be served is 414,031 inhabitants of the western part of Bali until 2040 is 930.61 liters/second. The current availability of clean water is 336.82 liters/second. The current clean water balance in the western part of Bali is -593.79 liters/second in 2040.

Table 4.3
West Bali Area Clean Water Balance

Description	unit	Year				
		2020	2025	2030	2035	2040
Jumlah Penduduk	Jiwa	365.330	377.283	389.381	401.628	414.031
Kebutuhan air	l/dt	371,76	588,48	818,48	870,21	930,61
Kapasitas Produksi PDAM	l/dt	274,09	274,09	274,09	274,09	274,09
Kapasitas produksi Non PDAM	l/dt	62,73	62,73	62,73	62,73	62,73
Total Ketersediaan saat ini	l/dt	336,82	336,82	336,82	336,82	336,82
Neraca Air	l/dt	-34,94	-251,66	-481,66	-533,39	-593,79

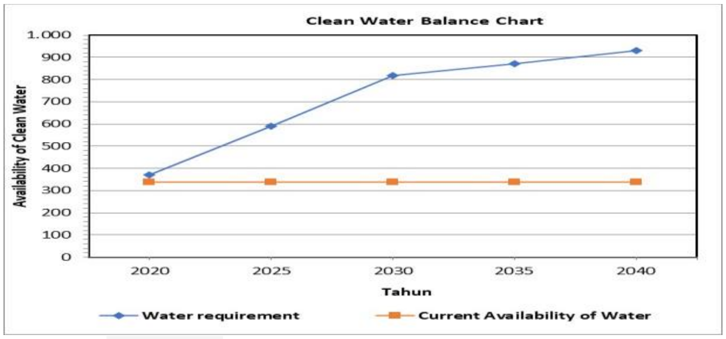

Figure 4.1 West Bali Area Clean Water Balance

To be able to meet these deficiencies, there are several plans for a clean water supply system that can be developed in the western part of Bali until 2040, including:

1. Benel reservoir with a capacity of 60 liters/second to meet the needs in the Melaya District area
2. Biluk Poh Longstorage with a capacity of 100 liters/second
3. Yeh Sumbul Longstorage with a capacity of 100 liters/second
4. Longstorage Balian with a capacity of 50 liters/second
5. Pulo Sae Springs with a capacity of 50 liters/second
6. Titab reservoir with a capacity of 300 liters/second to meet the needs of Western Buleleng

Table 4. 4
West Bali Area Clean Water Balance After Development

Description	Unit	Year				
		2020	2025	2030	2035	2040
Total population	Jiwa	365.330	377.283	389.381	401.628	414.031
Total water requirement	l/dt	**371,76**	**588,48**	**818,48**	**870,21**	**930,61**
Production capacity Local water company	l/dt	274,09	274,09	274,09	274,09	274,09
Production capacity Non Local Water Company	l/dt	62,73	62,73	62,73	62,73	62,73
Current Capacity	l/dt	**336,82**	**336,82**	**336,82**	**336,82**	**336,82**
Development Capacity						
SPAM Benel	l/dt	60	60	60	60	60
SPAM Titab	l/dt	-	150	300	300	300
Longstorage Biluk Poh	l/dt	-	-	100	100	100
Longstorage Yeh Sumbul	l/dt	-	-	100	100	100
Longstorage Tukad Balian	l/dt	-	50	50	50	50
Pulo Sae Water springs	l/dt	-	50	50	50	50
Total Development	l/dt	**60**	**310**	**660**	**660**	**660**
Total Capacity		**396,82**	**646,82**	**996,82**	**996,82**	**996,82**
Water Balance	l/dt	25,06	58,34	178,34	126,61	66,21

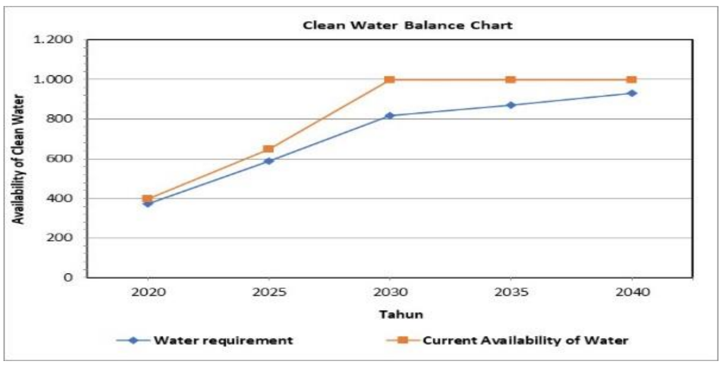

Figure 4.2. West Bali Area Clean Water Balance Development Projection Until the Year 2040

4 Conclusion

1. The current availability of clean water in the West Bali Region is 336.82 l/sec.
2. The need for clean water in the West Bali area until 2040 is 930.61/sec, there is a water deficit in 2040 of -593.79 l/sec.
3. The total development of water resources until 2040 is 660 l/s which includes: Benel SPAM of 60 l/s and Titab's SPAM of 300 l/s, Logstorage Biluk Poh, 1 100 l/s, Yeh Sumbul Longstorage 100 lt/s sec, Tukad Balian Longstorage 50 l/sec, Pulo Sae Spring 50 l/sec, bringing the total availability to 996.82 l/sec until 2040.
4. The development of a clean water supply system in western Bali will be able to meet the needs of clean water until 2040, resulting in a surplus of clean water of 66.21 l/sec.

Conflict of interest statement
The authors declared that they have no competing interests.

Statement of authorship
The authors have a responsibility for the conception and design of the study. The authors have approved the final article.

Acknowledgments
We are grateful to two anonymous reviewers for their valuable comments on the earlier version of this paper.

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