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Operational Analysis of South Bali's Integrated Regional Water Company Related to the Sidan Dam Operational Plan

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Abstract

The development of the population and the increase in tourist visits to the Province of Bali have had an impact on the increasing need for clean water. Several efforts to increase the amount of raw water have been carried out by the Government through the construction of several infrastructures such as the Titab dam and Tamblang dam in Buleleng and long storage in Petanu and Penet rivers. However, with the increase in water continues to increase, the Government is building the Sidan Dam in Badung Regency which can later be utilized by Badung Regency, Denpasar City, Gianyar Regency and Tabanan Regency. The Sidan Dam is one of 65 strategic dam projects in Indonesia which is being carried out in Bali through the Bali Penida River Basin Office with an estimated cost of Rp. 809 billion. This dam has an area of 82.73 hectares located in three regions, namely Badung Regency, Bangli Regency and Gianyar Regency. This dam has a storage capacity of 3.82 million m3 with an estimated raw water discharge that can be provided later at 1,750 liters/second. The resulting debit will later become an additional debit in the Badung, Denpasar, Gianyar and Tabanan areas so that the problem of shortages in this area can be reduced. In this regard, it is necessary to analyze the amount of water currently available in each area, add to the production of water in the Sidan dam, and compare it with the existing water demand in each region.

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1 Introduction

The development of tourism in Bali continues to increase from year to year even though it experienced a decline during the COVID-19 pandemic. Gianyar is one of the main tourist destinations in Bali Province among other areas. The Ubud Tourism Area with the icon of Puri Ubud has become an attraction for many travelers visiting Bali. Various tourist attractions and natural panoramas are the main attraction for many tourists visiting Ubud and the surrounding area. Likewise in several other areas which are tourist attractions in Gianyar Regency.

In order to maintain the conduciveness of tourist visits to Gianyar, various efforts have been made by the government through infrastructure arrangement and arrangement of services for tourists. All of these efforts are aimed at increasing the sense of comfort for tourists visiting Gianyar. One of the things that is of serious concern in supporting tourism activities in Gianyar Regency is the provision of clean water. The supply of clean water is provided through the infrastructure of tapping water springs, drilling groundwater, and by utilizing the downstream Petanu River water. So far, the supply of non-domestic clean water has only been based on Clean Water Planning Criteria based on the 1997 SNI issued by the Directorate General of Human Settlements in 1997 which allocates all non-domestic water needs of 20-30% of domestic water needs. This figure is the average condition of all regions in Indonesia. By looking at the conditions and developments of tourism in Gianyar, it is necessary to carry out a more thorough study so that the non-domestic water needs specifically for the tourism sector are truly in accordance with what is needed. This real demand figure is very important to know because it can form the basis of a clean water supply system, especially in tourist areas. Based on the current conditions related to the rapid development of tourism related to non-domestic water needs in Gianyar Regency, the problem can be formulated as follows: how many visits and tourism accommodations are there in Gianyar Regency at this time? what is the non-domestic water demand for the tourism sector in Gianyar Regency? what is the relationship between non-domestic water needs specifically for tourism and the clean water supply system in Gianyar Regency?

Literature review
Clean water needs

Water is a natural resource that is increasingly becoming a commodity that has a very high selling value. Adequate water availability is closely related to the level of community welfare (Cain & Gleick, 2005; Vollmer et al., 2016; Widodo & Budiastuti, 2019). Water availability can also trigger conflict between users in the same area if it is not managed wisely. (Jaya, 2004; SUDANA, 2016; Massie & Keskitalo, 2013; Sangkawati & Hadihardaja, 2005). Current conditions show that most countries in Asia and Africa are experiencing water scarcity. Meanwhile, in Australia, Europe, and America, there is a sufficient water supply. It is hoped that with more concrete conservation efforts in the future, water shortages can be reduced in the world, especially in Asia and Africa (Chakkaravarthy & Balakrishnan, 2019). An overview of the world's water shortages can be seen in Figure 1

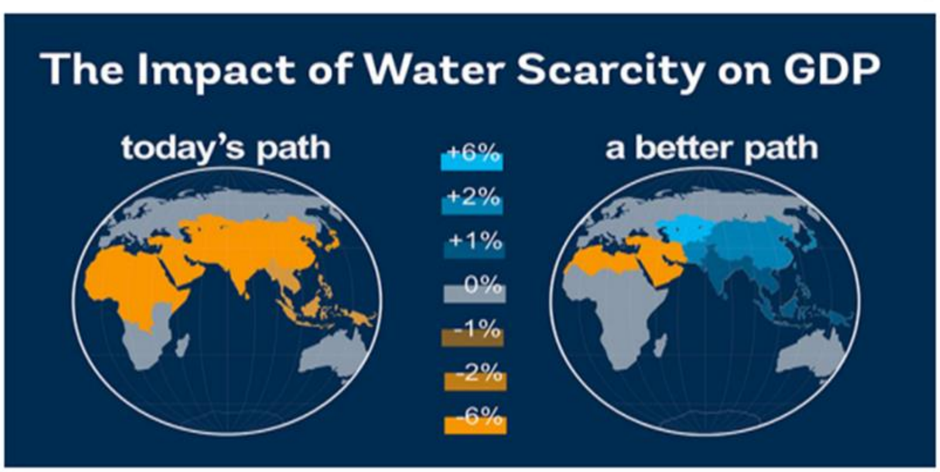

Figure 1. Distribution of Water Scarcity in the World
Source: (Chakkaravarthy & Balakrishnan, 2019), has been modified

Water potential

Water potential is the amount of water that exists in nature that has not been utilized. The water potential is on the surface of the ground and below the ground surface

Availability of water

Availability of water is water that can be utilized directly through developed infrastructure buildings such as reservoirs, weirs, and pipelines

Water needs
Clean water usage patterns

The use of clean water in an area will never be exactly the same as in other areas as a result of the characteristics of the area in question. The pattern of clean water use is largely determined by climate, population characteristics, environmental issues, industry and trade, water fees, city size and water conservation needs. Currently, the need for clean water in rural areas is estimated at 90 to 120 liters/person/day, while in urban areas it is around 120-150 liters/person/day.

Climate

The pattern of water use for household activities such as bathing, washing, watering the garden, air conditioning and other activities will be greater for areas that have a warm and dry climate than areas that have a humid climate. In areas with very cold climates, water may be wasted in taps to prevent the freezing of clean water pipes (Linsley, 2010). For example, clean water consumption in tropical countries such as Bangkok reached 218 liters/person/day (1999), Singapore 310 liters/person/day (2000), and Malaysia 230-321 liters/person/day (1995) which is greater than the consumption Clean water in sub-tropical countries such as Norway reaches 130 liters/person/day (1994), Netherlands 195 liters/person/day and Germany 196 liters/person/day.

Population characteristics

Water use will be influenced by the economic status of water users which states that the higher the level of people's welfare, the higher the level of water consumption.

Types of clean water needs

Types of clean water needs can be divided into two groups, namely domestic water needs and non-domestic water needs. Domestic water demand and non-domestic water demand plus water loss during distribution constitute the total water demand

Domestic water demand

The need for domestic water is the need for clean water for residents for the sake of daily life. Domestic water demand is calculated based on the amount of water demand from each connection service. Domestic water needs include water needs inside the house, water needs outside the house, and public taps. The need for water in the house includes the need for drinking, cooking, sanitation, cleaning the house, washing clothes, and washing vehicles. While needs outside the home include the need to water gardens, fountains, and swimming pools. The need for public faucets is the need for faucets that are utilized by the public (Zhang et al., 2019; Teo et al., 2022; Hickner, 2010; Chen et al., 2022).

Differences in domestic water use are largely determined by the characteristics of the components in it. For example, the domestic water needs of residents of large industrial cities in the United States are 600 to 800 liters/person/day, while the water needs of several big cities and urban areas in the world are 300 to 550 liters/person/day. In England and Wales, it was 288 liters/person/day in 1998/1999. While in 1997/1998 the average use of water in Scotland had reached 460 liters/person/day and in Northern Ireland at the same time it had reached 407 liters/person/day. In developed countries, the demand for water continues to rise in line with the increase in the per capita population. Another example is that the average domestic water use for residents of the City of Montreal in Canada amounted to 647 liters/person/day in 1975 while the use of domestic water in the same year in the City of Monaco, France amounted to 565 liters/person/day.

Domestic water demand in Indonesia according to the Directorate General of Water Resources (2000), refers to data released by the Directorate General of Human Settlement, Ministry of Public Works through the Directorate of Clean Water by classifying regions into two categories, namely cities and villages. City criteria are further divided into four categories, namely metropolitan cities, big cities, medium cities, and small cities (Parwita et al., 2020). The use of domestic water from various figures offered by various agencies shows that the largest use of water is for toilet and bathroom needs. The need for latrines which include toilets and toilets is an average of 35.4% of the total daily need for clean water. Meanwhile, the average need for bathroom water is 30.72% of the total need for clean water per day. While the average use for the kitchen is 6.2%, washing face and hands is 9.4%, cleaning is 4.6%, washing clothes is 9.02% and for other needs is 6.5% of the total clean water requirement per day.

Non-domestic water needs

Non-domestic water needs are water needs other than for household needs. This water need includes the need for water for schools, social places, education, and others.

Population projection

Population projections are carried out to estimate the future population in relation to the use of water that needs to be provided. In the analysis of population projections, several methods are used according to the characteristics of the population, such as arithmetic, geometric or exponential methods. The selection of three methods was chosen based on the results of the smallest deviation with the actual population. Population projections are carried out every five years with the assumption that the selection of this five-year terminal is related to the provision of the necessary clean water infrastructure.

The concept of integrated water management

Integrated water resources management is a process aimed at improving and developing the management of water resources, land and related resources in a coordinated manner by looking at the characteristics of the region in order to achieve community welfare. Integration that is carried out takes into account various interests coupled with the ability and carrying capacity of the environment wisely which in the end can increase the welfare of the community.

The availability of water in the hemisphere is not always spread evenly in every place and at every time as expected, causing people with various interests in water to try to fulfill it in various ways from various competencies they have and with various ways of legitimacy and participation in an integrated approach. Management of water resources in the past has not been sufficient to face the challenges of global water management. The management approach is mostly sectoral in nature, each sector (household utilization, agriculture, industry, environmental protection, and others) is managed separately with limited coordination between sectors. This approach causes fragmented and uncoordinated development of water resources. Many uses of water have spillover effects on other uses and sometimes have unintended social and environmental consequences. This is especially true for watersheds where upstream water and land practices have a direct impact on downstream water quantity and quality. As water becomes scarcer, it becomes increasingly inefficient to manage water without acknowledging the interdependence between institutions, between sectors, and between geographic areas (Iswandi & Dewata, 2020; Manalu, 2019).

The concept of integrated water resources management has been a necessity for a long time and is growing according to current and future developments. The United Nations has been trying to encourage the development of integrated water resources management between watersheds and regions since 1977 through the integrated water resources management (IWRM) program. Since 1992 the IWRM concept has begun to be massively adopted in almost all countries in the world with the common goal of achieving justice for access to water use as marked by the existence of a global water management partnership program (global water partnership, GWP) in 1996. The main mission of GWP is the process that promotes the coordinated development of water, land, and related resources to maximize economic outcomes and social welfare in an equitable and sustainable manner. In achieving its goals, IWRM has a scope of activities that are divided into four stages, namely (Fulazzaky, 2014): policy setting, pragmatic problem solving, operating mechanisms as well as evaluation and monitoring. In addition to the stages described above, to achieve fair access to water use in an equitable and equitable manner, it has been formulated in the 1992 Dublin Principles where IWRM adheres to the following principles: ecological principle: that fresh water is a limited water resource whose existence is very important for life, institutional principles: the development and management of water resources must be carried out in a participatory manner by involving all users, planners and policymakers so as to produce fair and equitable decisions for all levels, gender principles: women play an important role in the management of water resources and instrument principles: water has a high economic value so that it requires caution in its management. Since 2000, GWP has proposed three components in strengthening IWRM, namely: a strong supporting environment, strengthening of legal and regulatory institutions, clear, solid and comprehensive institutions as well as effective management and efficiency (Simons, 1993; Wang et al., 2013; Cole, 2012; Becken, 2014).

In connection with the concept of integrated management of water resources, it is necessary to carry out coordination that is cross-sectoral and cross-stakeholder which includes integration between sub-watersheds, between watersheds and between regions/countries. Experience has repeatedly shown that successful IWRM requires vertical integration across levels, from local to cross-border, as well as horizontal integration across sectors at all levels. With the existence of cross-sectoral dialogue, it is hoped that it will give birth to the concept of integration which has the principle of one river one management. In principle, the integration of water resources management results in a balance between economic, environmental and ecological issues. To make this happen, it needs to be supported by management structures, environmental management policies, and strengthening institutions/institutions. The combination of these structures creates a water balance to support human life

Dam

Dams are one of the water supply infrastructures both for irrigation and clean water in Indonesia. This dam was built in a location that is calculated to provide maximum storage and is technically safe (Wijayanti et al., 2021; Heydari et al., 2015; Ahmadi et al., 2017; Kartini & Permana, 2016).

2 Materials and Methods

Research design

Research is designed starting from preparatory work, field data collection, analysis and reporting.

Research methods

The method in this study was carried out according to the stages of analysis which included the following:

a) Analysis of population numbers and projections
This analysis was carried out by recording from BPS and calculating population projections using arithmetic, geometric and exponential methods.
b) Water source discharge analysis
This analysis was carried out by direct recording method using a current meter
c) Water use analysis
This analysis was carried out using field observation methods and compared with the recording of water usage data by PDAM customers
d) Analysis of the water resources infrastructure development system was carried out by holding hearings with PUPR agencies in Gianyar Regency, the Bali Penida River Basin Office and from the PDAM.

Surveys, Field Observations, and Follow-up Data Collection

Conduct a field survey to find out the clean water supply system:

a) Dam location
b) The physical condition of the dam
c) PDAM performance
d) Problems in the integration of clean water

3 Results and Discussions

Sidan Dam

The construction of the Sidan Dam which was carried out by the Ministry of PUPR through the Bali Penida River Basin Office has a capacity of 3.8 million m3 and provides benefits for a raw water supply of 1,750 liters/second and is used as a raw water supply system for Sarbagita, namely Denpasar City as much as 750 liters /second, Badung Regency as much as 500 liters/second, Gianyar Regency as much as 300 liters/second, and Tabanan Regency as much as 200 liters/second, PLTM with a capacity of 0.65 MW, tourism and water conservation.

The Sidan Dam is located in Badung Regency, Bangli Regency and Gianyar Regency with a total land area of 81.81 Ha. For land acquisition, Rp. 132,828,344,031 has been paid through APBN funds. Progressively, the construction of the Sidan Dam in Package I, which has been carried out since 2018, has reached 100 percent as of December 31 2021 with funding from the State Budget of IDR 808,603,374,137. Package II it is in the tender preparation stage with a budget of IDR 864,698,874,000, so the construction of Phase II is targeted to be contracted in April 2022 and completed in 2024. So the total budget for the construction of the Sidan Dam in Badung Regency, Bangli Regency, and Gianyar Regency from stages I and II, it reached IDR 1,673,302,248,137. Figure 2 shows the Sidan Dam site plan

Figure 2. Site plan Sidan Dam

Clean water supply system in the study area

The clean water supply system in the study area, namely in Denpasar City, Badung Regency, Gianyar Regency and Tabanan Regency is provided by PDAM and PAM des each village that has water potential in the village (Hassing, 2009; Rubin et al., 2006; Baldwin & Hamstead, 2014). At present, Badung Regency, Denpasar City and Gianyar Regency have a higher population development condition when compared to Tabanan Regency as a result of tourism development. Table 1 shows the availability of water in the study area

Table 1
Water availability in the study area

No.	Regency/City	Production of PDAM (liters/second)	Rural PDAM (litters/second)	Total (litters/second)
1	Denpasar City	1169,24	0,00	1169,24
2	Badung	1301,34	6,35	1307,69
3	Gianyar	743,72	55,56	799,28
9	Tabanan	644,90	107,29	752,19
	Jumlah	3859,20	169,20	4028,40

Source: Analysis

Population projection

Population projections are carried out to determine the number of residents in the future because it is closely related to the water that must be provided in the study area. Some areas, such as the cities of Denpasar, Badung, and Gianyar, have experienced greater population growth due to the presence of migrant workers coming to these areas. Calculation of the population can be seen in Table 2

Table 2
People projection in the study area

Regency/City	2022	Projection (people)					
		2025	2030	2035	2040	2045	2050
Denpasar	1,001,128	1.061,406	1,170,256	1,290,561	1,423,559	1,570,624	1,733,280
Badung	710,428	751,805	820,771	889,743	958,719	1,027,701	1,096,688
Gianyar	525,832	540,427	565,751	592,385	620,404	649,885	680,912
Tabanan	453,406	461,691	475,985	490,913	506,511	522,816	539,865

Source: Analysis

Need for clean water

Clean water needs are calculated based on domestic water needs, the assumption of non-domestic water needs, and water losses that occur. Domestic water needs in each study area are determined based on the provisions of the Directorate General of Cipta Karya, Ministry of Public Works for the category of medium cities, small towns, and rural areas. The assumption of non-domestic water demand is in accordance with the provisions of the Directorate General of Cipta Karya, Ministry of Public Works, which is estimated at 20% of domestic water needs. Water losses are calculated based on actual losses in each PDAM by finding the difference between the water produced and the amount of water released. Currently, the average water loss for PDAMs in Bali is around 20-30%. The results of the calculation of water needs can be seen in Table 3

Table 3
Water need projection

No.	Regency/City	Year (litters/second)						
		2022	2025	2030	2035	2040	2045	2050
1	Denpasar	1,807.79	1,916.64	2,194.23	2,419.8	2,847.12	3,141.25	3,683.22
2	Badung	1,650.5	1,819.41	1,986.31	2,153.23	2,320.15	2,676.31	2,855.96
3	Gianyar	1,123.57	1,154.76	1,208.87	1,332.87	1,395.91	1,543.48	1,617.17
4	Tabanan	968.82	986.52	1,017.06	1,104.56	1,139.65	1,241.69	1,282.18

Source: Analysis

The effect of Sidan Dam operation on clean water balance in the study area

The operation of the Sidan dam has had the impact of increasing the supply of water to the Study area. The Sidan dam discharge of 1750 liters/second will be distributed to each region with the following allocation: Denpasar City 750 liters/second, Badung Regency 500 liters/second, Gianyar Regency 300 liters/second and Tabanan Regency 200 liters/second. This water supply has a changing impact on the availability of clean water in each study area as shown in Table 4 and Figure 3

Table 4
Percentage of additional debit from Sidan reservoir on water availability in each regency

No.	Regency/City	Current Water Availability (litter/second)	Added From Sidan Dam (litters/second)	Percentage of Added (%)
1	Denpasar City	1.169,24	750	64,14
2	Badung	1.307,69	500	38,24
3	Gianyar	799,28	300	37,53
4	Tabanan	752,19	200	26,59

Source: Analysis

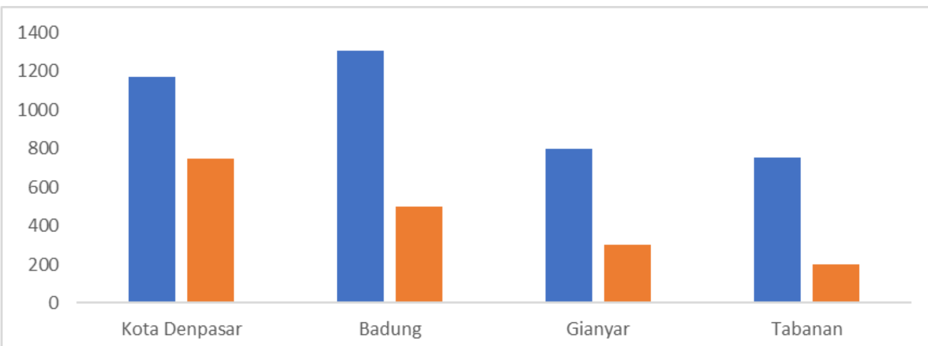

Figure 3. Water availability and water supply from the Sidan Dam

The addition of water due to the construction of the Sidan reservoir has increased the amount of water in the study area. The condition of the water balance is calculated based on the need for water and the addition of existing water in the Study Area. Specifically for Tabanan Regency, besides getting water from the Sidan Dam, the amount of water also comes from long storage from Tukad Yeh Empas. Table 5.20 presents the results of the water balance in the study area related to the addition of the Sidan reservoir and the Yeh Empas long storage. The balance is calculated based on all needs and all availability owned in each region and by including additions from new infrastructure in the form of existing dams and long storage (Asefa et al., 2014; Vieira & Ramos, 2009; Wesnawa, 2017). The calculation results show that Denpasar City will experience a water shortage until 2050, Badung Regency will reduce water at this time, and starting in 2035, Gianyar Regency will experience a water shortage until 2050 and Tabanan Regency will only experience a water shortage at this time. The growth in water demand in the City of Denpasar and Gianyar Regency shows that these areas are experiencing a rapid increase in population caused by the growth of the workforce, especially in the tourism sector and the growth of other sectors that require labor which has an impact on increasing population. The water balance in the study area can be seen in Figure 4 - Figure 7

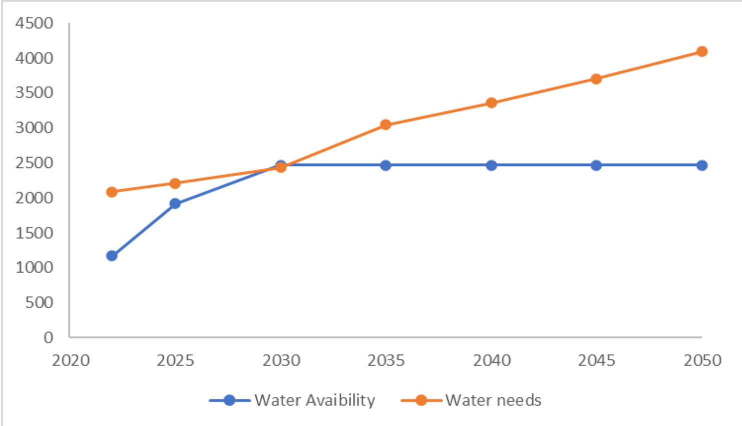

Figure 4. Water balance Denpasar City

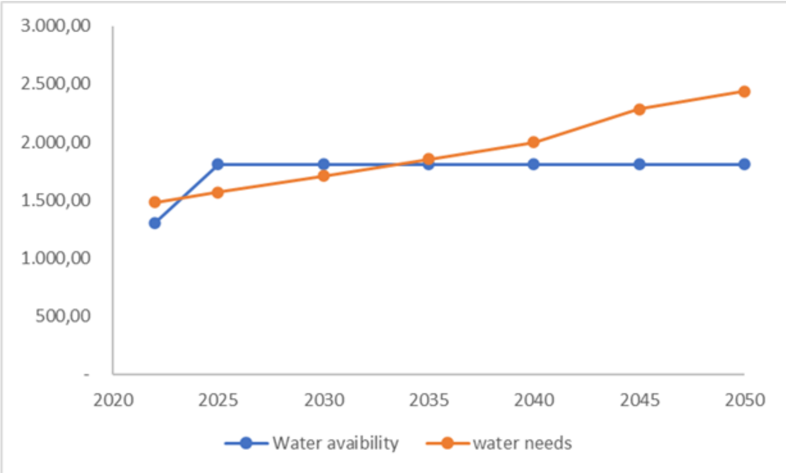

Figure 5. Water balance Badung Regency

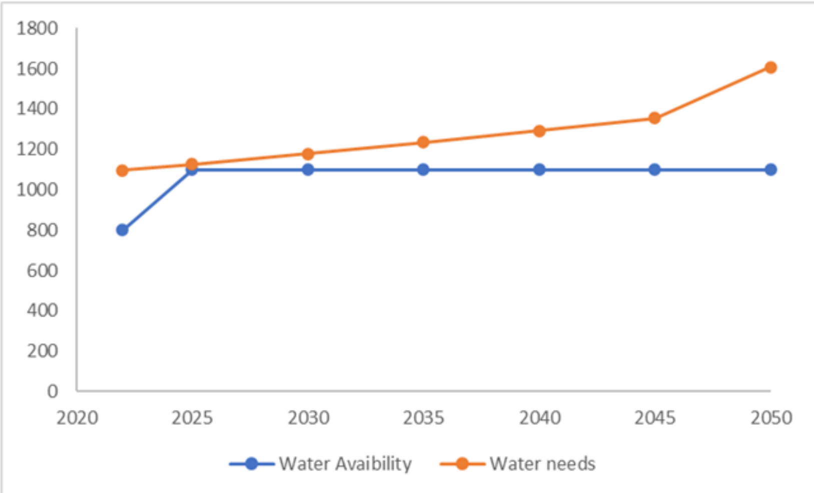

Figure 6. Water balance Gianyar Regency

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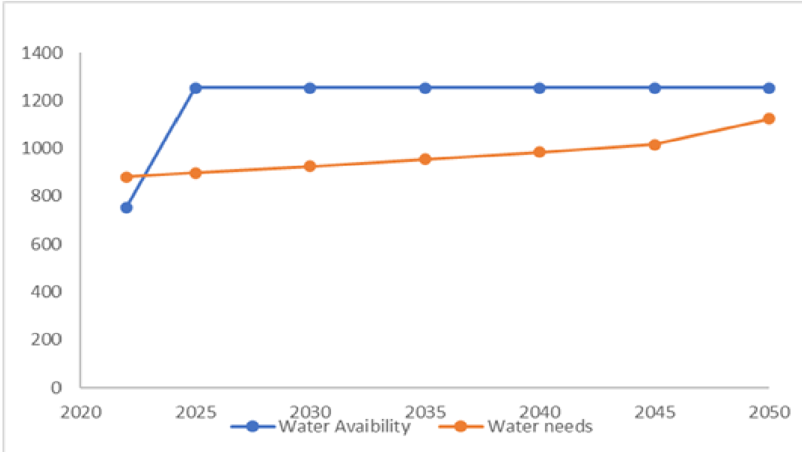

Figure 7. Water balance Tabanan Regency

Integrated water service development system

An integrated water service system is one way of developing water in the future. Integrated services are also a must in the future because water and other necessities are not available everywhere.

Denpasar City development system

The production capacity of PDAM Denpasar City only reaches 1,170.4 liters/second. If it is assumed that production capacity in 2040 has the current clean water production capacity, Denpasar City will experience a clean water shortage of 2,375.32 liters/second. To be able to meet these needs, several supply development plans are needed as follows:

- Optimization of Penet *long storage* with a capacity of 150 liters/second to meet demand in West Denpasar
- Optimization of the Petanu *long storage* with a capacity of 150 liters/second to meet demand in South Denpasar
- Sarbagita Reservoir with a capacity of 900 liters/second to meet demand in North Denpasar
- Sarbagikung Reservoir with a capacity of 200 liters/second to meet demand in East Denpasar
- Unda estuary Reservoir with a capacity of 850 liters/second to meet the demand in South Denpasar
- Mati *long storage* with a capacity of 50 liters/second to meet demand in South Denpasar
- Melangit *long storage* with a capacity of 80 liters/second to meet the needs in South Denpasar

Clean water planning system development will produce a capacity of 2,380 liters/second. This capacity is allocated for:

- East Denpasar of 200 liters/second, originating from the Sarbagikung Dam
- South Denpasar of 980 liters/second, originating from Mati River, *Long storage* Melangit, and estuary Unda Reservoir
- West Denpasar of 300 liters/second, which comes from the optimization of the Petanu River and Penet river
- North Denpasar of 900 liters/second, originating from the Sarbagita Reservoir.

Badung Regency

Badung Regency is projected to need 2,347.57 liters/second of clean water, while water production from Badung Regency PDAM reaches an average of 1,446.56 liters/second and Non-PDAM water production such as PAMSIMAS has a capacity of 8.47 liters/second. So, if it is assumed that water production from PDAM will remain constant in 2040, Badung Regency is expected to experience a shortage of clean water of 892.54 liters/second. To be able to meet these needs, several supply development plans are needed as shown in Figure 8

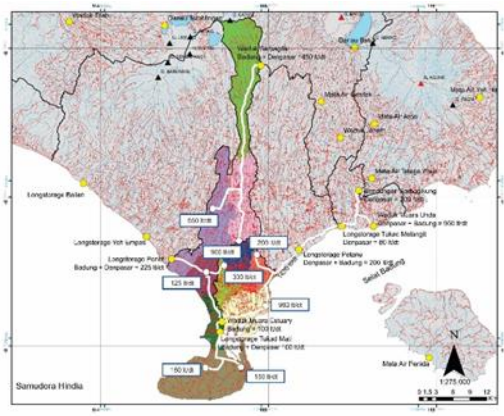

Figure 8. Distribution map of water capacity allocation from the clean water supply system development plan for Badung Regency and Denpasar City

- Sarbagita Reservoir with an allocated capacity of 550 liters/second
- Muara Unda Reservoir with an allocated capacity of 100 liters/second
- Optimization of Longstorage Penet with an allocated capacity of 75 liters/second
- Optimization of Longstorage Petanu with a capacity of 50 liters/second
- Longstorage Tukad Mati with a capacity of 50 liters/second
- Muara Estuary Reservoir with a capacity of 100 liters/second

The clean water planning system (SPAM) development will produce a capacity of 925 liters/second. This capacity is allocated for:

- Mangupura, Mengwi District with 550 liters/second originating from the Sarbagita Reservoir
- North Kuta of 125 liters/second which comes from the optimization of Tukad Penet and Tukad Mati
- South Kuta, which is allocated in Benoa and Jimbaran, each with 150 liters/second, coming from the Muara Unda Reservoir, optimizing Petanu Long storage, and Maduk Muara Estuary

Gianyar Regency

The production capacity of clean water by PDAM and non-PDAM in Gianyar Regency reaches 768.58 liters/second. However, this capacity has not been able to meet the demand for clean water which is projected to reach 1,419.81 liters/second in 2040. So that Gianyar Regency will experience a shortage of clean water sources of 651.17 liters/second. There are several development plans for the Clean Water Supply System that can be used to meet these water needs, including:

- Sarbagita Reservoir with an allocated capacity for Gianyar Regency of 100 liters/second which will be distributed to Ubud District.
- Embung Sarbagiikung with an allocated capacity of 50 liters/second which will be distributed to Gianyar District. The condition of the water supply can be seen in Figure 9

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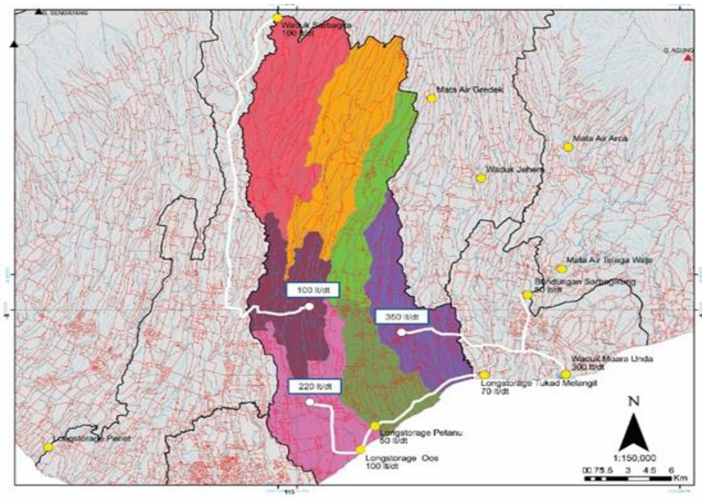

Figure 9. Distribution map of water capacity allocation from the clean water supply system development plan for Gianyar Regency

Estuary Unda Reservoir with a capacity of 300 liters/second which will be distributed to Gianyar District.

- Long storage Petanu with a capacity of 50 liters/second which will be distributed to Sukawati and Blahbatuh Districts.
- Long storage Melangit with a capacity of 70 liters/second which will be distributed to Gianyar District.
- Long storage Oos with a capacity of 100 liters/second which will be distributed to Sukawati District.
- The allocation of water with a capacity of 670 liters/second is planned to be channeled to distribution reservoirs in the following districts:
- Ubud District, 100 liters/second from Sarbagita Reservoir
- Gianyar District of 350 liters/second, which comes from the allocation of the Sarbagikung Dam and Muara Unda Reservoir
- Sukawati District of 220 liters/second which comes from the allocation of Longstorage Tukad Melangit, optimization of Longstorage Petanu, Longstorage Oos

Tabanan Regency development system

Based on the projected need for clean water in 2040 compared to clean water production from PDAMs and non-PDAMs, Tabanan Regency is expected to experience a water shortage of 390 liters/second. To be able to meet this shortfall, there are several plans for a Clean Water Supply System that can be developed up to 2040, as shown in Figure 10.

- Long storage Balian with a capacity of 50 liters/second which will be allocated for the East Selemadeg District
- Long storage Yeh Empas with a capacity of 300 liters/second which will be allocated for Tabanan and Kediri Districts
- Sarbagita Reservoir with a capacity of 100 liters/second will be allocated to the Baturiti and Marga Districts.

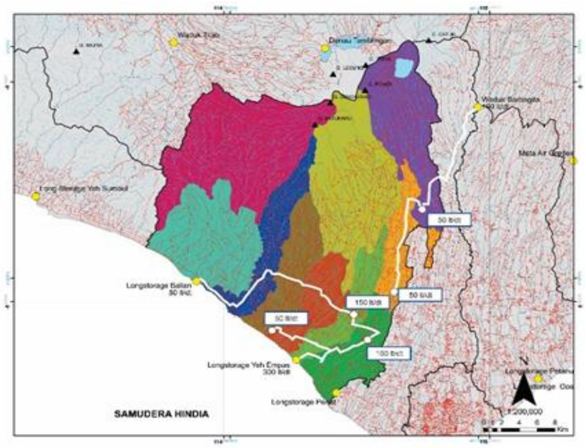

Figure 10. Distribution map of water capacity allocation from the clean water supply system development plan for Tabanan Regency

4 Conclusion

Based on the results of the analysis, it can be concluded several things as follows:

1) Water production in each PDAM is currently 1,169.24 liters/second for Denpasar City PDAM, 1,301.34 liters/second for Badung Regency PDAM, 866.25 liters/second for Gianyar Regency and 644.90 liters/second for Tabanan Regency. Judging from the contribution of the Sidan Dam for each region, Denpasar is 750 liters/second (64.14%), Badung is 500 liters/second (38.24%), Gianyar is 300 liters/second (37.53%), and Tabanan of 200 liters/second (26.59%)
2) Based on the existing water balance until 2050, Denpasar and Badung will experience a water deficit throughout the year. Meanwhile, Badung and Tabanan regencies are observing water shortages at this time and will start experiencing water shortages again in 2035.
3) The operational plan for the Sidan dam will be carried out with a single-purpose system for clean water only. The operating system is adapted to the needs of each region. This clean water management system really helps the amount of water that can be added in this area.

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.

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