



## Analysis of Non-Domestic Water Needs Tourism Sector for Accuracy of Clean Water Supply System in Gianyar District



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### Abstract

Gianyar is one of the regencies which are the main tourist destinations in the Province of Bali, with the icon of the Ubud tourism area which is one of the tourist areas which is already very well known in foreign countries. The increase in tourist visits, both domestic and foreign, certainly brings prosperity to the community and also to the government. Fulfillment of all the necessary facilities for the world of tourism should be a serious concern of the government so that tourists feel at home when visiting Gianyar. One very basic factor that needs serious attention is the availability of clean water. So far, the allocation for non-domestic water needs (schools, government, trade, social, and tourism) has only been determined based on the percentage of domestic water needs based on the decision of the Directorate General of Human Settlement with an amount of 20-25% of domestic water needs. Looking at the existing conditions in the field and with the development of tourism facilities, it certainly requires a more accurate calculation related to the predetermined percentage of non-domestic water needs. The research method in this case is a quantitative method by calculating all water needs for the tourism sector and so on the results are compared with the existing coefficients. Based on data on tourist visits to Bali in 2019 before the pandemic, there were 20,280,914 people, an increase from 2017 of 17,854,694 people. Of these, 5,037,459 people visited Gianyar Regency in 2019 or 24.84%.

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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 are 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 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 1997 which allocates all non-domestic water needs of 20-30% of domestic water needs (Astani et al., 2022). 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*

#### *Criteria for planning water requirements*

The provision of raw water in an area is planned to meet raw water needs including clean water for residents (domestic) and public facilities (non-domestic), thus it is necessary to consider factors that can support or cause an increase in the need for clean water. The need for clean water in an area is analyzed based on several considerations, namely: (Herschy, 2012; Rahman et al., 2021), the number of residents at the time of planning until the end of the planning year, the service target is the ratio of clean water services calculated based on the number of people who will get the service clean water in accordance with government recommendations, type of service and unit of water demand for, characteristics of water needs of an area which illustrates the variation in daily water needs, namely the average requirement and peak demand and the amount of water lost

From the above considerations, it can be seen that population is an important factor in determining the policy of supplying clean water needs. Population parameters that must be observed include number, density, rate of increase and distribution. The number of residents will determine the amount of water needs that must be met. The level of population density gives an indication of the need for a pipe system to be implemented in the area concerned. This is considering that increasing population density will increase the complexity of problems including clean water problems. Planning for water needs that meet the requirements must of course be used to be able to serve all members of the community starting at the time of planning until a certain period of time. For this reason, information about the rate of population growth is needed in the planning of clean water infrastructure. Finally, it is also necessary to know the state of a population distribution to determine the determination of network system to be used, both in terms of the network system and in the distribution system (Du et al., 2017; Gonzalez-Perez et al., 2023; Kent et al., 2002; Sutawa, 2012).

In relation to service targets, the provision of clean water infrastructure in addition to meeting domestic needs or household needs for citizens either through direct connections or through public faucets is also required to meet water needs in various urban facilities such as public facilities, business/trade facilities as well as to meet industrial needs and special needs (non-domestic needs) (Koop & van Leeuwen, 2015; Astani et al., 2022; Elimelech, 2006; Gu et al., 2014). Not all uses in the service area will be served with clean water. This happens because not all residents are willing to pay compensation for the clean water services provided. This relates to the installation of house connections for low-income people who will object because it involves fees/retribution so they will draw from

shallow wells and for people whose groundwater is not good will use water from public taps that are available. The technical planning criteria that will be used regarding the projection of clean water demand by city category can be seen in Table 1.

Table 1  
Level of household water usage by city category

No	City Category	Total population (people)	Water Usage (litter/second)
1	Metropolitan City	> 1.000.000	190
2	Big City	5.000.000 - 1.000.000	170
3	Medium City	100.000 - 500.000	150
4	Small City	20.000 - 10.000	130
5	District Town	< 20.000	100

Source: Indonesia Clean Water Standart, 1997

#### *Non-domestic water needs*

Non-domestic needs are the use of water outside of household use. Included in the group of water needs for non-domestic purposes include commerce, health, social, offices, education, and worship (Makawimbang et al., 2017; Widhiyastuti et al., 2017; Oktavianto et al., 2014; Raksanagara et al., 2017). The assumed value of non-domestic water needs can be seen in Table 2.

Table 2  
Level of non-domestic water usage

No	Description	Use Water
1	School	10 Litters/day
2	Hospital	200 Litters/day
3	Community health center	(0,5 - 1) m <sup>3</sup> /unit/day
4	Temple/Mosque/Church	(0,5 - 2) m <sup>3</sup> /unit/day
5	Office	(1 - 2) m <sup>3</sup> /unit/day
6	Shop	(1 - 2) m <sup>3</sup> /unit/day
7	Canteen	1 m <sup>3</sup> /unit/day
8	Hotel	(100 - 150) m <sup>3</sup> /unit/day
9	Market	(6 - 12) m <sup>3</sup> /unit/day
10	Industry	(0,5 - 2) m <sup>3</sup> /unit/day
11	Port/Terminal	(10 - 20) m <sup>3</sup> /unit/day
12	Public Patrol Station	(5 - 20) m <sup>3</sup> /unit/day
13	Park and Landscape	25 m <sup>3</sup> /unit/day

Source: Indonesia Clean Water Standart, 1997

#### *Fluctuations in needs*

In the planning of a clean water supply system, the terms fluctuations in water use during the day are known as maximum and fluctuations in water use during peak hours. What is meant by fluctuations in the use of clean water during peak hours are as follows (Khatiri et al., 2008; Suhendra et al., 2019):

- During the day there are certain hours when the use of clean water is higher than the average hourly usage.
- The use of water at the highest hour is referred to as the use of peak hours, which usually occurs in the morning and evening. What is meant by fluctuations in the use of clean water during the day is the maximum.
- Throughout the year there are certain days when water use is higher than the average daily water usage. This usage is called water usage on maximum days.

If there is no complete data showing several multipliers for maximum day and peak hour water use, then these factors are taken from Cipta Karya Standards, namely:

- Maximum day = 1.15 x Average requirement
- Peak hours = 1.75 x Average demand

#### *Calculation of Population Projection*

Population projections are used to estimate the population for the future. This population estimate is used as the basis for domestic water calculations. To get the right projection method, it is necessary to do a correlation test and existing methods. The results of the correlation test with results close to one is the method used.

The correlation test formula used: (PUPR, 1996).

$$r = \frac{n(\sum xy) - (\sum y)(\sum x)}{\sqrt{[n(\sum y^2) - (\sum y)^2][n(\sum x^2) - (\sum x)^2]}}$$

Information:

y (arithmetic): population growth

y (geometric): ln Population Growth

y (last square): Total Population

x: year – n

n: Number of years

There are several formulas for calculating population projections which are then adjusted to the characteristics of the existing population. Calculations using arithmetic, geometric and exponential formulas.

#### *The development of the tourism sector and the potential for increased demand for water*

The development of the tourism sector has increased the growing need for clean water to support activities in various fields that support tourism. Tourism facilities with supporting facilities such as swimming pools, restaurants, golf courses, as well as parks and hotel rooms require large amounts of water, (Yamamoto et al., 2021; Cole et al., 2020; Rimba et al., 2019; Folgado-Fernández et al., 2018). Cole provides an illustration of the relationship between water use for tourism involving the downstream industry as shown in Figure 1. In the figure, it appears that the use of water for tourism is large because it is followed by other downstream industries which also require large amounts of water.

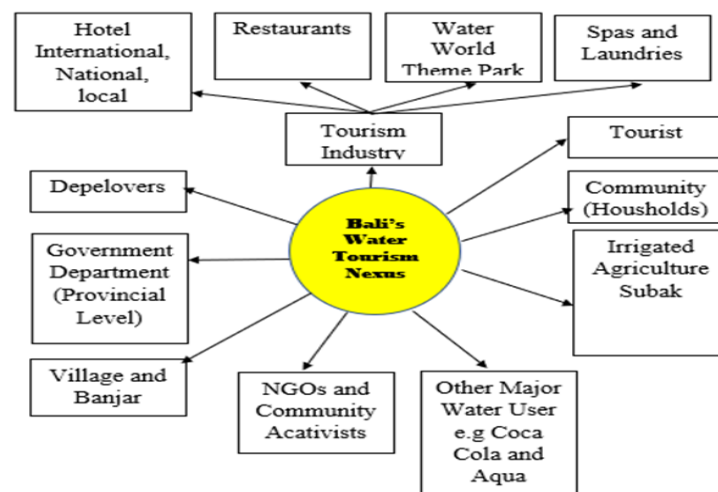


Figure 1. Tourism relations with other water users in Bali (Source: Cole (2012), has been modified)

## 2 Materials and Methods

### *Research design*

The research steps are arranged in stages and continuously so that all existing problems can be resolved. Broadly speaking, the method in this study was carried out as follows:

- a) Secondary data collection  
Secondary data collection includes population data from BPS Gianyar Regency, data on the number of tourists and tourism facilities from the Gianyar Regency Tourism Office, water production data from PDAM, data on community perceptions and the world of tourism regarding the use of clean water and data on clean water development systems from the Regional Government of Gianyar.
- b) Primary data collection  
Primary data collection includes direct measurements of water sources to determine the capacity of water taken as a source, interview data, and observations with residents and tourism actors related to clean water services
- c) Analysis
  - Analysis of the population and its projection using arithmetic, geometric and exponential methods
  - Analysis of tourism facilities is carried out by recording data from the Department of Culture and interviews
  - Analysis of water use by the tourism sector and the community by checking the method by random sampling from the existing data in the PDAM
  - Analysis of clean water development using the method of conducting hearings to the PDAM and the Public Works and Housing Agency of Gianyar Regency

### *Surveys and data collection*

- 1) Conduct a field survey to find out the following:
  - PDAM water production
  - The number of accommodations and types of tourist attractions
  - Number of residents
  - Sample water use by residents
  - Tourist visits
  - Comparison of domestic water use and Tourism
  - Government policy in tourism development in Gianyar Regency
  - Policies in the development of clean water
- 2) Stages of Analysis  
The analysis is carried out in stages by taking into account the needs and availability of data which includes the following analysis:
  - Population analysis  
This analysis refers more to the records from BPS related to the current population
  - Population Projection Analysis  
This analysis is carried out using several formulas such as arithmetic, geometric and exponential
  - Analysis of the number of tourists and their projections  
This analysis is carried out by estimating the current number of tourists and their development in the future based on the current rate of development
  - Analysis of the number of tourism facilities and attractions  
This analysis was conducted to determine the number of tourism facilities and attractions more precisely related to water use
  - Clean water development system analysis  
This analysis is carried out to find the direction and system for developing clean water in the future
  - Analysis of non-domestic water needs in the tourism sector

This analysis was carried out to find out the non-domestic water needs of the tourism sector, which can be used as a reference in tourism development in other regions.

#### *Research sites*

This research is located in Gianyar Regency, especially in Ubud and its surroundings can see in Figure 2.



Figure 2. Map of study location

### 3 Results and Discussions

#### *Tourism in Gianyar Regency*

#### *Tourism Visits in Gianyar Regency*

Based on data on tourist visits to Bali in 2019 before the pandemic, there were 20,280,914 people, an increase from 2017 of 17,854,694 people. Of these, 5,037,459 people visited Gianyar Regency in 2019 or 24.84%. Data on tourist visits can be seen in Table 3 and Figure 3 [23]

Table 3  
Tourist visits to Bali

Regency/City	Year		
	2.017	2.018	2.019
Jembrana	280.526	309.508	291.951
Tabanan	5.333.823	5.533.745	4.967.424
Badung	5.026.941	4.816.649	4.277.052
Gianyar	3.842.208	4.550.940	5.037.459
Klungkung	496.176	253.235	503.347
Bangli	790.822	703.010	1.230.573
Karangasem	559.232	1.135.119	1.165.674
Buleleng	954.730	1.003.810	642.242
Kota Denpasar	570.236	2.061.265	2.165.192
Jumlah	17.854.694	20.367.281	20.280.914

Source: (Handayani et al., 2021)

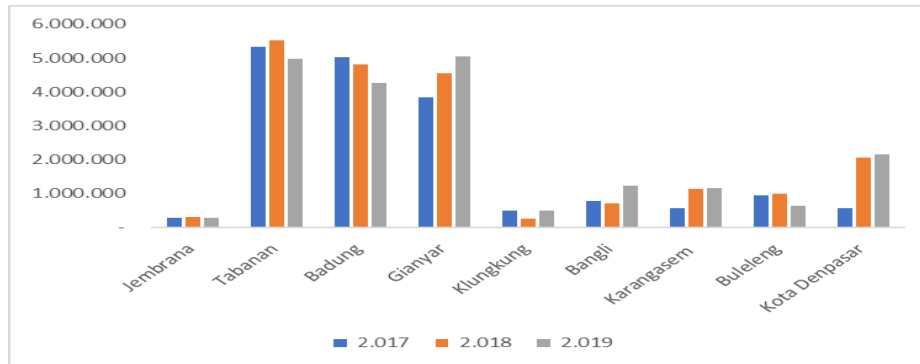


Figure 3. Tourist visits to Bali

Judging from the tourist objects visited in Gianyar Regency, the most visited tourist object is Mandala Suci Wanara Wana (Monkey Forest) with visits in 2019 reaching 1,666,666 or 33.73% of the total number of visits to Gianyar Regency. Complete data on tourist visits to tourist objects in Gianyar Regency in 2019 can be seen in Table 4 (Handayani et al., 2021).

Table 4  
Tourist visits to 10 main tourism objects in Gianyar Regency

No.	Tourism Destination	2019
1	Mandala Suci Wanara Wana	1.666.666
2	Tirta Empul	1.025.926
3	Air Terjun Tegenungan	496.677
4	Bali Zoo Park	398.315
5	Bali Safari And Marine Park	397.210
6	Goa Gajah	360.664
7	Pura Gunung Kawi	182.868
8	Air Terjun Blangsinga	179.009
9	Taman Burung dan Rimba Reptil	148.717
10	Wisata Gajah Taro	84.916
	<b>Total</b>	<b>4.940.968</b>

Source: Tourism Board of Gianyar, 2021

*Tourism Accommodation in Gianyar Regency*

Tourism accommodation in Gianyar Regency is classified as very complete, starting from star hotels, budget hotels, and homestays. restaurants, villas, and others. Hotel accommodation in Gianyar Regency can be seen in Table 4

Table 4  
List of Hotel accommodation in Gianyar Regency

No	Hotel Classification	Year		
		2017	2018	2019
1	Star Hotel	19	24	23
2	Non Star Hotel	371	1060	1014
	<b>Total</b>	<b>390</b>	<b>1084</b>	<b>1037</b>

Source: Tourism Board of Gianyar, 2021

Based on the number of rooms available in 2018 there were 2730 rooms dominated by rooms with a classification of more than 25 rooms. Details can be seen in Table 5

Table 5  
Room classification and number in Gianyar Regency

No	Room Classification	Number of Room (unit)
1	<5	1902
2	5-9	2722
3	10-24	3745
4	>=25	2730

Source: Tourism Board of Gianyar, 2021

#### Population growth projection

In the analysis of population growth based on population growth rate data in previous years. The calculated data begins with a test of the population projection formula in accordance with Table 6. The results of calculating the projected population of Gianyar Regency up to 2050 are shown in

Table 6  
Population projection of Gianyar Regency

Sub District	2022	People Projection (people)					
		2025	2030	2035	2040	2045	2050
Sukawati	130,597	136,033	145,602	15,843	166,805	178,538	191,096
Blahbatuh	74,090	76,226	79,923	83,799	87,863	92,124	96,592
Gianyar	97,023	99,649	104,186	108,930	113,889	119,074	124,496
Tampaksiring	49,662	50,625	52,271	53,971	55,726	57,538	59,410
Ubud	75,837	77,482	80,303	83,226	86,256	89,396	92,651
Tegallalang	54,789	55,918	57,850	59,848	61,916	64,056	66,269
Payangan	43,835	44,495	45,618	46,769	47,949	49,159	50,399
Total	525,832	540,427	565,751	592,386	620,405	649,886	680,913

Source: Analysis

#### Water demand and water availability in Gianyar Regency

Domestic water demand in Gianyar Regency is calculated based on the total population. The population is multiplied by the water requirement for medium/small town areas with a water requirement of 140 liters/person/day. The water requirement is then added with water losses and non-domestic water needs of 20% of domestic water needs. The availability of water in Gianyar Regency is calculated based on the current PDAM capacity added to the availability of water from village PAMs in several areas (Coelho & Andrade-Campos, 2014; Wee & Aris, 2017; Luna et al., 2019; Gössling et al., 2012). Domestic water demand in Gianyar Regency and its predictions can be seen in Table 5.13 Total water demand and water availability in Gianyar Regency can be seen in Table 7, Table 8, and Figure 4

Table 7  
Domestic water needs in Gianyar

Description	Year						
	2022	2025	2030	2035	2040	2045	2050
People of Gianyar	525,832	540,427	565,571	592,386	620,425	649,896	680,913
Service Coverage (%)	85,47	85,47	85,47	90	90	90	90
Domestic Water needs (litter/second)	780.26	801.92	839.49	925.60	969.38	1,071.86	1,123.03

Source: Analysis



Table 8  
Water balance in Gianyar (litters/second)

Description	2022	2025	2030	2035	2040	2045	2050
Water Availability	799.28	1099.28	1099,28	1099,28	1099,28	1099,28	1099,28
Water Needs	1,095.48	1125,89	1178,649	1234,137	1292,51	1353,929	1607,711

Source: Analysis

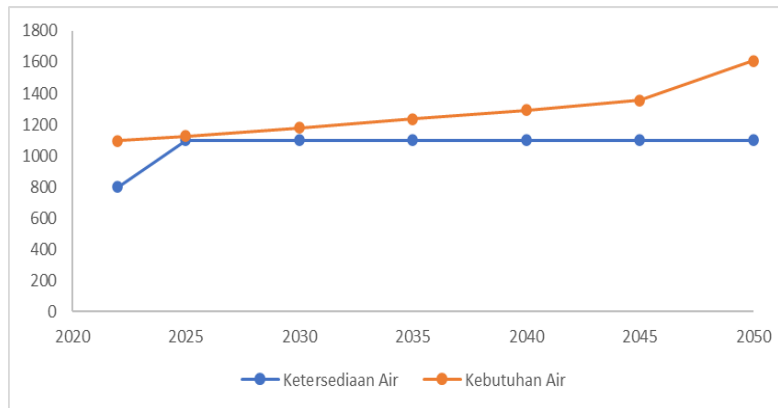


Figure 4. Water balace In Gianyar

*Water demand in the tourism sector*

Water demand for the tourism sector is calculated based on the amount of water provided at tourism objects such as washing hands, urinating and defecating as well as the water needs that must be provided at hotel accommodations. The water requirements needed in tourism objects are shown in Table 9, Table 10, and Table 11

Table 9  
Water needs at tourist attractions in 2019

No.	Tourist Destination	Tourist visits (people/year)	Water Needs (litters/year)	Water Needs (litters/second)
1	Monkey Forest	1,666,666	6,249,998	0.20
2	Tirta Empul Temple	1,025,926	3,847,223	0.12
3	Tegenungan Waterfall	496,677	1,862,539	0.06
4	Bali Zoo Park	398,315	1,493,681	0.05
5	Bali Safari And Marine Park	397,210	1,489,538	0.05
6	Goa Gajah	360,664	1,352,490	0.04
7	Gunung Kawi Temple	182,868	685,755	0.02
8	Blangsinga Waterfall	179,009	671,284	0.02
9	Bali Bird Park And Reptil	148,717	557,689	0.02
10	Tarp Elephant Park	84,916	318,435	0.01
	Total	4,940,968	18,528,630	0.59

Source: Analysis

Table 10  
Water needs for accommodation

No	Qualification	Number of Room	Water Need (litter/day)	Water Need (litter/second)
1	Star Hotel	4,624	1,849,600	21
2	Non Star Hotel	6,475	1,618,750	19
Jumlah				40

Source: Analysis

Table 11  
Water need for restaurant

No	Description	Number of Chairs (orang)	Water Need (litter/day)	Water Need (litter/day)
1	Restaurant	2,400	48,000	0,56

Source: Analysis

Based on the results of the analysis, it shows that the need for water for tourism, namely the water used in tourism objects, the water used for hotel rooms, and the water needed for restaurants, is 41.29 liters/second, this amount when compared to the estimate of domestic water in Gianyar Regency in 2022 it will be 5.29% and when compared specifically to non-domestic water needs it will be 26.45% (Wesnawa, 2017; Amerta et al., 2018; Vreeburg & Boxall, 2007; Janiawati et al., 2016).

## 4 Conclusion

Based on the results of the analysis, several things can be concluded related to the use of clean water in the tourism sector, namely:

- 1) Based on data on tourist visits to Bali in 2019 before the pandemic, there were 20,280,914 people, an increase from 2017 of 17,854,694 people, but when compared to 2018 it has decreased, the number of tourist visits in 2018 was 20,367,281 people. Of these, 5,037,459 people visited Gianyar Regency in 2019 or 24.84%. Tourism accommodation includes 1014 non-star hotels/homestays and villas and 23-star hotels with a total of 11,099 rooms.
- 2) The need for water in the tourism sector in 2022 is 41.29 liters/second or 5.29% of domestic water needs and when compared to the total need for non-domestic water needs it is 26.47%.
- 3) In view of the relatively large need for non-domestic water specifically for tourism, it is necessary to anticipate it by preparing several river estuaries that accommodate the remaining irrigation water which can be used for the allocation of clean water.

### *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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