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 1 Water management study in Denpasar, Badung, Gianyar and Tabanan (SARBAGITA) area

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Abstract. The areas of Denpasar, Badung, Gianyar and Tabanan in Bali are areas with the densest population concentrations in Bali. This area is also the main tourism area in southern Bali. Data from Bali Penida River Council in 2015 shows that the water potential in Sarbagita region is 2,182 cubic meters per year. The need of water in 2034 is estimated at 21,247 liter per second. Solving the 11 lack of water can be done by increasing the amount of raw water using water in the estuary section. Some potential rivers can be utilized, such as the Oos River, Unda River, Pakerisan River. The research method is carried out by analyzing the water requirements and the availability of water available. The results of the research show that 4 it is necessary to utilize surface water downstream which has not been maximally utilized. 1. Introduction Bali Province is one of the main tourism areas in Indonesia with the number of domestic and foreign tourist arrivals reaching 2.5 million tourists in 2018. The Bali Penida River council has mapped the estimated water needs

especially about surface water used for tourism [1]. The development of the number of tourists has been accompanied by a variety of supporting facilities in the form of adequate hotel accommodations, transportation and telecommunications facilities as well as adequate clean water supply. Likewise, seen from the agricultural sector, Bali still places a large portion of the rural community who depend on agriculture for a broader meaning. The number of waters needs in Bali is currently 70% more used by the agricultural sector, especially for the needs of rice irrigation. The Denpasar, Badung, Gianyar and Tabanan areas are regional regions in Bali which are experiencing rapid development because of the development of tourism and urban development. In this area the concentration of the Balinese population is more than 50% of the total population in Bali [2]. The author analyses the population and indeed it is found that the population residing in the southern part of Bali is more than 50%. The Provincial Government of Bali and the Central Government through the Bali Penida River council have made various breakthroughs in the water supply system through the construction of several water management infrastructures such as the construction of the Telaga Tunjung reservoir, Benel Reservoir, Titab Reservoir, Tamblang Reservoir, Beloksidan reservoir and the development of the supply system clean water through the Clean Water Planning System (CWPS) spread across several regions in Bali, namely Petanu CWPS, Penet CWPS and Telagawaja CWPS. With a total of 391 rivers and 4 lakes and the potential of ground water is enough supply water business in Bali.

 The problem faces currently is the need for water that continues to increase, while the government's ability to provide clean water facilities and infrastructure is still very limited. Therefore, it is very important to do a strategic and innovative study related to the clean water management system in the Sarbagita area. 2. Methods 2.1. Research design The study was designed with a systematic and coordinated research flow among all components that support research

activities. With this, the research can be done more closely. 2.2. Data collection activities Data collection is the first step of research by taking sources from agencies directly related to water supply, i.e., River potential data collection (data obtained from the Bali Penida River Council), Data collection on the potential of lake water, reservoirs (data obtained from the Bali Penida River Council), Data collection for each local water company in the Sarbagita area (data obtained from the Regency in the study area), Data collection on water management infrastructure in the Sarbagita area (data obtained from the Bali Penida River Council), Data on water management development system (obtained from Bali Penida River Council, Public Works Agency, Provincial and Regency Research and Development Agency). 2.3. Analysis The analysis includes analysis of the population, analysis of water demand, analysis of raw water infrastructure and analysis of the potential of water in the estuary section. From this analysis will be obtained the current water fulfilment conditions and future water needs. • Analysis of water available This analysis was conducted to determine the magnitude of the potential that exists at this time both surface water, ground water and springs. • Analysis of water demand Water needs analysis This analysis considers water needs for various needs both domestic and nondomestic [3-5]. The Asian Development Bank, Wuysang and Warren provide a way of assessing and determining water needs in Bali. The author analyses with the latest data in accordance with the existing population and by estimating the development of the tourism industry. • Analysis of integrated water management This analysis is carried out for territorial based water management [6-13]. Kooy described the management system for urban water development, especially Jakarta [6]. This is one of the basic considerations even though the conditions in Sarbagita are not as dense as in the city of Jakarta. Norken and Sriarta determine the water needs with the water needs for irrigation in the Bali region, While the authors conducted an analysis for the need for clean water in the Sarbagita region. World Bank analyses integrated water management in this case the authors conducted a study of special integrated water management in the Sarbagita region. Novonty, Brown, Western Australia Planning Commission and Bahri emphasized the

importance of water management in a sound and sustainable way. The author analyses based on integrated water management based on reducing groundwater use and increasing surface water use. 3. Discussion 3.1. Water availability in the Sarbagita zone Hydrological and irrigation management in Bali is generally carried out by the Government through several institutions such as Provincial Public Works Agency and District/ City Public Works Agency.

 3 In the case of more detailed handling and having a larger scope, the handling is charged to the Bali Penida River Council located in the Capital of Bali Province located on Cokorde Agung Tresna street in Denpasar. Water management by the Bali-Penida River Council is based on the watersheds area. In the potential analysis, the availability of water in Bali, especially in the Sarbagita zone consists of 85 watersheds with a potential surface water of 1,734 million m3 per year, groundwater with a potential of 225 million m3 per year and ground water of 222 million m3 per year or with a total potential of 2,883 million m3 per year. Some potential watersheds in the Sarbagita area can be seen in the following Table 1. Table 1. Potential watersheds in the Sarbagita area. No. Name of Watersheds Water Potential (million m3) Total Water Potential surface water ground water water springs million m3 1 Pakerisan 13.67 1.42 37.81 52.9 2 Petanu 88.89 0.06 13.42 102.37 3 Oos 80.69 2.52 2.84 86.05 4 Ayung 778.98 3.16 43.24 825.38 5 Badung 151.63 10.73 162.36 6 Tuban 0.20 148.34 148.54 7 Mati 30.05 42.79 72.84 8 Penet 106.1 1.27 32.52 139.89 9 Yeh Ho 55.68 0.95 34.08 90.71 10 Balian 125.53 11.99 137.52 Amount 1431.42 211.24 175.9 1818.56 Bali Province has a total area of 5,636.66 km2 or 0.29% of the total area of the Indonesian archipelago. Sarbagita area consists of 4 Regencies/ Cities covering Denpasar City 127.78 km2, Badung 418.52 km2, Gianyar 368.00 km2 and Tabanan covering an area of 839.30 km2. Service figures for each regional water supply company in each regency / city are as shown in Table 2. Table 2. The level of service of regional water supply companies in

the Sarbagita area. No Regency/city Service level (2013) 1 Denpasar City 76.29% 2 Badung Regency 74.88% 3 Gianyar Regency 61.12% 4 Tabanan Regency 69.30% 3.2. Water demand prediction The increase in water demand occurs due to increasing population and the level of human well-being. Specifically in the Sarbagita area the increase in water demand is strongly influenced by the increasing number of tourists coming to Bali, most of whom stay in this area. Predictions of increasing population must be made to estimate the magnitude of future water demand predictions. Prediction of water demand in the Sarbagita area in 4 the future can be seen in Table 3.

9 iCAST-ES 2019 Journal of Physics: Conference Series 1450 (2020) 012028 IOP Publishing doi:10.1088/1742-6596/1450/1/012028 4 Table 3. Prediction of the water needs of the Sarbagita area. No. Regency Production Capacity Requirement Prediction Requirement Prediction (l/sec)) 2024 2033 (l/sec)) (l/sec)) 1 Denpasar City 1,181.65 2,997.85 4,484.63 2 Badung Regency 650.00 1,559.40 1,847.12 3 Gianyar Regency 612.00 1,597.54 2,243.54 4 Tabanan Regency 498.73 1,618.52 1,737.51 TOTAL 5,117.34 13,946.30 21,247.25 3.3. The problems of each regional water company In general, the problem of each regional / municipal drinking water company is the limited water sources while the water demand continues to increase. Until now, the main water source of the regional drinking water company is still dependent on ground water sources even though in some places such as Badung and Denpasar have used surface water 1 in the form of river water downstream. The large number of regional companies that still use groundwater is due to reducing the high investment costs of pipelines when compared to taking river water with long pipelines. More specifically, some of the problems that become the problems of drinking water companies are as follows: Mostly using ground water which is certainly not good impact on the environment in the long run; The condition of the network is deeprooted, the number of customers is still limited, the relative selling price of water low, the water leakage rate is still high around 20-30%; There is no integrated water management cooperation for adjacent regions. 15 Badung Regency and Denpasar City

have utilized river water especially in the downstream to increase the amount of raw water. Badung River in the western part of Denpasar City has been utilized as a source of raw water with a capacity of 500 l / second serving the southern region of Badung Regency. Whereas the Ayung river has been exploited by taking water in Belusung and in Waribang. With water sources from this river the two regions, Badung and Denpasar, can reduce the use of ground water. 3.4. Water management concept of Sarbagita area To meet the needs and reliable management of clean water, the concepts offered in clean water management are: Limiting the use of ground water as a new source of water for regional water companies in the Regency / City level; Encouraging the use of surface water, especially water that is in the downstream river as a source of raw water; Utilization of surface water sources in the downstream area by prioritizing the territorial concept that divides the service area into several integrated areas; Encourage increased coordination between clean water managers at the Regency / City level in Bali; Improving the health of regional water supply companies in all Regencies / Cities; and Conservation of catchment areas as natural water supply areas. 3.5. The concept of development of regional-based water management In the development of territorial-based water management, it is necessary to anticipate the magnitude of the water potential in each region. Some considerations that form the basis of the territorial-based water development system are as follows. Potential water that still exists, proximity to service areas, efficiency in financing and operating and maintaining networks. In the development of clean water services Bali is grouped into groups such as the Sarbagita area. In the discussion of the Sarbagita area, there are several alternatives that can be developed, including the Long Storage of the Melangit River and the Long Storage of the Oos River, and the optimization of the Penet River and Petanu River raw water system development. the concept of water management of the Sarbagita area can be seen in Figure 1.

 Figure 1. Concept of water

management in the Sarbagita area. 3.6. Development of raw water in the Sarbagita region In an effort to meet the drinking water deficit that occurred in the South Bali Region, the provincial government of Bali with funding support from the central government has realized the development of infrastructure for supplying raw water for drinking water, some of which are: East system (raw water source from Petanu River) through the construction of WTP-Petanu with capacity of 300 Liters / second to serve Denpasar City, Badung Regency and Gianyar Regency. The construction realization was carried out from 2012 to 2013; West system (raw water source from Penet river) through the construction of WTP-Penet with capacity of 300 l / second to serve the City of Denpasar and Badung Regency, the construction was carried out from 2013 to 2014; WTP-Waribang optimization plan (source of raw water from Ayung River / Long Storage Ayung) with an additional capacity of 150 l / second to 300 l / second to serve Denpasar City. The construction plan is carried out in 2015 until 2016 with a planned construction cost of Rp 50 billion; WTP-Ayung plan, it is a plan to supply raw water for the central system of the Sarbagita to meet the drinking water deficit in the South Bali Region. The WTP- Ayung utilizes raw water sources from the upstream and middle Ayung River. The raw water supply infrastructure plan to be built includes: WTP- Ayung with capacity of 1,750 liter/ second, taking raw water from the Sidan Reservoir. Furthermore, from the Sidan Reservoir, the raw water channeled with a pump system to do raw water treatment in several WTP plans, namely: WTP-Plaga with a capacity of 800 liter/ second to meet drinking water needs in the Badung Regency (Petang, Abiansemal, Mengwi, southern Kuta and North Kuta) districts, then distributed with a gravity system; WTP-Petang, capacity of 500 liter/ second to meet drinking water needs in Tabanan Regency (part of Baturiti, Marga, Tabanan and Kediri districts), water distribution to service areas is carried out by gravity system; WTP- Abiansemal Latu (Capacity 650 liter/ second) with raw water supply from the Sidan Reservoir at 450 liter/ second and raw water supply of the Right Strait Reservoir (WTP – Ayung II) of 100 liter/ second and from the Left Strait Reservoir (WTP – Ayung III) amounting to 100 liter/second. This raw water supply system is to meet the raw water needs of Denpasar

City (North Denpasar, West Denpasar and East Denpasar Sub-districts); WTP – Ayung II Capacity of 200 liter/ second, extraction of raw water sources from the Right Side Reservoir, is planned to supply to WTP -

iCAST-ES 2019 2 Journal of Physics: Conference Series 1450 (2020) 012028 IOP Publishing doi:10.1088/1742-6596/1450/1/012028 6 Abiansemal at 100 liter/ second and supply to WTP - Payangan at 100 liter/ second. The WTP - Payangan is planned with a capacity of 400 liter/ second to meet the drinking water needs of Gianyar Regency (Sub-districts of Ubud, Sukawati and Blahbatuh); WTP - Ayung III with capacity of 400 liter/ second, extracts raw water sources from the Left Side Reservoir, is planned for supply to the WTP - Abiansemal Latu 100 liter/ second and IPA- Payangan at 300 liter/ second planned to meet the water needs of Gianyar Regency (Ubud, Sukawati and Blahbatuh District). 4. Conclusions 1 Based on the results of the analysis and discussion that has been carried out can be expressed several things, namely. Potential water in the Sarbagita area as many as 85 watersheds with the potential water is 2,182.80 m3/ year. Consists of surface water potential of 1,734.66 m3/ year, ground water of 225.77 m3/ year and springs of 222.37 m3/ year. Production of each local water company in the Regency/City in the Sarbagita Region in 2017 is as follows: Denpasar City amounted to 1,181.65 liter/ second, Badung: 650 liter/ second, Gianyar: 612.00 liter/ second and Tabanan amounted to: 498.73 liter/ second. Projection of water demand in 2033 for each region is as follows Denpasar: 2,997 liter/ second, Badung: 1,599 liter/ second, Gianyar: 1,597 liter/ second and Tabanan 1,618 liter/ second. Referring to the existing potentials and needs, there will be an imbalance between the needs that should be with the provision that tends to be fixed. Therefore, 4 it is necessary to optimize the regional-based water management in Sarbagita by utilizing some of the water from potential rivers that exist today. The drinking water treatment plant system (WTP) by utilizing the potential of downstream water will greatly assist water supply. Several WTP have operated and added supplies such as WTP - Petanu, WTP - Penet and estuary reservoir capacity improvement. Ayung River,

Pakerisan, Oos and several other rivers need to be studied for water utilization. 5.

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