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A Simple Method of Water Balance Analysis to Predict the Performance of Water Resource Management in the Unit of South Kalimantan Province Offices

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ABSTRACT

Banjarbaru city was legally established as the capital city of Kalimantan Selatan province, and it needed a new unit of government offices. In the new unit offices of 500 ha, the government built not only office facilities but also a small reservoir or *Embung*. This study aims to analyze the availability of water upstream of the *Embung* that can be provided to fulfill urban water demand in the service area with a simple method of water balance. The conclusions obtained from this research on a simple method of water balance analysis to predict the performance of water resource management in the unit of South Kalimantan province offices based on water available in upstream *Embung* in the year 2020 as 133,090,606.2 liter/day to fulfill water demands in service area as 87,478,894.55 liter/day after *Embung* construction is still quite adequate as much as 45,611,711.64 liter/day. Although until now, PDAM Intan Banjar still provides sufficient water to meet water needs in the service area. The construction of the reservoir is one of the methods applied by the South Kalimantan provincial government in managing water resources for conservation in the future. With the increase in the population in the future, it is necessary to think about other water sources to meet the water needs due to population growth.

Keywords: water availability, water demand, water balance, water resources management, government official offices, South Kalimantan

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1. Introduction

Banjarbaru city was legally established as the capital city of Kalimantan Selatan province and started on March 16, 2022. It was lawfully validated with Undang-Undang Nomor 8 in 2022 on March 16, 2022 (Undang-Undang RI, 2022). The relocation of the provincial capital has begun with the transfer of government official offices. The South Kalimantan Provincial Government office area is an integrated office area where the spatial layout in it requires various supporting facilities, one of which is an area that can be used as a water catchment area to accommodate/reduce surface runoff leading to Banjarbaru City. The South Kalimantan Provincial Government office area built in 2011, which began with the transfer of the South Kalimantan Provincial Government Offices, which will be occupied by the governor and deputy governor, began to move from the City of Banjarmasin to the City of Banjarbaru in August 2011. Then gradually continued with other offices within the provincial government of South Kalimantan. The official office area of South Kalimantan Province was built on a land area of about 500 hectares, with a total land prepared by the Banjarbaru City Government reaching 2,000 hectares (Gunawan, 2018). The office development program and regional arrangement in an area of 500 hectares will continue to be carried out in stages until 2025.

Changes in land use covering an area of 500 ha and increasing population growth as 2.43%_(BPS, 2022b) in Banjarbaru City lead to an increase in the need for clean water and an increase in the need for water resource management. Water resources are predicted to experience a crisis threat in 2025 in the city of Banjarbaru, along with the development of tourism and population growth of 1.9% annually, which can be accelerated by industrial activities. Extensive industrial and tourism activities will significantly accelerate the depletion of water supply and increase water demand, based on the calculation results of large-scale companies, will accelerate the shortage of water supply for the next ten years (Jarwanto Jarwanto, 2022).

Until now, Banjarbaru City has had a reasonably low intensity of land fires and floods at several points. This could change significantly with the relocation of the provincial capital of South Kalimantan, which will increase the population and increase land use.

The government also builds mini reservoirs. It is called *Embung* in Indonesia. The small reservoir, with an area of more than 6 hectares, is equipped with inlet and outlet buildings, outlet pumps, water pumps, reservoir towers, and jogging tracks (Gunawan, 2018). Many studies of small

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reservoirs in other countries. In Georgia Piedmont, USA, mini reservoir influence headwater water quality (Ignatius and Rasmussen, 2016). Small reservoir rise the economic benefits of water management objectives in other countries (Ortiz-Partida, Lane and Sandoval-Solis, 2016). Reservoir ecosystems also support the sustainability of ecosystem services, and help address many of the global threats driving the decline in freshwater biodiversity (Hill *et al.*, 2021).

This small reservoir built in government office area is named The *Embung Kampung Banjar*. The *Embung Kampung Banjar*, which was built in the provincial government office area, in addition to functioning as a catchment, also functions as a water tourism area and is also used for watering plants (Gunawan, 2018). *Embung* are one of the most frequently constructed forms of water conservation in Indonesia (Agung, 2019). Some other benefit of *Embung* is to provide clean water (Prastika, Sundari and Dea, 2010). The *Embung Kampung Banjar* is also expected to work as a water conservation and preservation area and can be used as a source of water and for various purposes in office areas. The project will be carried out in multi-year 2019 – 2020. So it is necessary to evaluate the conservation of water resources with the projected city growth caused by the population increase. The relationship between water availability and water demand is referred to as the water balance (Waligórski *et al.*, 2020). The purpose of this research is to evaluate the water balance that can be supplied by the reservoir to the planned service area (Gunawan, 2018).

2. Literature Review

2.1. Water Available

According to Konapala (2020), the availability of water is the amount of water discharge which is estimated to be continuously in a location (water structure) in a certain amount of water and within a certain period of time (Konapala *et al.*, 2020). There are many methods that can be used to calculate evapotranspiration (Lu *et al.*, 2005). Evapotranspiration can also be calculated with limited clomatological data using machine learning (Torres, Walker and Mckee, 2011). Evapotranspiration is a combination of evaporation and transpiration, which includes all evaporation of water that occurs on the earth's surface, including water bodies, soil and plants. The evapotranspiration formula used is the Penman-Monteith FAO-56 reference evapotranspiration (Allen, 1998).

$$ET_o = \frac{0{,}408\Delta(Rn - G) + \gamma \frac{900}{T+273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0{,}34u_2)}$$

Where:

ET_o	=	reference evapotranspiration (mm/day)
Rn	=	net radiation at the crop surface (MJ/m^2/day)
G	=	soil heat flux density (MJ/m^2/day)
T	=	mean daily temperature at 2 m height (°C)
u_2	=	wind speed at 2 m height (m/s)
e_s	=	saturation vapor pressure (kPa)
e_a	=	actual vapor pressure (kPa)
$e_s - e_a$	=	saturation vapor pressure deficit (kPa)
Δ	=	slope vapor pressure curve (kPa/°C)
γ	=	psychometric constant (kPa/°C)

So far, the availability of water is widely used to meet the irrigation water demand (Kylstra *et al.*, 2021) (Sun, Huang and Wang, 2017). The availability of water is not only used to meet irrigation water demand, but can also be used for water resource conservation, urban water demand and water disaster (Khalequzzaman K and Amirul, 2008)(Novitasari *et al.*, 2021). Water availability is calculated using the F.J. Mock model as the modification of Tank Model (Nurrochmad, Sujono and Damanjaya, 1998; Lee, Chegal and Lee, 2020). The F.J Mock model with the output value is in the form of discharge data in the watershed at the research location.

$$R = \sqrt{\frac{Dt^2 - D^2}{Dt^2}}$$

Where: $Dt^2 = \sum_{i=1}^{N} \left(Q^i{}_{obs} - \bar{Q}\right)^2$

$$D^2 = \sum_{i=1}^{N} (Q^i{}_{obs} - Q^i{}_{sim})^2$$

$$\bar{Q} = \frac{\sum_{i=1}^{N} Q^i{}_{obs}}{N}$$

The formula can calculate volume Error (VE):

$$VE = \frac{\sum_{i=1}^{N} Q^i{}_{obs} - \sum_{i=1}^{N} Q^i{}_{sim}}{\sum_{i=1}^{N} Q^i{}_{obs}}$$

Where:

Q_{sim}	= simulation discharge of the *i* period (m^3/s)
Q_{obs}	= observation discharge of the *i* period (m^3/s)
$\bar{Q}$	= average observation discharge (m^3/s)
N	= the amount of data

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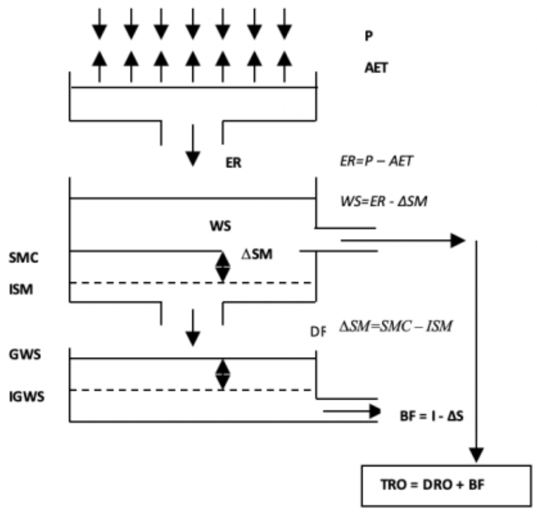

Figure 1. Mock methods schema (Nurrochmad, Sujono and Damanjaya, 1998).

2.2. Water Demand

The number of populations that will be served in accordance with the portion can affect the quantity requirements of urban water demand, which generally people must obtain clean water and drinking water anytime for 24 hours to meet their needs. Water demand can be divided into household and household demand. According to the Directorate General of Cipta Karya (2000) there are 2 (two) standards for water demand. The domestic water demand has standards for use in private residences so that daily needs can be met, such as drinking water, cooking, washing. The other household demand and non-domestic water demand are clean water demand that are not household demand. The use in non-domestic is commercial, industrial, and general. Household and urban water demands are essential to be met so that there is no unsuccessful to fulfill water demand which can lead to various kinds of disease outbreaks and unrest in the community. The water demand is correlated with population growth. Population projection is the calculation of the total population with the aim of obtaining past and future information in the context of long-term development planning. Population data is obtained from the census conducted by the Central Statistics Agency of Banjarbaru City and other government departments or institutions. In this study, the population projection calculation used is the geometric method (BPS, 2022b).

$$r = \left(\frac{P_t}{P_0}\right)^{1/t} - 1$$

Where:

r = Population growth rate
p_t = population of year t
p_0 = amount of base population year
t = time period between the base year and year t (in years)

2.3. Water Balance

A simple water balance analysis is based on a correlation between water availability and water demand in the location (Armstrong and Johnson, 2018). The water balance calculations are used to meet irrigation water demand (Ariyani, Putuhena and Wira, 2020) and urban water demand (Reed, Maidment and Patoux, 1997). The water balance is also used to calculate reservoir capacity (Brust *et al.*, 2018).

2.4. Water Quality Measurement

Water quality analysis is needed to get the water quality that suits its needs. There are two regulations used in this study: Government Regulation (PP) No 82 dated December 14, 2001 on Water Quality Management and Water Pollution Control (Pemerintah Republik Indonesia, 2001) dan Minister of Health Regulation enacted on May 31 2017 about Environmental Health Quality Standards and Water Health Requirements for Sanitary Hygiene, Swimming Pools, Solus Per Aqua, and Public Baths (Menteri Kesehatan Republik Indonesia, 2017).

2.5. Small Reservoir (*Embung*)

Embung, or what is usually also called a small reservoir, is a construction that is built to conserve the flow of water. This retained water will collect in *Embung* that can be used as the demand for irrigation, household, industrial water, hydroelectric power plants, and others (Arsyad, 2017a). Based on the opinion of one expert, a reservoir is an artificial building that functions to accommodate and store water with a certain small volume capacity, smaller than the capacity of the reservoir/dam (Kodoatie and Roestam Syarief, 2010). Types of reservoirs are grouped into four types, namely as follows: 1. based on the purpose of construction with reservoirs for residential purposes and multipurpose reservoirs, 2. based on their use as water reservoirs, deflectors, and retainers, 3. Based on their location to the flow of water, reservoirs on watercourses, and reservoirs outside the watercourse, and 4. based on the constituent material, embankment reservoirs and reservoirs of concrete (Soedibyo, 1993; Arsyad, 2017b).
The planning of a water reservoir in *Embung* is based on the estimation of water availability to ensure water supply every year in both rainy and dry seasons. This includes not only the capacity of the reservoir and the height of the dam in accordance with the availability of water, but also the entire

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utilization system must be designed based on the needs and benefits, for example, the installed capacity of hydropower, irrigation water distribution systems and so on (Arsyad, 2017c).

3. Research Methodology

3.1. Data

Rainfall analysis is calculated by adding up the daily rainfall per month in one period. The rainfall data used is derived from the Banjarbaru Climatology Station for a period of 20 years (2001 to 2020) (BMKG, 2022). The method used to calculate evapotranspiration is the Penman-Monteith FAO-56 method, with climatological data downloaded on the BMKG Online (BMKG, 2022).

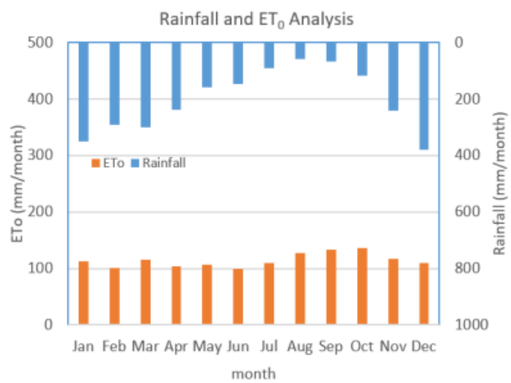

Figure 2. Rainfall and *ETo* Analysis

From rainfall data from the year 2000 to the year 2020, the average annual rain is 2439.99 mm/year. The yearly average evapotranspiration is 1374.13 mm/year. The lowest rainfall intensity occurred in August at 57.88 mm/month and the highest in December at 379.73 mm/month. The average monthly rainfall data is 203.33 mm/month. The monthly evapotranspiration data from the year 2000 to the year 2020, the highest data in October was 136.72 mm/month, and the lowest evapotranspiration data in June was 99.54 mm/month. The average monthly evapotranspiration data is 114.51 mm/month. Based on rain data and evapotranspiration data, it is determined the availability of water upstream of the reservoir.

Banjarbaru city, with a total area of 305.242 km^2 divided into five districts, Landasan Ulin, with an area of 74.054 km^2, Liang Anggang of 74.773 km^2; Cempaka of 114.543 km^2; North Banjarbaru 26.855 km^2, and South Banjarbaru 15.027 km^2 (BPS, 2022b). BPS (Central Bureau of Statistics) Banjarbaru City recorded data from 2013 – 2020. The highest population data is in the Landasan Ulin sub-district as many as 75,385 residents, and the lowest data is in the Cempaka sub-district as many as 35,584 residents (BPS, 2022a). Population growth is one of the effects of moving offices and government centers to Banjarbaru City.

In the South Banjarbaru sub-district, in the year 2013, the population of as many as 46,872 residents. It increases until years 2019, with as many as 67,542 residents but decreases in years 2020 to as many as 45,273 people, as shown in Figure 6. The Population in South Banjarbaru District in 2020 decreased by 32% because, in 2020, there was a Covid-19 pandemic (BPS, 2022b). The population growth rate reached 1.7.

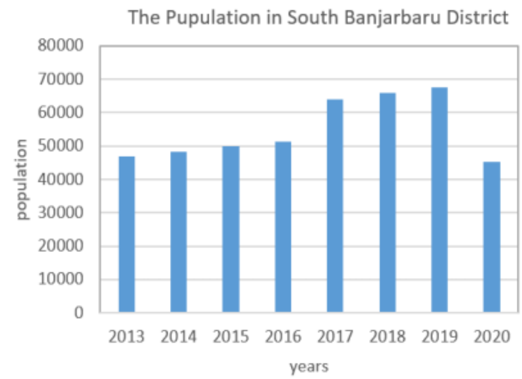

Figure 3. The Population in South Banjarbaru District

3.2. Research Area

The Banjarbaru City area is located at an altitude of 500 m above sea level, with an altitude of 0 – 7 m (33.49%), 7 – 25 m (48.46%), 25 – 100 m (15.15%), 100 – 250 m (2.55%) and 250 – 500 m (0.35%) (BPS, 2022b). The slope classification of Banjarbaru City is a slope of 0 – 2% covering 59.35% of the area, a slope of 2 – 8% covering 25.78% of the area, a slope of 8 – 15% covering 12.08% of the area. The rock classification in Banjarbaru City consists of Alluvium 48.44%. In the city of Banjarbaru, there are 3 (three) groups of soil types, namely Podzol soil (63.82%), Lathosol (6.36%), and Organosol (29.82%) (RPIJM, 2015). The South Kalimantan provincial government office building covering an area of 500 hectares in Banjarbaru city can be seen on the map below and is located in the Cempaka sub-district.

Figure 3. Research Study

The *Embung Kampung Banjar* was built in the area of the South Kalimantan provincial government office building in Kampung Banjar village. It is geographically 3°28′27,9" south latitude and 114°49′39" north latitude (Gunawan, 2018).

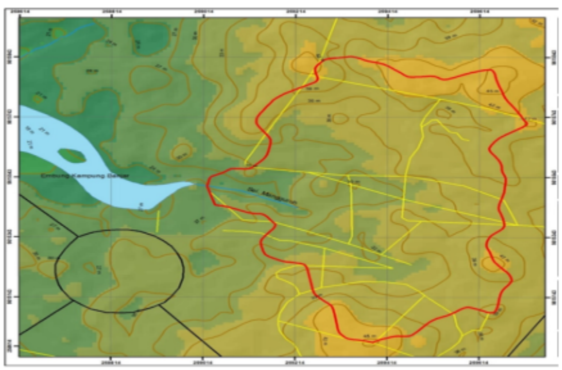

Figure 4. *The Embung Kampung Banjar*

The *Embung Kampung Banjar* has a service area in the part of the sub-district of South Banjarbaru and other sub districts with an area of 21.96 km^2. Facilities located at the *Embung Kampung Banjar* service location include water catchment areas, water tourism areas, reservoirs to reduce runoff to Banjarbaru city, watering plants, and water preservation and conservation areas. The water demand has increased with the increase in population.

4. Result

4.1. Water Available Analysis

Water available analysis calculates from the river discharge data of the Riam Kiwa River. The calibration was conducted in 2001 with an area of 382 km^2 (Novitasari *et al.*, 2021). Based on discharge data observed in 2001, water discharge in other years can be calculated using mock parameters from the Riam Kiwa River. The wet infiltration coefficient is 0.3, the dry infiltration coefficient is 0.4, the initial soil moisture (ISM) is 110 mm, the soil moisture capacity (*SMC*) is 220 mm, the initial ground water storage (*IGWS*) is 1000 mm, and groundwater recession Constant (k) as 0.810.

The average monthly discharge data for 20 years is presented in Figure 5. The average annual discharge data is presented in Figure 6. The effectiveness of using Riam Kiwa discharge data to determine the calculated discharge with the measured discharge data obtained at the research location is shown in Table 1.

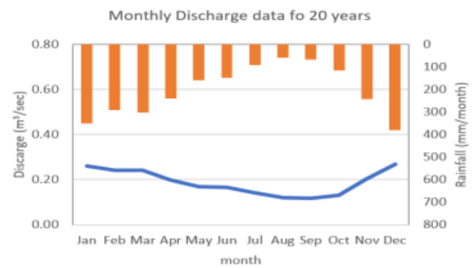

Figure 5. The average monthly discharge data for 20 years.

The highest monthly average discharge for 20 years occurred in December at 0.27 m^3/second, while the lowest discharge occurred in August and September at 0.12 m^3/second. Debit rata-rata bulanan sebesar 0.19 m^3/detik.

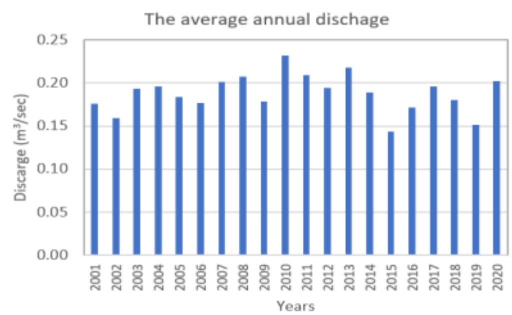

Figure 6. The average annual discharge data

Analysis of annual discharge from 2001 to 2020 found that the highest average annual discharge occurred in 2010 at 0.23 m^3/second, and the lowest average annual discharge occurred in 2015 at 0.14 m^3/second. The limitations of the discharge measurement data for analysis using the mock model need to be eliminated by measuring the instantaneous discharge at the research site. Measured discharge in upstream *Embung* (Paring River), *Embung* Inlet, and *Embung* outlet in April and May 2021.

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Table 1. Data for Measured Discharge of *Embung* Kampung Banjar

Location	Qobs (2021) (m^3/s)		Qcal (2021) (m^3/s)		Qcal mean (m^3/s)	
	Apr	May	Apr	May	Apr	May
Upstream	0.04	0.04				
Inlet	0.02	0.08	0.08	0.09	0.19	0.15
Outlet	**0.02**	**0.002**				

The effectiveness is analyzed against the calculated discharge in 2021 and the average annual discharge in April and May. The value of the effectiveness of using the Riam Kiwa River discharge data for the calibration process at the *Embung Kampung Banjar* is 25% in April 2021 and 88% in May 2021. In April 2021, the effectiveness value was very small because, at the time of measurement, it was a day that rarely rains, starting from the middle of April, causing the measured discharge to be very low.

The mainstay discharge is calculated by sorting the average discharge per year (2001-2020) from the largest value to the smallest value so that the average discharge value is obtained at a probability of 90% for domestic water purposes. The following are the steps for calculating the mainstay discharge.

a. The monthly average discharge data is sorted from the largest to the smallest.
b. Give a sequence of r from 1 to N where the value of N is 20.
c. The probability of the Weibull methodthat r is 1
d. $P = \frac{r}{(N+1)} \times 100\% = \frac{1}{(20+1)} \times 100\% = 4{,}76\% \approx 5\%$
e. Then look for the required mainstay discharge; because the function of the reservoir is of them to meet the needs of r water in the neighborhood of the location, the mainstay discharge used is Q90, specifically for domestic water demand.

The results of the monthly Q90 calculation can be seen in the table below.

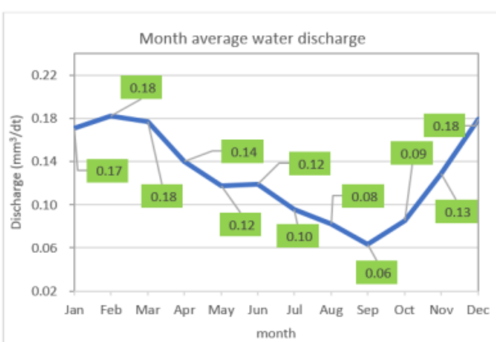

Figure 7. Month Average Water Discharge in 2001-2020

The most reliable discharge for water demand was obtained in February, March, and December with a discharge value of 0.18 m^3/s and the smallest occurred in with a discharge value of 0.06 m^3/s. The availability of water in the *Embung Kampung Banjar* will be used to fulfill the water demand of the local population, the need for watering plants, and also the drinking water demand of livestock, especially during the dry season, when very little rain occurs. The reservoir is expected to be fully filled at the end of each rainy season so that it can be used during the dry season.

4.2. Water Demand

The amount of urban water demand according to the density criteria (people per hectare) is taken at 25-35. This is because the Population of Banjarbaru City is 506,884 people with an area of 37,130 Ha, so a population density of > 100 people/ha is obtained. The standard of household water demand is based on the type of city and population. Banjarbaru City is a type of big city whose accuracy criteria are more than 100, and the number of urban water demand taken is 25-35. The standard amount of non-domestic water demand according to the Population of Banjarbaru City is 40.

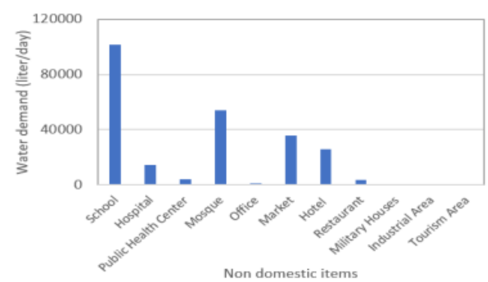

Figure 8. Non-Domestic Water Demand

In Banjarbaru city, non-domestic water demands include water for public facilities such as schools from kindergarten to college, public and private hospitals, public health centers, mosques, government and non-government offices, traditional markets, hotels, restaurants, military houses, and some tourism area.

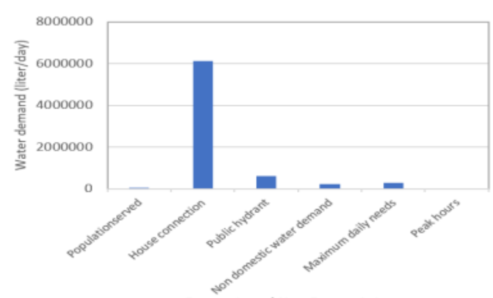

Figure 9. Domestic and Urban Water Demand

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The population served is 45,273 people with a house connection (SR) of 90% times the population served multiplied by 150 liters. The water requirement for a public hydrant (KU) is 90% times the house connection (SR). All water requirement includes domestic and non-domestic water demands, and maximum daily needs in peak hours.

The results of the analysis of water demand, the City of Banjarbaru is included in the category of a large city type with a population of 506,884 people. It can be concluded that the total number of non-domestic water demand in 2020 after the *Embung* was built was 240,593.4 Liters/day, and the total number of household and urban water demand was 7,289,740 Liters/day. The population reduction that occurred in 2020 in South Banjarbaru District impacts the amount of water demand in the service area.

Long-term development planning by taking into account the population for the next five years, ten years, 15 years, 20 years, and 25 years using the Geometric Method as shown in Figure 10.

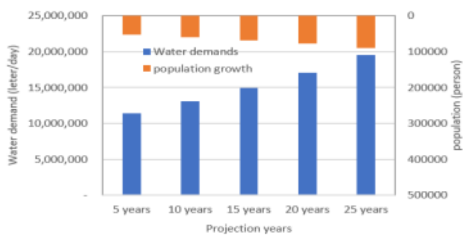

Figure 10. Projection of water demand and population growth after the construction of the *Embung*

The increase of population is used to calculate population projections for five years, ten years, 15 years, 20 years, and 25 years after 2020. Based on population projection, residents served as many as 88,987 people in the next 25 years. This population projection will be used to calculate the need for domestic and non-domestic water in Banjarbaru city.

The projected total domestic water demand after the construction of the Embung is 7,807,526 liters/day in 5 years, 8,937,414,318 liters/day in 10 years, 10,230,759.48 liters/day for 20 years, 1,1621,681,5 liters/day, and at 25 years as many as 1,3406,046.2 liters/day.

The projection of total household and urban water demand after the construction of the *Embung* is 11,366.893 liters/day; in 10 years, it is 13,045,123.53 liters/day; in 15 years, it is 14,932,900.78 liters/day; in 20 years as many as 17,093,784.53 liters/day, and at 25 years as many as 19,567,575.3 liters/day.

4.3. Water Balance

Analysis of the water balance that is planned to meet domestic and non-domestic water demand is carried out on population data in 2020, at the time of the start of office relocation in Banjarbaru city. The population growth area is taken in South Banjarbaru District. The analysis of water available to fulfill water demand in the service area of *Embung* in 2020 as shown in Figure 11.

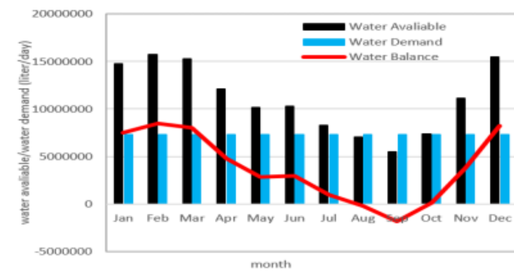

Figure 11. Water Balance Analysis

The water balance obtained by the construction of the *Embung Kampung Banjar* and the water demand to be obtained a surplus water balance for most of the year, except for August and September. In August has a deficit of water as much as 220,829.51 liter/day, and in September, the deficit as 1,815,842.40 liter/day. The highest deficit value occurred in September. It is necessary to regulate the water resource system to cope with these conditions, given the increase in population after 2020 with the movement of office complexes accompanied by the movement of the provincial capital in 2022. Analysis of water demand is carried out on population growth of 5 years, 10 years, 15 years, 20 years, and 25 years as shown in Figure 12.

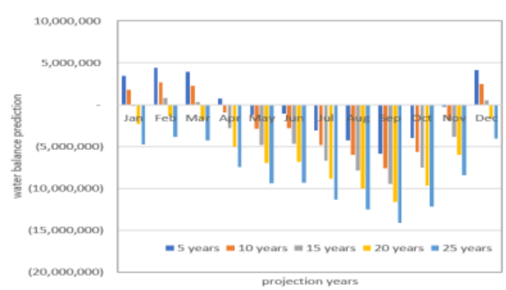

Figure 12. Water Balance for projected to meet water demand

Based on the current water availability data, it is projected to meet water demand for the 5 years, 10 years, 15 years, and 20 years to 25 years projections. It can be seen that water available only can fulfill the water demand in five years projections in January, February, March, April, and December. The deficit of water from May to November. The water deficit occurs from May to November. The water deficit occurs throughout the year to meet water demand for population projections for 20 years and 25 years.

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4.4. Water Quality Analysis

Water quality testing at the Embung Kampung Banjar took four samples in the Embung service area, namely Inlet, Outlet, and Paring River.

The tool used in this test is U-50 HORIBA (multi-water quality checker). This test is to determine the parameters contained in the water sample. The test is carried out by dipping the U-50 HORIBA (multi-water quality checker) tool into a water sample from which water quality data will be taken.

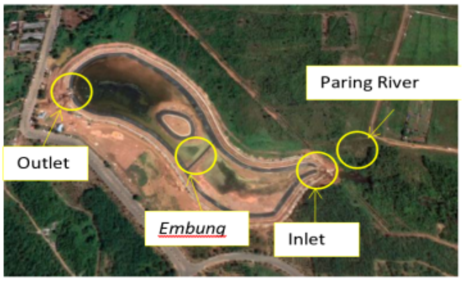

Figure 13. Location of Water Quality Sampling Data

Water quality testing consists of physical, chemical, and biological tests. Based on the tools available at the Hydraulic Laboratory, Faculty of Engineering, Lambung Mangkurat University, the only tests that can be done are physical and chemical tests. The measured water quality includes physical and chemical quality, which consists of water turbidity measurement, water temperature, degree of acidity of the water (pH), and total Dissolved Solid (TDS).

In the physical test, the results obtained from the U-50 HORIBA (multi-water quality checker) tool get turbidity and temperature parameters, while for chemical testing, the results obtained are Ph and Total Dissolved Solid (TDS). From the physical and chemical tests, the parameters of the four samples met the maximum allowable levels. Based on direct observation, it was also found that the water entering and leaving the reservoir was tasteless, odorless, and colorless.

Table 2. Water Quality Sampling Data

No.	Parameter	Unit	Max rate allowed	Inlet	Outlet	Em-Bung	Paring River
	A. Physical						
1	Turbidity	Scala NTU	25	0.73	0.93	1.03	0
2	Water temperature	◦C	air temperature ± 3 ◦C	30.51	30.34	30.22	29.46
	B. chemical						
1	Ph	Mg/L	6,5-9,0	6.77	7.16	7.06	6.4
2	Total Dissolved Solid (TDS)	Mg/L	1500	0.007	0.002	0.002	0.007

Water sampling for 4 locations consisted of an inlet for the first sample, an outlet for the second sample, an Embung for the third location, and the paring river for the fourth sample. Based on the test at the 4 locations, it can be taken from the data that the water quality in the service area of the Embung Kampung Banjar meets the class D water standard. Water turbidity less than 25 NTU. Water temperature based on air temperature ± 3 ◦C. the average maximum air temperature for the last 5 years is 32.27◦C. The degree of acidity of the water (pH) is around 7. TSD less than 1500 Mg/l. It can be used for agriculture, urban businesses, industry, and hydroelectric power plants that can be used by the community around Banjarbaru District.

5. Discussion

5.1. Water balance as water resource management

Water balance in the unit of South Kalimantan Province Offices based on water available in upstream Embung in the year 2020 as 133,090,606.2 liter/day to fulfill water demands in service area as 87,478,894.55 liter/day after Embung construction is still quite adequate as much as 45,611,711.64 liter/day. The construction of the Embung Kampung Banjar is a good solution to overcoming the current problems of water resource management in Banjarbaru City as the new capital city of South Kalimantan province.

A well-managed reservoir can be used as a water provider to cover water demand in the dry season from water stored in the rainy season. The average annual rain that occurs based on observations at the Banjarbaru climatology station is around 2439.99 mm/year for 20 years, so it has the potential to be captured and utilized. The *Embung Kampung Banjar* is the solution for current water demand. However, in the future, with the increase in population, it is necessary to build other reservoirs or other water source supplies in the South Kalimantan government office.

5.2. Water resources management as water conservation and tourism.

The Banjarbaru City Government's planning during the construction of the Embung Kampung Banjar was to function as water conservation as an Embung for groundwater storage, watering plants, and water tourism. Embung also uses to reduce water runoff to Banjarbaru city and water plants. The Banjarbaru city government's planning was in accordance with the conditions when direct observations were made in the field.

Until now, water available needed to fulfill the need for clean water in the service area, namely South Banjarbaru District; it is still served by PDAM Intan Banjar. So the building of Embung still functions more as water conservation for groundwater storage and tourism with the jogging tracks around Embung. In addition to the need for rainwater storage during the rainy season, there is also a need for infiltration areas that are used to replace lands that have changed functions into office areas that are massively closed, and covering an area of 500 ha, it is necessary to take into account how much water runs over the surface considering that Banjarbaru city is a city with a clay soil structure, so it is an area that really needs good groundwater infiltration, considering that the groundwater level in Banjarbaru City is quite deep.

6. Conclusion and Implication.

6.1. Conclusion

The conclusions obtained from this research on a simple method of water balance analysis to predict the performance of water resource management in the unit of South Kalimantan province offices based on water available in upstream *Embung* in the year 2020 as 133,090,606.2 liter/day to fulfill water demands in service area as 87,478,894.55 liter/day after Embung construction is still quite adequate as much as 45,611,711.64 liter/day. Although until now, PDAM *Intan Banjar* still provides sufficient water to meet water demand in the service area.

The construction of the reservoir is one of the methods applied by the South Kalimantan provincial government in managing water resources for conservation in the future. In order to increase the population in the future, it is necessary to think about other water sources to meet the water demand caused by population growth.

6.2. Future Research

This research had a small scope of the area of water resources management in the new unit of government offices, with an area of 500 ha. Changes in land use covering an area of 500 ha also need to be considered regarding groundwater storage in the future and the effect of land erosion that can occur, considering that Banjarbaru City is a city with varying land heights.

In general, the relocation of the provincial capital will also cause the transfer of public facilities and other activities. It means needed more water resources management in the future on a larger scale.

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References

Agung, P. (2019) "Kajian Dampak Pembangunan Embung Konservasi Mendekati Zero Run Off Dalam Pengendalian Banjir Kawasan," *Techno-Socio Ekonomika*, 12(1), pp. 47–60. doi: 10.32897/techno.2019.12.1.5.

Allen, R. G. (1998) *FAO Irrigation and Drainage Paper Crop*.

Ariyani, D., Putuhena, F. and Wira, D. (2020) "Using Water Balance to Analyse Water Availability for Irrigation with Upraising Surface Temperature (Acase Study Pasar Baru Barrage in Cisadane Watershed," *Civil and Environmental Science*, 003(01), pp. 001–009. doi: 10.21776/ub.civense.2020.00301.1.

Armstrong, L. E. and Johnson, E. C. (2018) "Water intake, water balance, and the elusive daily water requirement," Nutrients, 10(12), pp. 1–25. doi: 10.3390/nu10121928.

Arsyad, K. M. (2017a) Modul 3. Modul Konsepsi Kebijakan Embung. Bandung, Indonesia.

Arsyad, K. M. (2017b) Modul 4. Modul Pengantar Perencanaan Embung. Bandung, Indonesia.

Arsyad, K. M. (2017c) Modul 6. Modul Analisis Hidrologi, Kementerian PUPR. Bandung, Indonesia.

BMKG (2022) Data Hujan Online. Jakarta. Available at: http://dataonline.bmkg.go.id (Accessed: June 30, 2022).

BPS (2022a) "Kecamatan Cempaka dalam Angka," pp. 1–15.

Available at: http://wakatobikab.bps.go.id/index.php?hal=subject&id=1.

BPS (2022b) "Kota Banjarbaru Dalam Angka," pp. 1–12.

Brust, K. et al. (2018) "The water balance of a Sphagnum farming site in north-west Germany," 20, pp. 1–12.

Vol.4, Issue 1, pp.10-20, 2023
Available online at: http://tljes.org/index.php/tljes/data

doi: 10.19189/MaP.2017.OMB.301.

Gunawan, H. (2018) Laporan Ringkasan DED Embung Kampung Banjar. Banjarbaru.

Hill, M. J. et al. (2021) "Pond ecology and conservation: research priorities and knowledge gaps," Ecosphere, 12(12). doi: 10.1002/ecs2.3853.

Ignatius, A. R. and Rasmussen, T. C. (2016) "Small reservoir effects on headwater water quality in the rural-urban fringe, Georgia Piedmont, USA," Journal of Hydrology: Regional Studies. Elsevier B.V., 8, pp. 145–161. doi: 10.1016/j.ejrh.2016.08.005.

Jarwanto Jarwanto (2022) Neraca Suberdaya Air Kota Banjarbaru - Kalmantan Selatan. doi: ISSN: 1979-0090.

Khalequzzaman K and Amirul, H. M. (2008) Water Resources Management of Bangladesh Potentials and Problems.

Kodoatie, R. J. and Roestam Syarief (2010) Tata Ruang Air. Yogyakarta, Indonesia: CV. Andi Offset.

Konapala, G. et al. (2020) "Climate change will affect global water availability through compounding changes in seasonal precipitation and evaporation," Nature Communications. Springer US, 11(1), pp. 1–10. doi: 10.1038/s41467-020-16757-w.

Kylstra, S. et al. (2021) "Irrigation Water Demand Model as a Comparative Tool for Assessing Effects of Land Use Changes for Agricultural Crops in Fraser Valley, Canada," Agricultural Sciences, 12(08), pp. 888–906. doi: 10.4236/as.2021.128057.

Lee, J. W., Chegal, S. D. and Lee, S. O. (2020) "A Review of Tank Model and its Applicability to Various Korean Catchment Conditions."

Lu, J. et al. (2005) "A Comparison Of Six Potential Evapotranspiration Methods For Regional Use In The Southeastern United States 1," 29414, pp. 621–633.

Menteri Kesehatan Republik Indonesia (2017) Peraturan Menteri Kesehatan Republik Indonesia Nomor 32 Tahun 2017 Tentang Standar Baku Mutu Kesehatan Lingkungan Dan Persyaratan Kesehatan Air Untuk Keperluan Higiene Sanitasi, Kolam Renang, Solus Per Aqua dan Pemandian Umum, Peraturan Menteri kesehatan Republik Indonesia. Jakarta, Indonesia.

Novitasari, N. et al. (2021) "A Study of Flood Disaster Mitigation It the Tambak Anyar Traditional Polder in Banjar Regency South Kalimantan," 9(2), pp. 14–23.

Nurrochmad, F., Sujono, J. and Damanjaya, D. (1998) "Optimasi Parameter Model Hujan-Aliran Mock dengan Solver," Media Teknik. Yogyakarta, Indonesia: Media Teknik, 2(XX), pp. 58–62.

Ortiz-Partida, J. P., Lane, B. A. and Sandoval-Solis, S. (2016) "Economic effects of a reservoir re-operation policy in the Rio Grande/Bravo for integrated human and environmental water management," Journal of Hydrology: Regional Studies. Elsevier B.V., 8, pp. 130–144. doi: 10.1016/j.ejrh.2016.08.004.

Pemerintah Republik Indonesia (2001) Peraturan Pemerintah tentang Pengelolaan Kualitas Air Dan Pengendalian Pencemaran Air, Peraturan Pemerintah tentang Pengelolaan Kualitas Air Dan Pengendalian Pencemaran Air. Jakarta, Indonesia.

Prastika, D., Sundari, Y. S. and Dea, J. (2010) Studi Optimasi Embung Aji Raden Sebagai Sumber Air Baku Untuk Kebutuhan Air Bersih Kecamatan Balikpapan Timur. Available at: http://ejurnal.untag-smd.ac.id/index.php/TEK/article/download/3206/3125.

Reed, S., Maidment, D. and Patoux, J. (1997) Spatial Water Balance of Texas, CRWR Online Report. Center for Research in Water Resources University of Texas at Austin. Available at: http://www.ce.utexas.edu/prof/maidment/GISHydro/seann/texas/wbtexas.htm.

RPIJM (2015) RPIJM Kota Banjarbaru 2016-2021.

Soedibyo (1993) Teknik Bendungan. Jakarta: PT. Pradnya Paramita.

Sun, T., Huang, Q. and Wang, J. (2017) "Estimation of irrigation water demand and economic returns of water in Zhangye Basin," Water (Switzerland), 10(1), pp. 1–21. doi: 10.3390/w10010019.

Torres, A. F., Walker, W. R. and Mckee, M. (2011) "Forecasting daily potential evapotranspiration using machine learning and limited climatic data," Agricultural Water Management. Elsevier B.V., 98(4), pp. 553–562. doi: 10.1016/j.agwat.2010.10.012.

Undang-Undang RI (2022) Undang Undang No 8 Tahun 2022 tentang Provinsi Kalimantan Selatan. Jakarta, Indonesia.

Waligórski, B. et al. (2020) "The water balance in a dam reservoir – a case study of the przebędowo reservoir," Rocznik Ochrona Srodowiska, 22(1), pp. 324–346.

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