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Analysis of Batujai Weir Water Balance to Meet the Demand of Irrigation Water and Domestic Water in Central Lombok Regency

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Abstract: Water availability is a function of abundant time in the rainy season and decreases in the dry season. One of the efforts to handling the availability of water is the construction of weirs or reservoirs, to collect excess water in the rainy season and use it in the dry season. In the management and development of water resources in the Batujai weir requires an analysis of water balance based on current conditions and programs in the future. This study analyzes the availability of Batujai weir water, the amount of water demand based on domestic water needs and irrigation for the next 20 years, and the current water balance of the Batujai weir and its projections for the next 20 years. It is hoped that this research can become a reference for planning and handling in the operation of the Batujai weir.

By utilizing water level data and echosounding data, IKA values (Water Availability Index) successively for 2019, 2024, 2029, 2034 and 2039 are 57.54%, 58.37%, 59.36%, 60.31%, 61.21% and 62.07%. Based on the value of IKA with a value of <70%, the balance of demand and availability of water in Batujai is a surplus for the next 20 years (2019-2039).

Keywords: Dam, Water, Domestic, Irrigation, Balance Sheet.

1. Introduction

Concern for water is everyone's problem, given the population on earth continues to grow from time to time. With the increasing population, as well as the development of development in all milliontors, the need for water for various purposes also increases. By looking at the fact that the availability of water is relatively, it is felt that water is an economic commodity whose availability are limited and increasingly scarce.

Water availability is a function of abundant time in the rainy season and decreases in the dry season. One of the efforts in handling for the availability of water is the construction of dams or reservoirs, to collect excess water in the rainy season and use it in the dry season. In the management and development of water resources in the Batujai weir requires an analysis of water balance based on current conditions and programs in the future. This study analyzes the availability of Batujai weir water, the amount of water demand based on domestic water needs and irrigation for the next 20 years, and the current water balance of the Batujai weir and its projections for the next 20 years. It is hoped that this research can become a reference for planning and handling in the operation of the Batujai weir.

2. Basic Theory

Water balance is a description of the potential and utilization of water resources in a certain period. From this water balance, it can be seen the potential of water resources that have not been utilized optimally.

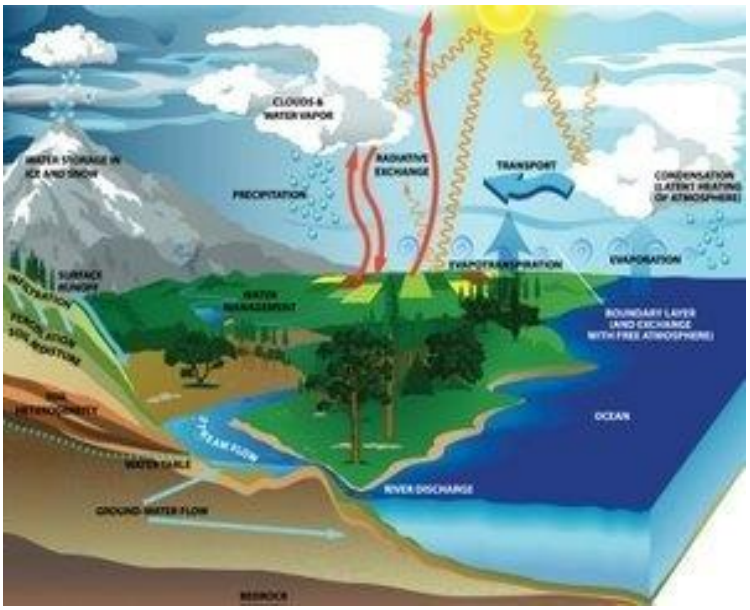

Figure 1. Hydrologi cycle
(source: adopted from http: //blog.uin-malang ac.id)

Quantitatively, the water balance illustrates the principle that over a period of time the total water input is equal to the total water output plus change in storage. The value of changes in the reserve water can be positive or negative.

The water balance concept basically shows the balance between the amount of inflow, storage availability, and outflow. Generally, the water balance equation (Sri Harto Br., 2000) is formulated with:

$$I = O \pm \Delta S \quad (1)$$

dengan :

I = inflow
O = outflow
ΔS = change of storage

Inflow is all water that enters the system, while outflow is all water that comes out of the system. The change in storage is the difference between the amount of storage (in various sub-systems) in one unit of time under review, between the time inflow occurred and the time the outflow occurred. This equation cannot be separated from the other basic concepts (hydrological cycle) because in essence, inflow into existing sub-systems, is the outflow of other sub-systems in the cycle.

Water balance is total inflow and total outflow that occurs in a watershed that contains components such as river flow, rainfall, evapotranspiration, percolation, soil moisture, and time periods.

Water balance technique as one of the main subjects in hydrology, is a way to get important answers to the practical problems of hydrology, namely in terms of quantitative evaluation of regional water resources, as well as changes due to human activity interventions. Information on land use and reservoir water balances for a certain time interval is needed for reservoir water management operations and for the purpose of hydrologic forecasts in general water management. Calculation of regional water balance is also important to comparison of the potential of a region's water resources with other regions.

3. Methodology

In this research, the analysis conducted includes:

1. Data collection,
2. Observation in the field,
3. Analysis of potential surface water availability for now and future trends,
4. Analysis of surface water demands for various demands and projections until 2039,
5. Analysis of demands and potential availability of surface water,
6. Analysis of the potential surface water balance.

A. Determination of Domestic Water Demands

To determine water demands for domestic use, the following procedures are:

1. Determine administrative boundaries with the smallest sub-district,
2. Counting population numbers in each district,
3. Set the standard of population / domestic water demands based on the value set by the Cipta Karya DPU
4. Calculate the amount of domestic water demands by equation,

$$Q_{domestik} = Pt. Un \quad (2)$$

with:

$Q_{domestik}$ = total water demands of the population (litres / millionond)
P_t = population in the year (soul)
U_n = standard water demands (litres / person / day)

Data on population is obtained from the Central Statistics Agency (BPS) of Central Lombok Regency and water demand standards are obtained from DPU Cipta Karya.

B. Determination of Irrigation Water Demands

Procedure for determining irrigation water requirements is obtained from:

1. Calculate the demands for irrigation water based on the area of irrigation available in DI Batujai multiplied by the standard water demands in the fields,
2. Calculate the total irrigation water demands from the total irrigation water demands of each paddy field area in DI Batujai,

Data on irrigation area is obtained from the Department of Public Works of Central Lombok Regency.

C. Total Water Demands

Total water demands obtained by adding up the water demands of various milliontors.

$$Q_{total} = Q_{domestic} + Q_{irrigation} \quad (3)$$

dengan :

Q_{total} = water total demands (million m^3)
$Q_{irrigation}$ = water demands for irrigation (million m^3)
$Q_{domestic}$ = watre demands for domestic (million m^3)

D. Water Demands Projection

The water demand projection is projected up to 2039 (20 years) with a 5-year prediction, 2015, 2019, 2024, 2029, 2034, 2039. Components of water demand to be projected are the population (as a function of domestic water demand), growth and depreciation of agricultural land.

The procedure for calculating the projected water demand for the population is:

1. From the calculation of the total population at this time known the total population in the area of the Batujai weir Irrigation Network,
2. Determine the population growth rates of each administrative region from Central Lombok Regency BPS data,
3. From the results of the projections obtained the population of the future and domestic water needs.

The procedure for calculating the growth and depreciation of agricultural land for the projected irrigation water requirements is:

1. Determine the rate of growth and depreciation of paddy fields that are drained by the Batujai weir water in each sub-district from the area of agricultural land each year,
2. Determine the standard of irrigation water demands by dividing the known irrigation water demands by the existing irrigation area,
3. Projecting the area of paddy fields up to 2039 in each sub-district,
4. Calculate the amount of irrigation water demands up to 2039 by multiplying the standard irrigation water demands of each district with the projected rice paddy fields that have been obtained until 2039.

E. Analysis of the Potential Balance for Surface Water of the Batujai Weir

Analysis of the surface water potential of the Batujai Weir Irrigation Network is based on equation (1) in the form of total inflow and total outflow. With its components is evapotranspiration obtained from in the

equation given by Penman Modification which is used to calculate potential evapotranspiration, discharge in the Batujai Weir Irrigation Network obtained from the NTB Water Resources Information Center.

To calculate the balance of demands and availability of surface water is by compare the total water demand with the availability of total surface water. After comparing, it can be seen the advantages and disadvantages of water in the month setup, whether for current conditions or projections in the future.

Calculation of the projected balance of demands and potential availability of surface water is by projecting water needs for the next 20 years. From the results of this analysis it can be recommended that efforts to manage water resources anticipate the scarcity of water resources in the future.

4. Results and Discussion

Based on the results of the analysis and calculations, a projection of irrigation and domestic water needs is obtained. Then the two demands are totaled as total irrigation water demands then projected in the next 20 years.

Table 1. Domestic water demand

No.	District	Domestic Water Demands (Million m^3)						Total
		2015	2019	2024	2029	2034	2039	
1	Praya Barat	2,149	2,265	2,418	2,582	2,757	2,943	15,115
2	Pujut	2,998	3,145	3,339	3,545	3,764	3,996	20,787
	Total	**5,147**	**5,410**	**5,757**	**6,127**	**6,521**	**6,940**	**35,902**

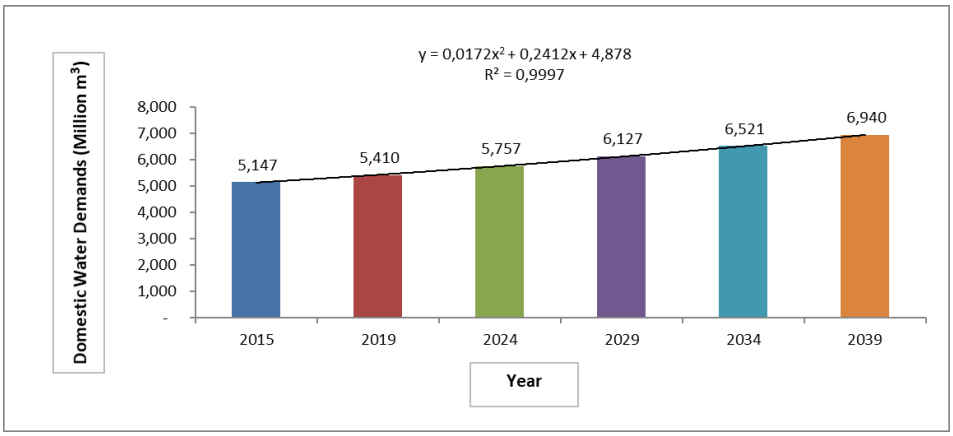

Figure 2. Graphic of domestic water needs of Batujai Weir

Table 2. Irrigation water demands

No	Irrigation Area	Year	Area (ha)	Unit	Total (million m^3)
1	Batujai	2015	2815,88	litre/detik	
				million m^3	90,56
		2019	2749,9	litre/detik	
				million m^3	88,43
		2024	2669,6	litre/detik	

				million m^3	85,85
		2029	2591,65	litre/detik	
				million m^3	83,34
		2034	2515,97	litre/detik	
				million m^3	80,91
		2039	2442,5	litre/detik	
				million m^3	78,55
JUMLAH					**507,64**

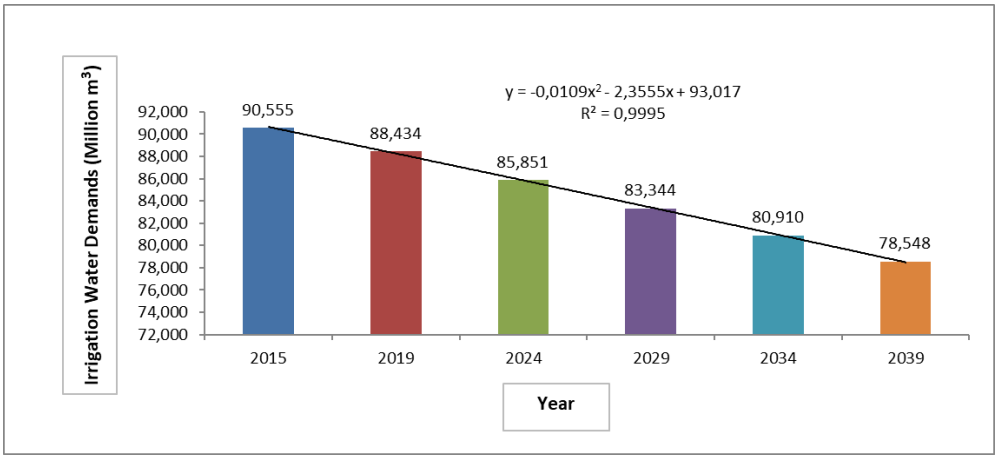

Figure 3. Graphic of irrigation water needs of Batujai Weir

Table 3. Total water demands of Batujai Weir

Year	**Demands**		
	Irrigation	**Domestic**	**Total**
	Million m^3	Million m^3	Million m^3
2015	90,56	5,15	95,70
2019	88,43	5,41	93,84
2024	85,85	5,76	91,61
2029	83,34	6,13	89,47
2034	80,91	6,52	87,43
2039	78,55	6,94	85,49
Average	**84,61**	**5,98**	**90,59**

Source : Calculation

Based on water availability and total water requirements, the Batujai water balance by 20 years projection is as follows:

Table4. Water balance of Batujai Weir

Year	Demands			Potency		NERACA	IKA	Explanation
	Irrigation	Domestic	Total	Storage average/year	Total	(Pot –Dem)	(%)	
	Million m^3	Million m^3	Million m^3	Million m^3	Million m^3	Million m^3		
2015	90,56	5,15	95,70	225,40	225,40	129,70	57,54	Surplus
2019	88,43	5,41	93,84	225,40	225,40	131,56	58,37	Surplus
2024	85,85	5,76	91,61	225,40	225,40	133,79	59,36	Surplus
2029	83,34	6,13	89,47	225,40	225,40	135,93	60,31	Surplus
2034	80,91	6,52	87,43	225,40	225,40	137,97	61,21	Surplus
2039	78,55	6,94	85,49	225,40	225,40	139,91	62,07	Surplus
Average	**84,61**	**5,98**	**90,59**	**225,40**	**225,40**	**134,81**	**59,81**	

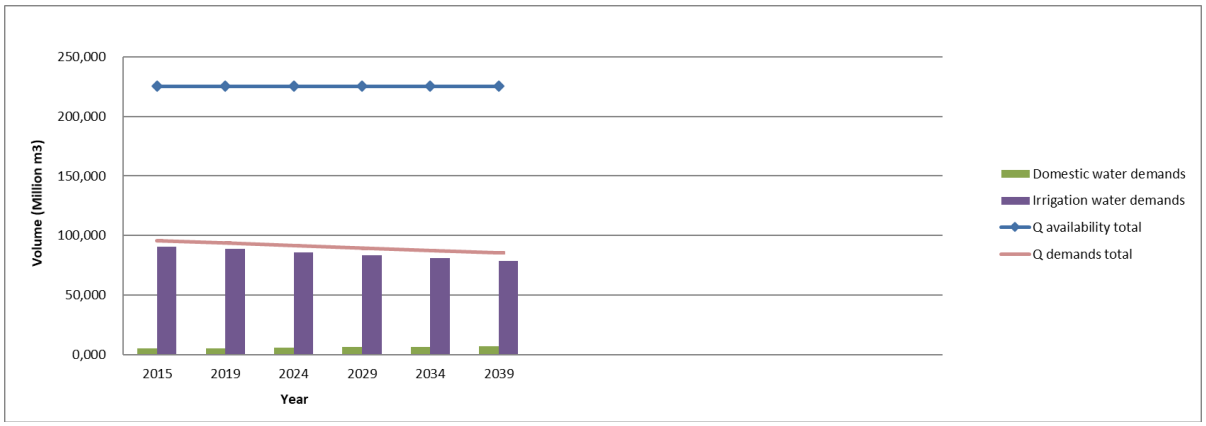

Figure 4. Graphic of watre balance in Batujai Weir

4. Conclutions and Suggestions

A. Conclutions

Based on the formulation of the problem and the studies that have been carried out, the following conclusions can be drawn:

1. Potential water availability in DI Batujai is currently 225.40 million m^3 / year in terms of the volume of the Batujai weir reservoir. Then the mainstay volume (80%) at the Batujai weir is 3.43 million m^3,
2. The amount of water demand in DI Batujai in 2019 to 2039 is an average of 90.59 million m^3, which includes water demands for irrigation 84.61 million m3 and domestic water demands of 5.98 million m^3.
3. Projection of water demand from 2019 to 2039 in accordance with NSAD Prov. NTB on average 59.81% means that the level of water use is still in a surplus condition, while up to 2039 IKA of 62.07 means that the level of water use is still in a surplus.

B. Suggestions

From the results of the calculation and analysis of the water balance analysis that has been carried out, the composer can provide suggestions that should be considered in maintaining surface water balance including:

1. Improve the implementation of more professional water management that is equipped with water allocation guidelines for each user sector,
2. For further research it is recommended to analyze by looking at the dry and wet months, and also calculating the technical and non-technical losses as well as other water demands sectors.

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