PREDICTION OF RESERVOIR CONTENTS TO IDENTIFY DISCHARGE NEEDS AT THE INTAKE DOOR

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Article History:
Received: 28-11-2024
Revised: 17-12-2024
Accepted: 31-12-2024

Keywords:
Prediction, Reservoir Contents, Intake Door

Abstract: *The rapid development of technology has given rise to new methods in science. Among these sciences, data prediction is a science that is often used to find out data on events that will appear in the future, one of which is forecasting discharge data. Water data that fills a reservoir can also be predicted by knowing past rainfall data that occurred in that area. This study aims to examine the water content of the Lowayu Reservoir by predicting past rainfall data to find out the rainfall that occurred in 2026. The results of the rainfall data prediction are then transformed into water discharge that will fill the reservoir and then be used to meet water needs for agriculture. The prediction method used is the Holt-Winters exponential smoothing model multiplicative method. The results of the study showed that the highest rainfall was obtained in December - January 2024 - 2026 at 220 mm - 224 mm with a MAPE error value of 15.8% and produced a maximum water volume in the reservoir of 213,400,000 liters -217,280,000 liters/month during 2024-2026. Based on the reservoir water content data, intake gate 1 has an opening height of 0.37 m for 115 days for 1 harvest season with an agricultural land area of 231.5 ha. While intake gate 2 has an opening height of 1.2 m for 1 harvest season with an area of 1137.5 ha*

INTRODUCTION

Rain is the result of a process of condensation of water vapor in the atmosphere which then becomes water droplets that are quite heavy and fall on the surface. Generally, rain occurs due to the cooling of air temperature or the addition of water vapor to the air (Perdana, 2015). Rain or precipitation is the descent of water from the atmosphere to the earth's surface. In tropical areas, rain provides the largest contribution so rain is often considered precipitation (Triatmodjo, 1998).

The incoming rainfall needs to be recorded continuously, it is very important to be used in engineering planning, especially for dam reservoir planning, and others. Therefore, recording rainfall data in an area must be done continuously. Even recording rainfall data in a watershed can be done at several points to find out the distribution of rainfall in the watershed.

Rainfall data is very useful in providing information in various fields, one of which is irrigation in agriculture. In the field of irrigation, rainfall intensity is even predicted, this is to determine the amount of water discharge that will fill a reservoir. According to Sisinggih et al. (2021:3), the reservoir has the main function of storing water during the rainy season, and in the dry season, the water from the reservoir will be utilized optimally.

Lowayu Reservoir is located in Lowayu Village, Dukun District, which is approximately 40 km from the center of Gresik City. The reservoir, which was built in 1936, is expected to accommodate as much water as possible to be used by the surrounding population for irrigation. It should be noted that Lowayu Reservoir has the largest technical irrigation system in the Gresik Regency. The Lowayu Reservoir Irrigation System irrigates an agricultural area of 1445 Ha which is divided into 2 intake gates, intake 1 irrigates land with an area of 1213 Ha, and intake 2 irrigates land with an area of 232 Ha. The total area of the reservoir is 97 Ha, and under normal conditions, this reservoir can accommodate around 1,690,000 m^3 of water. The catchment areas of the two intakes cover 15 villages in the Dukun District, namely; The villages of Bangeran, Lowayu, Petiyin Tunggal, Tirem, Twin Shamans, Tebuwung, Mentaras, Madu Mulyorejo, Mojopetung, Ima'an, Sekargadung, Babak Bawo, Babak Sari, Kalirejo, and Sambogunung.

The availability of reservoir water for irrigation in the Lowayu area is highly expected, and high rainfall is expected to fill the reservoir so that it is sufficient for water needs during the planting season. Forecasting rainfall data in the coming year can help provide information on surplus or deficit in the condition of the reservoir contents. So that anticipation of cropping pattern planning can be rearranged according to the amount of water available. Furthermore, the results of rainfall data forecasting can also provide information on awareness of negative aspects caused by high rainfall intensity.

Based on the explanation, it is necessary to forecast the rainfall time series data for the next period. Forecasting of rainfall data can be done using a time series model with computer software. Research on rainfall prediction has also been conducted by other researchers including; Desvina and Ratnawati (2014), Luthfiarta et al., (2020). Desmonda et al., (2018), and many other researchers.

Given the importance of knowing rainfall data in the future, this study discusses the problem of predicting rainfall in the local area of Lowayu Reservoir using the exponential smoothing method. To get an overview of the reservoir discharge data in the future, past rainfall data will be generated to find out future rainfall data. After the data is obtained, the next step is to transform the rainfall data obtained into discharge data, thus the total amount of available supply discharge in Lowayu Reservoir can be known. This study tries to examine and find the amount of discharge that will be available that can be used to meet the water needs of farmers. The purpose of this study is to analyze local rainfall data from predictions to meet water needs. And analyze the availability and release of water discharge in Lowayu Reservoir to meet agricultural water needs until 2026.

METHOD

 ISSN 2798-3471 (Cetak)
ISSN 2798-3641 (Online)

After the rainfall data is obtained, it is immediately grouped and calculated using the Excel program on the computer. Furthermore, analysis is carried out using the Holt-Winters Exponential Smoothing (HES) software. HES is quite good for use with fluctuating data and is very relevant because the rainfall data currently obtained has a fluctuating pattern. In this method using a multiplicative model. Model analysis if the data plot showing seasonal fluctuations varies, then it will use a multiplicative model (Wei, 1994). The following are the analysis steps of the Holt-Winters exponential smoothing multiplicative model for level, trend, and seasonal equations (Sinay and SN Aulele, 2015):

a. Set the values of the smoothing constants (α), (β), and (γ) between 0-1 each.

b. Calculating initial values (initialization) for level smoothing(L_s)

$$L_s = \frac{1}{s}(Y_1 + Y_2 + Y_3 \ldots \ldots \ldots + Y_s)$$

c. Calculating initial values (initialization) for trend smoothing ()b_s

$$b_s = \frac{1}{s}\{\frac{(Y_{s+1} - Y_{1})}{s} + \frac{(Y_{s+2} - Y_2}{s} + \ldots\ldots + \frac{(Y_{s+s} - Y_{s})}{s}\}$$

d. Calculating initial values (initialization) for seasonal smoothing(S_s)

$$S_1 = \frac{Y_1}{b_1}, S_2 = \frac{Y_2}{b_2}, \ldots\ldots, S_s = \frac{Y_s}{b_s}$$

e. Countsmoothing level value using the formula:

$$L_t = \alpha \frac{Y_t}{S_t - s} + (1 - \alpha)(L_{t-1} + b_{t-1})$$

f. Counttrend smoothing value using the formula:

$$b_t = \beta(L_t - L_{t-1}) + (1 - \beta)b_{t-1}$$

g. Countseasonal smoothing value

$$S_t = \gamma \frac{Y_t}{L_t} + (1 - \gamma)S_{t-s}$$

h. Doforecasting for future periods

$$F_{t+m} = L_t + b_t m + S_{t-s+m}$$

Error value forecasting is measured about the actual value of the series using the MAPE method. The forecasting results will be more accurate if the percentage error value in MAPE is smaller. Here is the equation for calculating the MAPE value:

$$MAPE = \frac{\sum_{t=1}^{n} |PE_t|}{n} X100\%$$

In calculating the reservoir contents, which rely on rainfall, the main source is rainwater that enters the reservoir. Rainfall in 1 millimeter (mm) is the amount of rainwater that falls on the surface of the ground in square meters (m^2). Thus, rainfall of 1 millimeter (mm) is equivalent to 1 liter/m^2, which means that in a place with an area of 1 square meter, there is an amount of water of 1 liter (Sri Dewi, 2019). Meanwhile, uTo calculate the height of the intake door opening, a simple discharge equation is used using Q = V. A with A = b (intake door width) x h (opening height). In addition, the loss of water discharge in each channel will also be considered according to the provisions.

FINDING AND DISCUSSION

Lowayu Village is 40 km from the center of Gresik City to the west. The reservoir with a total area of 97 Ha, a pool of 85 Ha, and a storage capacity of 1,690,000 cubic meters was built/renovated in 1986. Furthermore, there are 2 intake buildings, 1 spillway, and 14 distribution buildings. The secondary channel for irrigation is 9,198 meters long and divided into several agricultural land areas. The length of the reservoir embankment is 2,700 meters and the average depth is 2.33 meters. Rainfall that occurred from 2013 to 2023 according to data from the Lowayu rain gauge station is shown in Table 1 below.

Table 1. Rainfall data (mm) Lowayu 2013-2023

Year	Jan	Feb	Mar	Apr	May	June	Jul	Ags	Sep	Oct	Nov	Dec
2013	253	134	159	208	201	216	114	1	1	19	92	175
2014	244	186	120	154	97	30	49	2	1	1	107	146
2015	253	134	159	208	201	216	114	1	1	19	92	175
2016	123	208	133	83	228	167	63	28	126	126	150	234
2017	160	134	156	164	83	280	52	1	26	44	275	229
2018	382	271	300	37	1	26	1	1	13	28	131	194
2019	293	132	303	213	24	1	34	1	1	1	49	139
2020	263	290	184	292	196	1	11	79	3	72	135	561
2021	64	32	45	30	52	10	1	5	17	51	59	55
2022	332	171	267	259	158	61	180	41	10	120	141	264
2023	317	220	133	175	62	1	37	1	1	1	160	120

Table 1 above shows monthly rainfall data in millimeters (mm) recorded at the Lowayu Rain Gauge Station during the period 2013 to 2023. During the last 10 years, the highest rainfall was in January, namely a maximum of 382 mm.

The data forecast used in this study forecast is the Holt-Winters Multiplicative Model. According to Sinay and SN Aulele (2015), this model was chosen because the data has seasonal variations with a constant time series. The following are the results of the Holt-Winters exponential smoothing multiplicative model analysis for level, trend, and seasonal equations.

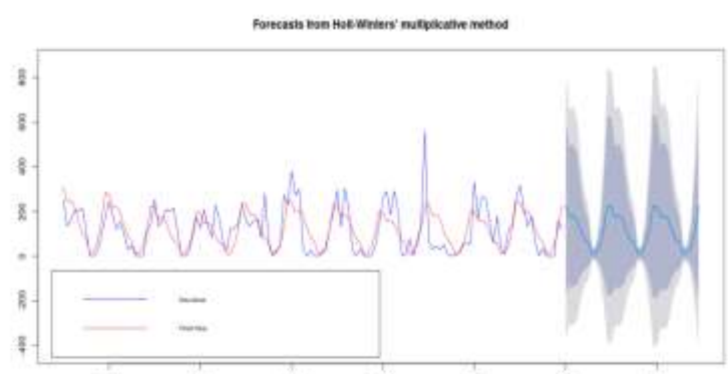

Figure 1. Forecasting results of the multiplicative Holt-Winters method

Figure 1 above shows the forecasting results using the Holt-Winters method with multiplicative seasonal components. The Blue Line represents actual data or actual historical data. This line shows how the data moves over time. The Red Line is the forecasted value line (fitted value) from the Holt-Winters model. This line follows the general pattern of the actual data, showing how the model tries to adjust to the existing data. Based on the graph above, the forecasting results for rainfall data for 2024-2026 are shown in Table 2 below.

Table 2. Results of rainfall data forecasting (mm) for 2024-2026

Year	Jan	Feb	Mar	Apr	May	June	Jul	Ags	Sep	Oct	Nov	Dec
2024	222	176	180	165	110	75	59	10	15	47	120	224
2025	221	175	179	164	110	75	59	10	15	47	120	223
2026	220	174	178	163	109	74	58	10	15	46	119	222

Table 2 explains that the prediction results for rainfall data in 2024-2026 have a maximum value of 224 mm falling in December 2024 and a minimum value of 10 mm in August throughout 2024-2026. Meanwhile, the Mean Absolute Percentage Error (MAPE) value produced is 15.8%, which means it is declared "good".

Furthermore, to find out the reservoir volume each month that comes from rainfall, Sri Dewi's (2019) equation theory is used, namely that rainfall of 1 millimeter (mm) is equivalent to 1 liter/m^2 which means that in a place of 1 square meter, there is 1 liter of water. It is previously known that the reservoir area of the Lowayu Reservoir has an area of 97 ha or 970,000 m^2. Based on this theory, the total discharge in the Lowayu Reservoir based on rainfall data from the predicted results from 2024 to 2026 obtained the results of the reservoir water content as in Table 4.6 below.

Table 3. Results of the predicted contents of the Lowayu Reservoir in 2024-2026

Prediction of the Contents (m^3) of the Lowayu Reservoir 2024-2026												
Year	Jan	Feb	Mar	Apr	May	June	Jul	Ags	Sep	Oct	Nov	Dec
2024	215340	170720	174600	160050	106700	72750	57230	9700	14550	45590	116400	217280
2025	214370	169750	173630	159080	106700	72750	57230	9700	14550	45590	116400	216310
2026	213400	168780	172660	158110	105730	71780	56260	9700	14550	44620	115430	215340

Table 3 shows the calculation results for the prediction of the contents of the Lowayu reservoir in 2024-2026. These results explain that the maximum reservoir contents occur in January - December, namely between215,340,000 liters – and 217,280,000 liters, and the minimum reservoir content occurs in August 2024-2026 amounting to 9,700,000 liters. Overall, if totaled per year, the contents of the Lowayu reservoir are respectively in 2024 = 1,360,910,000 (1,360,910 m^3) liters, 2025 = 1,356,060,000 liters (1,356,060 m^3), and 2026 = 1,346,360,000 liters (1,346,360 m^3).

Agricultural Water Needs Analysis

The area of agricultural land that requires water flow in Lowayu in 2023 is known to have an area of 3,704 hectares (Gresik Regency Agriculture Service, 2023), while the planting pattern throughout the year is rice-rice-rice. A cropping pattern means regulating land use for planting within a certain period (Pradana, 2017). Another definition is an effort to plant on a plot of land by arranging the arrangement and layout of plants during a certain period including land cultivation and fallow periods (Yonida, 2018).

Arranging cropping patterns aims to increase farmers' income in a farming system and can reduce the risk of failure due to no harvest. Increasing production with high technical efficiency is very important because it can increase yields and income for farmers. Efforts to use technical efficiency with optimal allocation of available resources are expected to increase land and crop productivity and can reduce farming costs (production) as small as possible, thus farmers' income will increase, this can be achieved through the application of cropping patterns (Manihuruk, et al., 2018).

Further information is the division of land according to the irrigation network that has been regulated by the Gresik Regency Agriculture Service. The irrigation network scheme planned by the Irrigation Service and implemented to date can be seen in Figure 3 below.

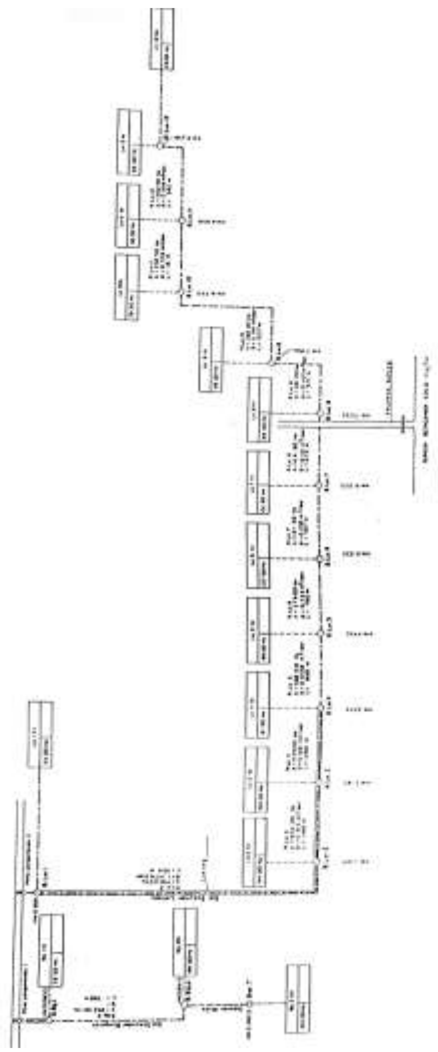

Figure 3. Lowayu Reservoir Irrigation Network Scheme

In Figure 3 above, it can be explained that until now the irrigation network scheme is still used as a guideline. If there is a damaged irrigation channel, the repair is only done as a patchwork without changing or adding dimensions to the existing channel. Repairs such as landslide embankments or damaged embankments can sometimes occur, but the repairs are only small-scale and are attempted not to disrupt the flow in the irrigation channel.

ISSN 2798-3471 (Cetak)
ISSN 2798-3641 (Online)

The image also explains that there are 2 water intake gates in the reservoir. Intake gate 1 irrigates the right side of the land covering an area of 104 ha, 99 ha, and 28.50 ha with a total of = 231.5 ha. While intake gate 2 irrigates land covering an area of 1132 ha with the appropriate details in the network schematic drawing. In the middle is also equipped with a supplementary channel, this channel is useful for entering water when the reservoir elevation is below the water level of the Bengawan Solo River or when requiring water supply during incidents. Therefore, the supplementary channel is equipped with a water gate to be opened when taking water and closed when the channel has met the water needs.

The implementation of the rice-rice-rice cropping pattern throughout the year does require adequate water availability, therefore with the prediction of the contents of the Lowayu reservoir whose data has been known, it will facilitate the arrangement of agricultural cropping patterns. Based on the data obtained from the prediction of the reservoir water discharge, the adjustment of the cropping pattern will follow the months when the reservoir contents are sufficient. The following table will present the cropping pattern plan for the Lowayu Reservoir irrigation area.

Table 4. Monthly planting and water patterns of Lowayu Reservoir 2024-2026

Planting Pattern

		Paddy				Paddy				Paddy	
Jan	Feb	Mar	Apr	May	June	Jul	Ags	Sep	Oct	Nov	Dec
2153	1707	1746	1600	1067	727	572	970	145	455	1164	2172
40	20	00	50	00	50	30	0	50	90	00	80
2143	1697	1736	1590	1067	727	572	970	145	455	1164	2163
70	50	30	80	00	50	30	0	50	90	00	10
2134	1687	1726	1581	1057	717	562	970	145	446	1154	2153
00	80	60	10	30	80	60	0	50	20	30	40

The Reservoir Irrigation Area has a reservoir area of 97 Ha and has a water depth of 2.33 m and a normal water capacity of 1,690,000 m3. The Lowayu Reservoir Irrigation Network System is a semi-technical irrigation network, namely the primary and secondary channel buildings have been installed with stone embankments. While the tertiary channel is still in the form of embankments from excavated soil forming a trapezium.

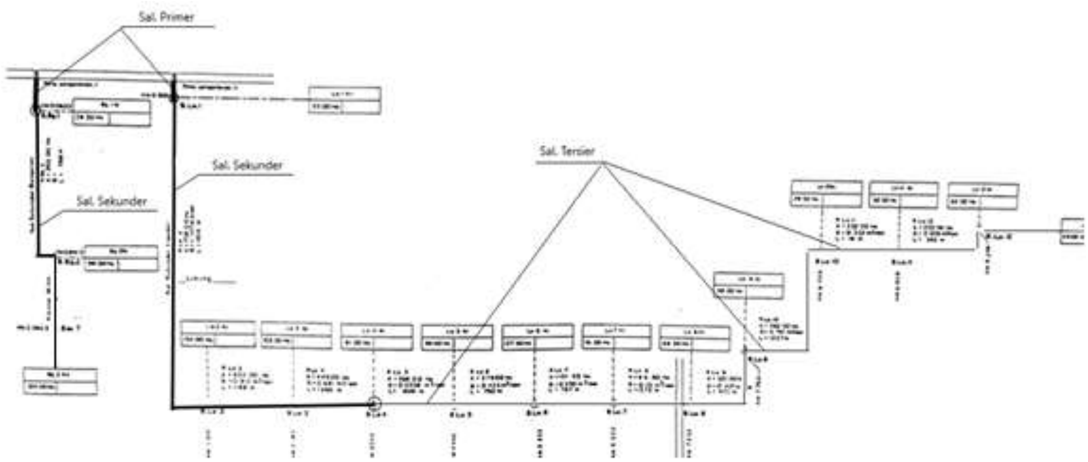

Figure 4. Location of primary, secondary, and tertiary channels

The water loss factors applied to the calculation of water discharge in the channel must also be considered. Based on the planning criteria guideline book (KP. 03) presented in Table 5 below.

Table 5. Water loss limits in irrigation networks in general

No.	Channel Type	Water Loss (%)
1	Main channel	5 – 10
2	Secondary channel	5 – 10
3	Tertiary plot, between tertiary tapping building and rice field	12.5 - 20

Source: Planning Criteria – KP 03 Channel

The regulations used to calculate water requirements for agriculture according to the guidelines are: *SNI 19-6728.1-2002 (Preparation of resource balances)*quoted from the national Water Resources Balance, Cooperation between the National Survey and Mapping Coordinating Agency and the Directorate of Irrigation Program Development of the Department of Public Works is presented in Table 6 below.

Table 6.Water Requirement Coefficient Standard

Type of Use	*Standard*	Selected Standards	Unit
Agriculture Pond Fisheries Farm	1 3.91- 5.91	4.91	1 liter/sec/ha 1 liter/sec/ha 1 liter/head/day

Source; SNI 19-6728.1-2002 (Preparation of Water Resources Balance Sheet)

Based on the existing network scheme, the distribution of water on the land is that intake gate 1 serves the agricultural land area on the left, and intake gate 2 serves the agricultural land area on the right. The area of agricultural land on the left has an area = 231.50 ha and the right has an area = 756 ha + 55 ha + 321 ha = 1132 ha. The total area of agricultural land served by the Lowayu Reservoir is 1132 ha + 231.50 ha = 1363.5 ha. The next step is to calculate the water requirements issued by the 2 intake doors. The calculation of water requirements for each land will use the following equation.

$A = L \times Itxa$

Information :

A: Water usage
L: Irrigation area (Ha)
It: Plant intensity in percentage (%) season/year
a: Water usage standard (1 L/sec/ha);
or A = 0.001 m/sec/ha x 3600 x 24 x 115 days/season

The complete calculation of water requirements to irrigate 231.5 ha of rice fields at intake gate building 1, each variable can be explained as follows:
It is known:

- A =Water requirement per unit area per unit time (in m^3/sec/ha)
- A =Conversion value to change units from m^3/sec/ha to m^3/day/ha (0.001 m^3/sec/ha x 3600 seconds/hour x 24 hours/day = 86.4 m^3/day/ha)
- Area of rice fields =231.5 ha
- Length of planting season: =115 days

Calculation of water requirements per hectare per day, namely:

- Water requirement/hectare/day = ax rice field area
  = 86.4 m^3/day/ha x 231.5 ha
  =19,994.4 m^3/day
- Total water requirements during one growing season:
  Total water requirement = Water requirement/day x length of growing season
  = 19,994.4 m^3/day x 115 days
  = 2,299,356 m^3/season = 2,299,356,000 liters/season

To calculate the water requirements for irrigating 1132 ha of rice fields at intake gate building 2, more details on each variable can be explained as follows:

- a =Water requirement per unit area and time (m^3/ha/second)
- a =Conversion factor to change units from m^3 / ha / second to m^3 / ha / season (where 1 season = 115 days)
- Area of rice fields =1132 ha

So the total water requirement per season for rice at intake gate 2 is:
a = 0.001 m^3/ha/second x 3600 seconds/hour x 24 hours/day x 115 days = 86.4 m^3/day/ha
Calculation of water requirements per hectare per day, namely:

- Water requirement/hectare/day = ax rice field area
  = 86.4 m^3/day/ha x 1132 ha
  = 97,804 m^3/ha = 97,804,000 liters/ha/day

So each hectare of land requires 97,804 m^3 of water in one planting season, so the total water requirement for the entire land can be calculated as follows:

Total water requirements =Water requirement per hectare x rice field area
= 97,804 m^3/ha/season x 1132 ha
= 110,714,128 m^3/season

Door opening analysis

Furthermore, if you want to know the door opening at each intake, it is necessary to involve the water loss factor in the channel. The water loss factors applied to the channel calculation are presented in Table 5 previously.

The details of the calculation of each channel will be explained. For buildings served by intake gate 1, there are 2 channel sections, namely; primary and secondary channels. According to the KP.03 regulation above, a loss of 5% must be calculated. While for tertiary channels, the loss is calculated at 12.5 - 20%. The results of the discharge calculation in each channel at intake 1 and 2 can be seen in Table 7 below.

Table 7. Results of debit calculations in each channel at intake 1 and 2.

Building Name	Intake 1				Intake 2			
	B (m)	L (m)	A (ha)	Q keb (ltr)	B (m)	L (m)	A (ha)	Q keb (ltr)
Prime Ch.	2	6	231.5	20,994,000	1.80	6	-	-
Second Ch.	1.8	63.50			1.80	3543	403	36,560,200
Tertiary Ch.	-	-	-		2.60	5520	734.5	71,393,400

The results of the calculation of water requirements for agricultural land in the 1st, 2nd, and 3rd planting seasons for rice plants/season are the same, namely:

Q water requirements/season = 20,994,000 +71,393,400+36,560,200
= 128,947,600 liters

The division of each intake door consists of:

- Intake Door 1 = 20,994,000 liters
- Intake Door 2 = 71,393,400 liters + 36,560,200 liters = 107,953,600 liters.

Water needs in planting season 1 will be supplied from the reservoir discharge in planting season 1, namely November-mid-February. Planting season 2 is supplied from the reservoir discharge in March-mid-June, and planting season 3 is supplied from the reservoir discharge in July-October. For more details, see Table 5 below.

Table 5. Planting Season Distribution and Monthly Discharge (liters)

Planting Season and Monthly Discharge (liters)												
Year	Jan	Feb	Mar	Apr	May	June	Jul	Ags	Sep	Oct	Nov	Dec
Season				Paddy Season 2				Paddy Season 3			Paddy Season 1	
2024	215340	170720	174600	160050	106700	72750	57230	9700	14550	45590	116400	217280
2025	214370	169750	173630	159080	106700	72750	57230	9700	14550	45590	116400	216310
2026	213400	168780	172660	158110	105730	71780	56260	9700	14550	44620	115430	215340
Qsupply				1,534,540,000				379,270,000			2,149,520,000	

Next, the door opening arrangement. The standard door opening in the field is 1 m, therefore it is necessary to determine the height of the door opening. The dimensions of the intake door for each location have different sizes. Figure 6 below will explain in detail the dimensions of the intake door.

 ISSN 2798-3471 (Cetak)
ISSN 2798-3641 (Online)

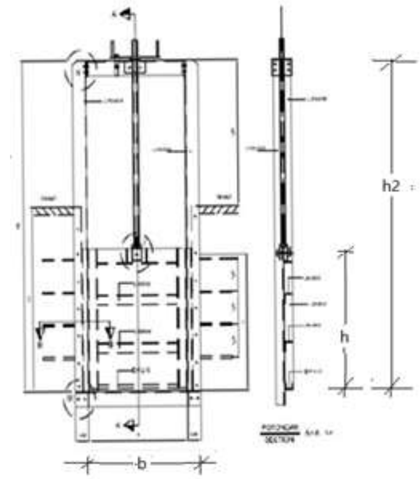

Figure 6. Type C3 Intake Gate at Lowayu Reservoir

The gates on each intake at Lowayu Reservoir have type C3. The selection of type C3 intake gates is based on their simple operating method, affordable price, and easy operation. Gates of this type are commonly used in channels with various dimensions according to needs. In addition to being cheap, their operation in the field is very easy, by turning to the left to close and vice versa, to the right to flow the water discharge according to needs. The dimensions of each gate can be seen in Table 6 below.

Table 6. Dimensions of the Lowayu Reservoir Intake Gate

No	Door Intake	Distance (Km)	Building Name	Dimensions			Amount
				h^2	b	h	piece
1	Lowayu Secondary	0.00	BLw. 1	2.00	1.65	0.90	1
2	Secondary Bangeran	6.35	BBg. 1	0.88	0.55	0.90	1

Source: Public Works Department, East Java Regional Office

Next, to determine the opening height of each intake door, it can be calculated as follows.

It is known:

- Area of land irrigated by intake gate 1 =231.5 ha
- Water requirement on land =20,994,000 ltr/hr = 20,994 m^3/hr
- Intake Door Dimension 1; b door = 0.55 m; h door = 0.9 m
- Flow velocity (V) = 1.2 m/sec
- Daily water requirement on land =20,994,000 ltr/hr
- Looking for the height of the door opening

Qkeb =20,994 m^3/hr
= 20,994 m^3 / 24 hours
= 20,994 m^3 / 86,400 seconds = 0.243 m^3 /sec

Debit equation:

Qkeb = V.Awet cross-sectional area

Qkeb = V. (door width opening height)
0.243 m^3/sec = 1.2 m/sec. (opening height)
(b. opening height) = 0.243 m^3/sec : 1.2 m/sec
(opening height) = 0.20 m
opening height = 0.20: 0.55 m
opening height = 0.37 m

From the calculation results above, it can be concluded that intake door 1 for 1 harvest season (115 days) requires a door opening height of 0.37 m. Furthermore, the calculation of intake door opening 2 in the same way can be described as follows.

- Area of land irrigated by intake gate 2 =734.5 ha + 403 ha = 1137.5 ha
- Water requirement on land =407,953,600 liters/hr = 407,953.6 m^3/hr
- Intake Door Dimension 1; b door = 1.65 m; h door = 0.9 m
- Flow velocity (V) = 2.3 m/sec
- Daily water requirement on land =407,953.6 m^3/hr
- Looking for the height of the door opening

Qkeb = 407,953.6 m^3/hr
= 407,953.6 m^3/ 24 hours
= 407,953.6 m^3/ 86,400 seconds = 4.72 m^3 /sec
Debit equation:
Qkeb = V.Awet area
Qkeb = V. (bdoor width).(hopening)
4.72 m^3 /sec = 2.3 m/sec. (hopening)
h opening height = 4.72 m^3 /sec : 2.3 m/sec
h opening height = 2.05 m
h opening height = 2.05 m^3 /sec: 1.65 m
h opening height = 1.2 m

From the calculation results, it is concluded that 2 intake doors for 1 harvest (115 days) require a door opening height of 1.2 m.

CONCLUSION

The results of rainfall data forecasting using the Holt-Winters exponential smoothing model multiplicative method produce fairly good predictions. This is evidenced by the results of the highest rainfall data of 220 mm - 224 mm which produces a maximum water volume in the reservoir of 213,400,000 liters -217,280,000 liters/month during 2024-2026 with a MAPE error value of 15.8%. Based on the information from the results, intake gate 1 has an opening height of 0.37 m for 115 days for 1 harvest season with an agricultural land area of 231.5 ha. While intake gate 2 has an opening height of 1.2 m for 1 harvest season with an area of 1137.5 ha. Limitations of calculations in discussing height inner door openingThis article intentionally does not relate to elevation, either on land, channels, or the base of the intake door. This is due to the lack of coverage of the problem which ultimately distorts the focus because the discussion will be more complex.

ACKNOWLEDGEMENT

Special thanks are expressed to all parties who have helped achieve the objectives of this research, especially to the Gresik district water public works office, supervisors, and experts who cannot all be mentioned here.

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 ISSN 2798-3471 (Cetak)
ISSN 2798-3641 (Online)