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Simulation of Dungdo Reservoir Water Distribution for Irrigation and Raw Water

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Abstract

Small reservoirs are structures that function to accommodate excess water during the rainy season so that it can be used during the dry season. Dungdo Reservoir is expected to help meet the needs of irrigation water and raw water for livestock in the surrounding community. Water distribution simulation aims to optimize water availability efficiently and evenly. The methodology used includes water balance analysis based on rainfall data, evapotranspiration, inflow, and changes in reservoir capacity. Irrigation water requirements are calculated based on the crop coefficient (Kc), while raw water requirements are calculated based on the number of livestock. Based on the simulation results with the existing planting pattern with an irrigation area of 171.60 Ha, it shows that the average water requirement is 279605.66 m3/15 days, while the reservoir's capacity to provide water is 53135.20 m3/15 days. The simulation results show that Dungdo Reservoir has not been able to optimally meet irrigation water and raw water needs.

Introduction

Regional development in Karanganyar Regency can lead to an increase in water needs. Water availability during the rainy season needs to be managed so that water needs during the dry season can be met. Brangkal Dam is located across the Siwaluh River which functions to irrigate the Brangkal Irrigation Area. Water availability at Brangkal Dam is divided proportionally based on the area flowed by each distribution channel (Khan, 2022; Bastola et al., 2024). Dungdo Reservoir is located in the Brangkal Irrigation Network which collects rainwater and water from the Left-Left Brangkal Secondary Channel as a channel inlet of Dungdo Reservoir. A schematic section of the irrigation structure can be seen in Figure 1 below.

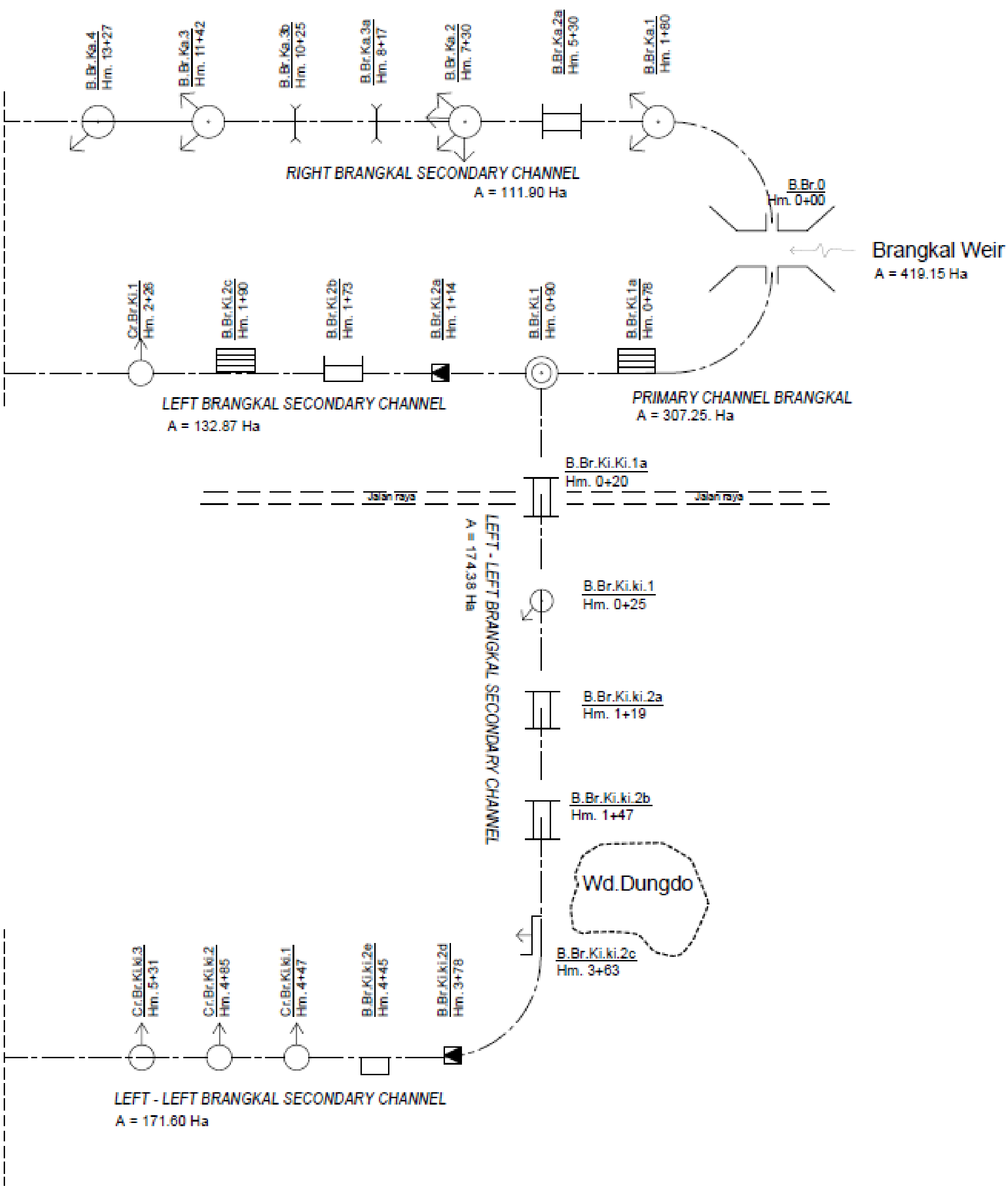

Figure 1. Irrigation Building Scheme

Dungdo Reservoir has the main function to meet the water needs of the Brangkal Irrigation Area. However, the community also uses raw water for livestock needs. So that the reservoir of the Dungdo Reservoir become dry quickly and at the end of the dry season the water reservoir can no longer meet the priority of irrigation water needs which can result in crop failure. The availability of water without proper water planning and management can endanger the environment and have an impact on its sustainability (Singh, 2014; Mishra, 2023; Mishra et al., 2023; Gavrilescu, 2021; Alotaibi et al., 2023; Srivastav et al., 2021; Wineland et al., 2022; Salem et al., 2022; Sivakumar, 2011; Gleick, 1998; Loucks & Van Beek, 2017; Jackson et al., 2001; Koop & van Leeuwen, 2015; Gayen et al., 2024; Belhassan, 2021).

Inefficient water distribution can result in water scarcity in priority sectors, decreased agricultural productivity, and conflicts between users (Molle & Berkoff, 2010; Ingrao et al.,

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2023; Suna et al., 2023; Tork et al., 2021; Hejazi et al., 2023). Therefore, this study aims to determine water availability, water needs, and water distribution management with water supply simulations so that existing potential can be utilized properly to meet the needs of agriculture and raw water for local residents.

Methods

Dungdo Reservoir is located in Banyak Hamlet, Jantiharjo Village, Karanganyar District, Karanganyar Regency. Dungdo Reservoir is geographically located at the coordinates 7°37'12.25"S 110°59'41.85"E. The study began by collecting data in the form of rainfall data around the location, climatology data, irrigation network schemes, irrigation area data, planting patterns, area and reservoir capacity, and livestock data. Water distribution simulations were analyzed based on existing planting patterns, namely Rice - Rice - Secondary Crops with an area of 171.60 Ha and the number of livestock fulfilled.

Method Rescaled Adjusted Partial Sums (RAPS)

Data consistency testing is carried out using the RAPS method, which is most widely used to test inaccuracies between data in a station by detecting shifts in average values (means). This is because the results of the RAPS method are more reliable (Harto, 1993). The results of this analysis will show the data eligibility.

$$Sk^{**} = \frac{Sk^{*}}{Dy} \quad (1)$$

k = 0, 1, 2, ... , n

$$Dy^2 = \frac{\sum_{i=1}^{n}(Yi-\bar{Y})^2}{n} \quad (2)$$

$$Sk^{*} = \sum_{i=1}^{k}(Yi - \bar{Y}) \quad (3)$$

Q statistic value

$$Q = \max_{0 \le k \le n} |Sk^{**}| \quad (4)$$

Nilai statistik R (*Range*)

$$R = \max_{0 \le k \le n} Sk^{**} - \min_{0 \le k \le n} Sk^{**} \quad (5)$$

With:

n = number of rainfall data

Y_i = rainfall data

$\bar{Y}$ = average amount of rain

Sk*, Sk**, Dy = statistical values

Q = statistical value,

n = amount of rainfall data.

Average rainfall of the area

According to Chow et al. (1988) , if there is only one rainfall station representing an area, then the average rainfall value of the area is assumed to be the same as the rainfall value recorded at the station. This is based on the assumption that the distribution of rainfall is relatively uniform throughout the area. The equation that can be used is as follows:

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$Pavg = P1$ ....(6)

with :

Pavg = Average rainfall of the area (mm)

P1 = Recorded rainfall (mm)

Evapotranspiration

In Triatmodjo (2008), evapotranspiration is evaporation that occurs on the land surface which includes the land surface and plants growing on the land surface which is usually expressed in mm/day or mm/month. In this study, the Penman Modification calculation method was used. This method requires an average daily climate of weather conditions throughout the day and night which are estimated to have an effect on evapotranspiration (Hadisusanto, 2011; Han et al., 2021; Dimitriadou & Nikolakopoulos, 2021; Nassar et al., 2021).

$ET0 = C \times (W \times Rn + (1 – W) \times f(U) \times (ea – ed))$ ....(7)

with:

ET_0 = Potential evapotranspiration

C = Correction factor for differences in weather between day and night

W = temperature correction factor for radiation

Rn = net solar radiation exposure (mm/day)

F(U) = wind speed function

Ea = saturated vapor pressure (mbar)

Ed = apparent vapor pressure (mbar)

Effective rainfall

Effective rainfall is rainfall that falls in an area and can be used by plants for their growth. The effective rainfall period for a rice field starts from land cultivation until the plants are harvested, not only during the growing period (Subramanya, 2008; Fu et al., 2023; Hussain et al., 2022). Effective rainfall for rice and secondary crops is calculated using the following equation:

For rice plants

$Re = 0,7 \times (R_{80}/15)$ ....(8)

For secondary crops

$Re = 0,5 \times (R_{80}/15)$ ....(9)

with:

Re = effective rainfall (mm/day)

R_{80} = Rainfall that is unlikely to occur 20% (mm)

= m/(n+1) x 100%

m = Sequential number (ranking)

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n = Number of observations.

Availability of reservoir water

Dungdo Reservoir has an inflow originating from the inlet channel discharge and rainfall falling above the reservoir. The availability of water in the reservoir can be calculated using the following equation:

$$V = Qinlet + (P \times A) – (P \times E) \quad \text{..........(10)}$$

with:

V	= Volume of water stored in the reservoir (m3)
Qinlet	= Discharge at the reservoir inlet channel (m3/second)
P	= Rainfall that fell (mm)
A	= Surface area of reservoir (m2)
E	= Evaporation rate (mm)

Irrigation water requirements

Irrigation water requirements are the amount of water required to meet evaporation requirements, water loss, and water requirements for plants by taking into account the amount of water provided by rain and the contribution of groundwater (Sosrodarsono & Takeda, 1987; Jiao et al., 2023).

Net irrigation water requirement in rice fields for rice plants (NFR)

$$NFR = Etc + P – Re + WLR \quad \text{..........(11)}$$

with:

Etc	= consumptive use (mm)
P	= water loss due to location (mm/day)
Re	= effective rainfall (mm/day)
WLR	= replacement of water table layer (mm/day)

Water requirements for plants (Etc)

$$Etc = Kc x Eto \quad \text{..........(12)}$$

with:

Kc= crop coefficient

Eto= potential evapotranspiration

Irrigation water requirement (WRD) in (l/dt/ha)

$$WDR = NFR / ef x 8{,}64 \quad \text{..........(13)}$$

with:

NFR = water requirement for plants in tertiary land (mm/day)

Ef= overall irrigation efficiency (%)

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Raw water requirements

Water requirements for livestock farming can be calculated using the following equation ((BSN) Badan Standarisasi Nasional, 2015) :

qe = q1 x P1 x q2 x P2 x q3 x P3...(14)

with:

qe = water requirements for livestock

q1 = water requirements for cows, buffalo, horses (liters/head/day)

q2 = water requirements for goats and sheep (liters/head/day)

q3 = water requirements for poultry (liters/head/day)

P1 = Number of cows, buffalo, horses (tails)

P2 = Number of goats and sheep (tails)

P3 = Number of birds (tails)

Results and Discussion

Method Rescaled Adjusted Partial Sums (RAPS)

To determine the amount of rainfall that occurs at the research location, daily rainfall data for the last few years at the nearest station is needed. Daily rainfall data was obtained from the Public Works and Public Housing Agency of Karanganyar Regency. In this study, the consistency test of rainfall data was carried out at 1 station, namely Matesih Station. Calculations using the RAPS method are presented in Table 1.

Table 1. Matesih Rain Station RAPS Test Results

Year	Rain (mm)	Sk*	Dy2	Sk**	ISk**I
2014	6858	3652	1666909,76	2,07	2,07
2015	2512	-694	60247,88	-0,39	0,39
2016	3513	307	11761,95	0,17	0,17
2017	4883	1677	351436,32	0,95	0,95
2018	2784	-422	22286,88	-0,24	0,24
2019	881	-2325	675848,45	-1,32	1,32
2020	1766	-1440	259290,01	-0,82	0,82
2021	2453	-753	70923,20	-0,43	0,43
Amount	**25650**		**3118704,44**		

Source: Calculation Results

Average = 3206

n = 8

Dy = 1765,99

Qcount = 2,07

Rcount = 3,38

$Q/n^{0,5}$ = 0.73 < 1.29 (Consistent)

$R/n^{0,5}$ = 1.20 < 1.38 (Consistent)

From the results of the annual rainfall consistency test at Matesih Station, it was found that the rainfall data used was consistent.

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Evapotranspiration Analysis

Evapotranspiration is calculated using the Modified Penman method, the data required includes temperature, air humidity, duration of sunlight, and wind speed. Climatology data was taken from the Adi Soemarmo Air Force Base Meteorological Station for 8 years, from 2014 to 2021. The results of the calculation of evapotranspiration each year are presented in Table 2 below.

Table 2. Recapitulation of Evapotranspiration Values (ET_0)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Des
2014	4,11	3,94	5,22	4,10	3,94	3,68	3,78	5,23	6,77	7,83	5,94	4,75
2015	4,63	4,53	4,97	4,05	3,75	3,67	4,29	5,49	5,90	5,52	5,21	4,85
2016	3,44	4,20	4,62	3,90	3,82	3,40	3,50	4,57	5,21	5,23	4,38	4,94
2017	3,81	4,01	4,99	3,75	4,14	3,65	4,22	4,28	5,42	5,87	4,15	4,14
2018	3,65	4,59	4,08	4,01	4,08	3,77	4,53	5,77	6,19	7,79	6,26	5,16
2019	4,08	4,27	4,07	3,87	3,94	4,03	4,32	5,31	6,55	7,66	7,40	5,35
2020	4,20	4,16	3,97	3,58	3,71	3,58	4,02	5,21	6,40	6,02	5,42	5,39
2021	3,51	3,89	4,33	3,76	3,68	3,30	4,17	5,05	6,21	6,75	4,70	4,70

Source: Calculation Results

Effective Rainfall Analysis

Calculation of effective rainfall is done by sorting 15 daily rainfall data from the largest to the smallest to determine the probability (P80) of effective rainfall. After calculating the probability value of rainfall with a reliability level of 80%, it is continued with the calculation of effective rainfall (Re). The calculation of effective rainfall (Re) for rice and secondary crops is presented in Table 3 below.

Table 3. Effective Rainfall

Month	Period	P_{80}	Re Padi	Re Secondary Crops
			mm/day	mm/day
January	1	22	1,01	0,72
	2	83	3,64	2,60
February	1	36	1,81	1,29
	2	73	3,66	2,61
March	1	72	3,36	2,40
	2	31	1,34	0,96
April	1	28	1,29	0,92
	2	50	2,33	1,67
May	1	10	0,45	0,32
	2	8	0,35	0,25
June	1	0	0,00	0,00
	2	0	0,00	0,00
July	1	0	0,00	0,00
	2	0	0,00	0,00
August	1	0	0,00	0,00
	2	0	0,00	0,00
September	1	0	0,00	0,00
	2	0	0,00	0,00
October	1	0	0,00	0,00

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	2	9	0,41	0,29
November	1	15	0,72	0,51
	2	28	1,29	0,92
December	1	77	3,57	2,55
	2	58	2,54	1,81

Source: Calculation Results

Water Availability Analysis

The water availability of Dungdo Reservoir comes from rainwater that falls on the embankment and the inlet channel, namely the Left-Left Brangkal Secondary Channel. Therefore, it is necessary to calculate the discharge at the Brangkal Dam using the FJ. Mock method to be divided proportionally on each channel according to the comparison of the area of the area being flowed. The results of the calculation of water availability at the Brangkal Dam and at each distribution channel are presented in Table 4 below.

Table 4. Recapitulation of Debit of Each Channel (m^3/second)

Month	Period	Debit				
		Weir	Right Secondary Channel	Primer Channel	Left Secondary Channel	Left Left Secondary Channel
Jan	1	0,11	0,03	0,08	0,04	0,05
	2	0,17	0,04	0,12	0,05	0,07
Feb	1	0,10	0,03	0,07	0,03	0,04
	2	0,18	0,05	0,13	0,06	0,07
Mar	1	0,17	0,05	0,13	0,05	0,07
	2	0,07	0,02	0,05	0,02	0,03
Apr	1	0,08	0,02	0,06	0,02	0,03
	2	0,11	0,03	0,08	0,03	0,04
May	1	0,04	0,01	0,03	0,01	0,02
	2	0,03	0,01	0,02	0,01	0,01
Jun	1	0,02	0,01	0,01	0,01	0,01
	2	0,01	0,00	0,01	0,00	0,01
Jul	1	0,01	0,00	0,01	0,00	0,00
	2	0,00	0,00	0,00	0,00	0,00
Agu	1	0,00	0,00	0,00	0,00	0,00
	2	0,00	0,00	0,00	0,00	0,00
Sep	1	0,00	0,00	0,00	0,00	0,00
	2	0,00	0,00	0,00	0,00	0,00
Oct	1	0,00	0,00	0,00	0,00	0,00
	2	0,02	0,00	0,01	0,01	0,01
Nov	1	0,05	0,01	0,04	0,02	0,02
	2	0,05	0,01	0,04	0,02	0,02
Of the	1	0,16	0,04	0,12	0,05	0,07
	2	0,12	0,03	0,08	0,04	0,05

Source: Calculation Results

Based on Table 4, the maximum debit is obtained on the Left Left Secondary Channel that functions as a channel inlet reservoir of 0.07m^3/second and a minimum discharge of 0.00 m^3/second.

Water Needs Analysis

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The need for irrigation water is determined by the planned planting pattern. This study used the existing planting pattern, namely Rice - Rice - Secondary Crops with the beginning of planting on October 1 covering an area of 171.60 Ha. The calculation of plant water requirements is presented in Table 5 below.

Table 5. Plant Water Requirements

No.	Description	Unit	O	N	D	J	F	M	A	Mei	Jun	Jul	Agt	Sep
1	Planting Pattern	-	-	-	-	-	-	-	-	-	-	-	-	-
2	Evapotranspiration (ET_o)	mm/day	6.58	5.43	4.91	3.93	4.20	4.53	3.88	3.88	3.63	4.10	5.12	6.08
3	Percolation (P)	mm/day	2	2	2	2	2	2	2	2	2	2	2	2
4	WLR	mm/day	1.67	1.67	1.67	-	1.67	1.67	-	-	-	-	-	-
5	C1	-	1.20	1.27	1.33	1.30	0	1.20	1.27	1.33	1.30	0.95	0.55	
6	C2	-	LP	1.20	1.27	1.33	1.30	0	LP	1.20	1.27	1.33	0.95	0.55
7	C	-	LP	1.24	1.30	1.32	0.65	LP	1.24	1.30	1.32	0.95	0.55	
8	$Etc = ET_o \times Kc$	-	6.71	6.46	2.55	0	5.59	5.10	2.52	1.84	3.10	4.86	3.34	
9	$E_o = 1.1 \times ET_o$	-	7.24	5.98	5.40	4.32	4.62	4.98	4.26	4.27	4.00	4.51	6.69	
10	$M = E_o + P$	-	9.24	7.98	7.40	6.32	6.62	6.98	6.26	6.27	6.00	6.51	8.69	
11	$k = MT/S$	-	0.92	0.80	0.74	0.63	0.66	0.70	0.63	0.63	0.60	0.65	0.87	
12	S	mm	300	300	300	300	300	300	300	300	300	300	300	
13	$IR = M \cdot ek/(ek-1)$	mm/day	15.3	14.5	14.2	13.5	13.7	13.9	13.5	13.5	13.3	13.6	15.0	
14	Re	mm/day	0.00	0.72	3.57	1.01	1.81	3.36	1.29	0.45	0.00	0.00	0.00	
15	Total Water Req.	mm/day	15.3	10.4	10.1	4.55	13.7	9.26	8.76	4.52	3.84	5.10	5.34	
16	NFR	mm/day	15.3	9.66	6.55	3.55	11.9	5.90	7.48	4.07	3.84	5.10	5.34	
17	NFR	l/sec/ha	1.77	1.12	0.76	0.41	1.37	0.68	0.87	0.47	0.44	0.59	0.62	
18	DR = NFR/e	-	2.73	1.72	1.17	0.63	2.11	1.05	1.33	0.73	0.68	0.91	0.95	

Source: Calculation Results

The need for raw water for livestock is determined by the type and number of livestock. The amount of raw water needed based on the type of livestock based on ((BSN) National Standardization Agency, 2015) The amount of raw water needed for livestock is presented in Table 6 below.

Table 6. Raw Water Requirements for Livestock

Month	Number of days	Need		
		l/day	m^3/second (x10^{-6})	m^3
January	15	607,00	7,03	9,11
	16	607,00	7,03	9,71
February	14	607,00	7,03	8,50
	14	607,00	7,03	8,50
March	15	607,00	7,03	9,11
	16	607,00	7,03	9,71
April	15	607,00	7,03	9,11
	15	607,00	7,03	9,11
May	15	607,00	7,03	9,11
	16	607,00	7,03	9,71
June	15	607,00	7,03	9,11
	15	607,00	7,03	9,11
July	15	607,00	7,03	9,11
	16	607,00	7,03	9,71
August	15	607,00	7,03	9,11
	16	607,00	7,03	9,71
September	15	607,00	7,03	9,11
	15	607,00	7,03	9,11
October	15	607,00	7,03	9,11
	16	607,00	7,03	9,71
November	15	607,00	7,03	9,11

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	15	607,00	7,03	9,11
December	15	607,00	7,03	9,11
	16	607,00	7,03	9,71

Source: Calculation Results

Water Distribution Simulation

The simulation principle of Dungdo Reservoir is that at the beginning of the dry season (April) the reservoir is in a fully filled condition. The results of the water supply simulation in each period are presented in Table 7 and Table 8 below.

Table 7. Water Distribution Simulation (April – September)

No	Description	Unit	April		May		June		July		August		September	
			1	2	1	2	1	2	1	2	1	2	1	2
1	Number of days		15	15	15	16	15	15	15	16	15	16	15	15
2	Water requirements	m3	296075.62	252377.70	161363.91	110688.53	151894.48	163408.99	201894.71	240487.30	271652.17	289762.31	259825.42	211661.07
	a. Irrigation	m3	296066.51	252368.60	161354.81	110678.81	151885.37	163399.89	201885.60	240477.59	271643.06	289752.60	259816.31	211651.96
	b. Raw Water	m3	9.11	9.11	9.11	9.71	9.11	9.11	9.11	9.71	9.11	9.71	9.11	9.11
3	Inflow	m3	42190.46	58703.03	20609.05	16896.37	10715.28	7842.10	4705.26	2823.15	1693.89	1016.34	609.80	365.88
	a. Channel Debit	m3	41641.22	57708.03	20418.01	16737.17	10715.28	7842.10	4705.26	2823.15	1693.89	1016.34	609.80	365.88
	b. Rainwater	m3	549.24	995.00	191.04	159.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	Evaporation	mm/day	1.82	1.85	2.36	2.36	2.41	2.42	3.44	3.45	4.11	4.14	4.91	4.95
	Flood Area	m2	19900.00	15516.36	16011.52	15720.20	15626.72	15076.40	14351.63	13316.15	11977.05	10429.73	8801.85	7390.47
	Evaporation Volume	m3	544.04	429.51	566.44	593.75	565.80	546.85	739.87	735.00	738.62	690.84	648.44	549.24
5	Elevation 1	m	242.00	241.57	241.62	241.59	241.58	241.52	241.44	241.31	241.13	240.90	240.61	240.32
6	Volume 1	m3	500000	486872.43	501358.43	492839.62	490103.81	473975.55	452674.23	422115.62	382358.98	336046.77	286822.91	243653.25
7	Outflow(giving)	m3	54773.99	43787.53	28561.41	19038.43	26277.74	28596.57	34523.99	41844.79	47267.48	49549.36	43131.02	32172.48
8	Volume 2	m3	486872.43	501358.43	492839.62	490103.81	473975.55	452674.23	422115.62	382358.98	336046.77	286822.91	243653.25	211297.41
9	Elevation 2	m	241.57	241.62	241.59	241.58	241.52	241.44	241.31	241.13	240.90	240.61	240.32	240.06
10	k = Provision/Need		0.185	0.174	0.177	0.172	0.173	0.175	0.171	0.174	0.174	0.171	0.166	0.152

Source: Calculation Results

No	Description	Unit	October		November		December		January		February		March	
			1	2	1	2	1	2	1	2	1	2	1	2
1	Number of days		15	16	15	15	15	16	15	16	14	14	15	16
2	Water requirements	m3	606783.41	629864.44	382502.47	373943.85	259342.93	317331.31	140414.55	9.71	438400.98	370024.98	233713.97	347111.01
	a. Irrigation	m3	606774.31	629854.73	382493.37	373934.74	259333.82	317321.60	140405.45	0.00	438392.48	370016.48	233704.87	347101.30
	b. Raw Water	m3	9.11	9.71	9.11	9.11	9.11	9.71	9.11	9.71	8.50	8.50	9.11	9.71
3	Inflow	m3	477.23	9531.73	27291.29	27450.81	86270.65	67586.06	61345.11	98241.91	49376.53	89775.46	94868.29	42086.87
	a. Channel Debit	m3	477.23	9344.67	26984.83	26901.57	84746.31	66431.86	60915.27	96586.23	48656.15	88318.78	93435.49	41477.93
	b. Rainwater	m3	0.00	187.06	306.46	549.24	1524.34	1154.20	429.84	1655.68	720.38	1456.68	1432.80	608.94
4	Evaporation	mm/day	5.53	5.65	3.25	3.30	2.40	2.35	1.70	1.66	1.68	1.74	1.88	1.84
	Flood Area	m2	6344.16	4192.09	2154.08	1576.72	1016.49	1491.87	1013.88	1667.86	4675.18	2404.23	1768.45	2648.92
	Evaporation Volume	m3	526.45	378.83	105.06	78.11	36.52	56.09	25.87	44.28	110.16	58.57	49.86	78.08
5	Elevation 1	m	240.06	239.37	238.25	237.73	237.00	237.64	237.00	237.83	239.55	238.44	237.92	238.60
6	Volume 1	m3	211297.41	143531.16	77100.33	57621.26	38250.98	54721.87	38159.04	60723.86	158911.78	85425.87	64135.28	93513.79
7	Outflow(giving)	m3	67717.03	75583.73	46665.30	46742.98	69763.25	84092.80	38754.42	9.71	122752.27	111007.49	65439.91	97191.08
8	Volume 2	m3	143531.16	77100.33	57621.26	38250.98	54721.87	38159.04	60723.86	158911.78	85425.87	64135.28	93513.79	38331.51
9	Elevation 2	m	239.37	238.25	237.73	237.00	237.64	237.00	237.83	239.55	238.44	237.92	238.60	237.01
10	k = Provision/Need		0.112	0.120	0.122	0.125	0.269	0.265	0.276	1,000	0.280	0.300	0.280	0.280

From the simulation table above, it can be seen that the value of the k factor < 1 so it can be concluded that Dungdo Reservoir has not been able to meet irrigation water needs with existing cropping patterns and area and raw water. The results of the water supply simulation show that the average water requirement is 279605,66 m3/15 days, while the reservoir's capacity to provide irrigation water averages 53135,20 m3/15 days.

Conclusion

From the results of the above analysis, it can be concluded that Dungdo Reservoir has not been able to meet the needs of irrigation water and raw water. The results of the water supply simulation show that the average water requirement is279605,66 m3/15 days, while the reservoir's capacity to provide irrigation water averages 53132,28 m3/15 days. Based on these results, a simulation is needed using a planting pattern that is more appropriate to the

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availability of water or can be done by reducing the area of irrigation served so that there is no drought in the reservoir which will cause crop failure.

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