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ANALYSIS OF HYDROLOGY OF THE KALIGUNG RIVER AT TEGAL

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ABSTRACT

Rivers drain water by embracing a gravitational philosophy, in which water always flows from high to low or downstream to downstream. The process of river water flow is an endless natural process, closing the hydrological cycle by restoring the river runoff to the sea. For centuries, rivers have been used as a source of clean water, meeting human needs for drinking water, sanitation, irrigation, and so on. Large rivers are dammed to store water in the wet season and use it in the dry season for various purposes.

Kali Gung or Kaligung or also known as Kaligung river is a river that flows in Tegal regency, Central Java. This river is one of the largest rivers in Tegal besides Kali Ketiwon and Kali Kemiri. This river is called Kali Gung because it is tangent to the spring that comes from Mount Agung is an ancient name from Mount Slamet in pre-Islamic times in Java. Upstream or spring water Kaligung located in the north of Mount Slamet and empties to the north precisely in the sea of Java.

Keywords: *Hydrologycal cycle, rivers, downstream, upstream, Kaligung.*

1. BACKGROUND

Kali Gung or Kaligung or also known as Kaligung river is a river that flows in Tegal regency, Central Java. This river is one of the largest rivers in Tegal besides Kali Ketiwon and Kali Kemiri. This river is called Kali Gung because it is tangent to the spring that comes from Mount Agung is an ancient name from Mount Slamet in pre-Islamic times in Java. Upstream or spring water Kaligung located in the north of Mount Slamet and empties to the north precisely in the sea of Java.

Gung River is located in Gung river basin (DAS) area of 765,625 km^2 which includes Tegal regency and Tegal city with main river length about 55,58 km.

River management, in general, is a technical, administrative, legal, regulatory and management matters concerning river facilities and buildings, Forest observations, maintenance and repair of doors and drainage facilities, flood forecasting, flood warning and countermeasures and others -other. To be able to realize it requires supporting facilities

and infrastructure optimally include analyzing River Gung Hydrology.

2. FORMULATION OF THE PROBLEM

The problems and conditions need to be the implementation of the review of countermeasures and improvements as follows:

1. Is the potential for water and discharge sufficient?
2. How much flood discharge the gung river plan?

3. INTENT AND PURPOSE OF RESEARCH

The following purposes of the study of River Gung Hydrology Analysis are:

1. Analyzing the discharge to be utilized the potential of water availability optimally, to serve the Irrigation area.
2. Analyzing flood prevention on the river

4. STUDY AREAS LOCATION

The study location that will be discussed in this final project report is gung river. Overall DAS gung area of 765,625 km^2 is located in Tegal.

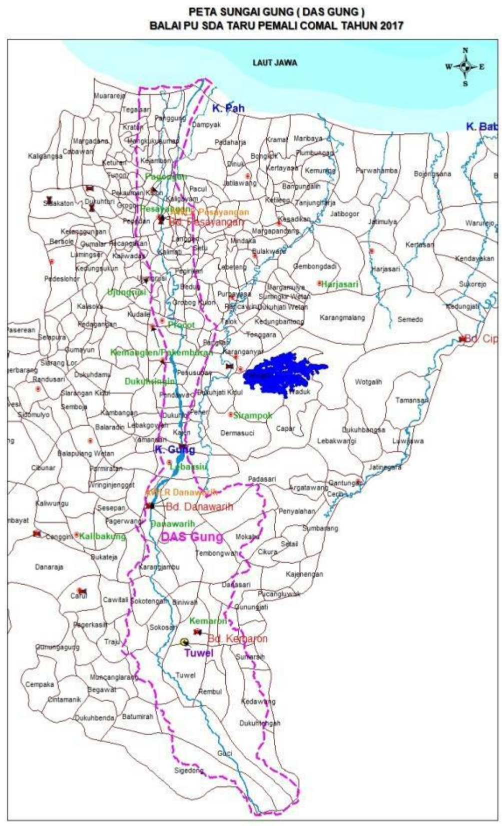

Figure 1. Das Maps of Rivers Gung

5. FRAMEWORK

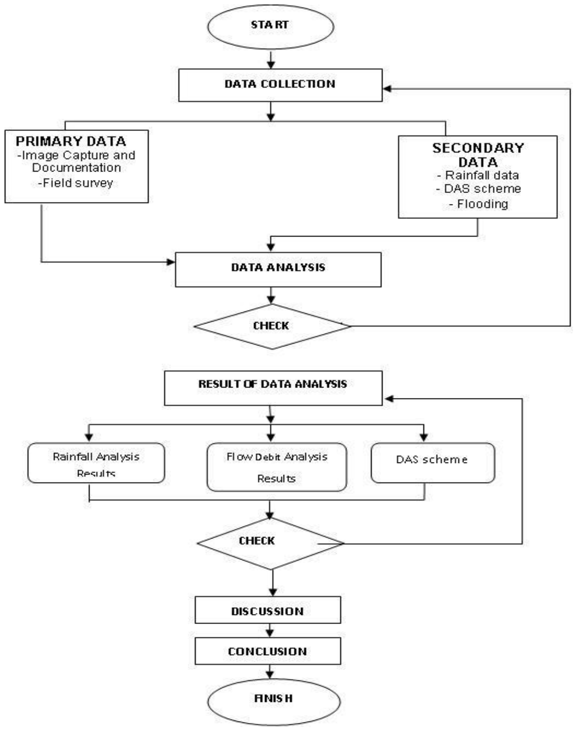

Figure 1. Framework

6. THEORETICAL BASIS

8.1 Hydrology

Hydrology is derived from the Greek Hydrologia which means water science, etymologically hydrology consists of the word hydro and logy where "hydro" means water and " logos " means science, so hydrology can be a said water problem. In general, hydrology is the study of the problem of water existence on earth and hydrology itself provides alternative for the development of water resources for the purposes of raw water, industrial agriculture and electricity.

8.2 Watershed

Watersheds are a land area which is a unity with rivers and tributaries, which functions to accommodate, store, and drain water from rainfall to the lake or to the sea naturally, whose boundaries on land are topographical and boundary separators in the sea up to the waters area that is still affected by the mainland activities.

8.3 Hydrological Cycle

The hydrologic cycle is actually very complex and has a wide scope so for the analysis, it is necessary to simplify the model to represent the actual state. To determine the relationship between rainfall, flow and evaporation this can be explained by the hydrological cycle.

8.4 River

The river is a large and long flow of water that flows continuously from upstream (source) to downstream (estuary). Water in rivers is generally collected from precipitation, such as rain, dew, springs, underground runoff, and in certain countries also comes from melt ice/snow. In addition to water, rivers also drain sediment and pollutants.

8.5 Rainfall

Rain is one of the natural phenomena contained in the hydrological cycle and strongly influenced by climate. The existence of rain is very important in life because rain can meet the water needs that are needed by all living things.

8.6 Water Availability

In general in Indonesia, which is a benchmark in irrigation planning is the planning of irrigation water needs for rice crops. The need for rice crops for rice varieties often used in Indonesia is 1 liter/second/hectare average, or the average height of rice puddle is 10 cm.

8.7 Flood

Floods are usually regarded as rising river water levels that exceed their normal state or in the general sense of the overflow of water beyond the normal channel capacity limit. Floods are also defined as large streams of water, flowing water that floods and overflows the normally dry plains.

8.8 Plant Patterns

In cultivating, there are several planting patterns to be efficient and facilitate us in land use and to rearrange the planting calendar. Cropping pattern itself there are three kinds, namely: monoculture, polyculture (tumpangsari), and crop rotation.

7. DATA RESEARCH METHODS

In this study the data obtained by the way, as follows:

1. Looking for data of primary data and secondary data (at the related institution and department) needed to complete data needed for thesis preparation.
2. Study literature as a literature review both from books and other media (internet).
3. Processing and analyzing the data obtained. Taking conclusions and suggestions from the results of thesis studies.

7.1 HYDROLOGY ANALYSIS METHOD

Some of the successful hydrological data collected come from several recording stations, such as manual rainfall scattered in several locations such as Kemaron Station, Lebaksiu Station, Grogol Station, Traju Station, and Pesayangan Station (located in DAS Gung). Hydrological analysis conducted is as follows :

8.5.1 Determination of The Watershed

Determination of Watershed (DAS) is done based on the 1: 25000 scale DAS map Determination of this area by using Thiessen polygon method. A number of stations used as many as five rain stations. The need to calculate the area's rainfall is for the preparation of a potential water plan.

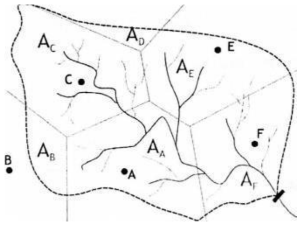

Figure 3. Poligon Thiessen of Watershed

8.5.2 Mainstay Debit

For the mainstay discharge Q 80% of the average discharge taken within a certain time (10 years).

$$N = 80\,\%\ x\ n$$

Information :

N = year sequence whose Q is used as a mainstay debit

n = number of years of observation

8.5.3 Availability Debit

In general in Indonesia, which is a benchmark in irrigation planning is the planning of irrigation water needs for rice crops. Rice water requirement for rice varieties that are often used in Indonesia is an average of 1 liter/second/hectare, or the average height of rice puddle is 10 cm.

8.5.4 Debit Requirement

In general, hydrological analysis is carried out:

a. water demand analysis for irrigation water demand planning
b. calculation of plan debit analysis to determine river cross-sectional capacity in flood control building planning
c. hydrological analysis for drainage water planning.
d. hydrological analysis for calculation of water potential in order to determine the volume of the reservoir plan
e. analysis of the relationship between rainfall and flow rate in order to develop a flood early warning system (Anwar, 2011).

8.5.5 Flood Debit Analysis Plan

A. Rain Distribution According to Monobe

Average rain from scratch

$$Rt = \left(\frac{R_{24}}{t}\right)\left(\frac{t}{T}\right)^{2/3}$$

The amount of rainfall to -T

RT = t . Rt . - (t - 1). Rt

Where

Rt	= mean rain intensity.
R24	= Rainfall in 1 day (mm).
T	= concentration time (6 hours).
T	= Start time of rain (hour)

B. Method E.J. Gumbel

With a repeat period of T = 2 years,

T = 10 years, T = 25 years, T = 50 Years, and T = 100 Years and the equations can be seen below.

By formula:

$$X_T = X_r + \frac{Y_T \quad Y_n}{S_n}\ Sd$$

Where :

XT = maximum daily rainfall with T year re-period (mm).

Xr = daily mean annual rainfall $Xr = \frac{\sum x}{n}$ (mm)

Y_T = *reduced variate* : $YT = \left\{\ell n.\ell n\left(\frac{T}{T-1}\right)\right\}$.

Yn	= Reduced mean.
Sn	= Standard deviation.
N	= Length of observation year.

C. Nakayasu Hydrograph Method Unit (HSS)

Nakayasu of Japan has made the hydrograph formula of the cytentic unit from the results of his investigation. In the formula as follows:

$$Qp = \frac{1}{3.6} x A x \frac{R_0}{(0,3Tp + T_{0.3})}$$

Where :

Tp	= tg + 0.8 tr
Tg	= 0.21 $L^{0.7}$ .... L > 15km
Tg	= 0.4 + 0.058 L .... L < 15 km
$T_{0.3}$	= α . tg
a	= 0,47 . $(A.L)^{0,25}$ / tg

D. Metode Der Weduwen

The calculation steps are

Calculate the magnitude of

flood discharge by re-use the formula :

$$Q_n = \alpha x \beta x q x A$$

Qn = Flood Debit Plan (m3 / sec)
α = Runoff Coefficient / Run Off
β = Coefficient of Reduction
A = Wide watershed (km2)
q = Rainfall

8. ANALYSIS AND DISCUSSION PROBLEMS

8.1 DETERMINATION OF RIVER FLOWS

Based on thiessen polygon method results in the broadest catchment area as follows:

Table 1. Wide of DTA

No.	Name of Station	Wide of DTA (Km^2)
1.	Kemaron Station	237,5
2.	Traju Station	131,25
3.	Pesayangan Station	28,125
4.	Grogol Station	156,25
5.	Lebaksiu Station	212,5
	Total	765,625

8.2 RAINFALL ANALYSIS

Table 2. The Data of Rainfall from Kemaron Station (Semimonthly) (2007-2016 mm)

Tahun	Januari		Pebruari		Maret		April		Mei		Juni		Juli		Agustus		September		Oktober		Nopember		Desember		Tahunan
	Jan-1	Jan-2	Peb-1	Peb-2	Mar-1	Mar-2	Apr-1	Apr-2	Mei-1	Mei-2	Jun-1	Jun-2	Jul-1	Jul-2	Ags-1	Ags-2	Sep-1	Sep-2	Okt-1	Okt-2	Nop-1	Nop-2	Des-1	Des-2	
2007	108	178	458	163	159	298	262	257	166	83	88	18	1	20	0	7	3	0	11	23	127	129	152	274	2811
2008	249	90	477	157	339	188	63	69	23	8	10	3	0	0	1	10	10	0	177	182	405	180	177	235	3036
2009	104	157	189	145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	89	156	102	343	343
2010	448	500	428	269	289	226	96	241	301	125	195	81	83	124	134	248	267	202	209	369	169	145	451	460	6060
2011	368	532	193	316	195	233	113	292	180	219	0	14	5	23	0	0	0	0	35	130	429	485	266	251	4279
2012	344	317	148	551	520	100	380	242	160	100	10	4	0	7	0	0	0	0	8	156	192	318	317	211	4085
2013	477	541	273	215	99	297	370	382	171	147	166	83	189	101	0	55	67	27	0	0	90	125	292	198	4150
2014	93	631	437	220	121	248	274	241	141	233	42	186	68	59	129	11	0	0	0	68	99	163	196	175	3835
2015	115	174	280	89	278	69	127	144	46	11	33	0	0	0	0	5	0	0	5	10	106	141	289	155	2103
2016	89	208	193	316	255	122	113	292	132	185	142	155	50	168	47	16	237	385	78	64	178	218	180	90	3861
Max	477	631	477	551	520	298	380	382	301	233	195	186	189	168	134	248	267	385	209	369	429	485	451	460	
Rerata	240	333	308	244	226	178	180	216	132	111	69	54	40	50	31	35	58	61	52	100	188	206	242	239	
Min	89	90	148	89	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	89	125	102	90	

Table 3. The Data of Rainfall from Lebaksiu Station (Semimonthly) (2007-2016 mm)

Tahun	Januari		Pebruari		Maret		April		Mei		Juni		Juli		Agustus		September		Oktober		Nopember		Desember		Tahunan
	Jan-1	Jan-2	Peb-1	Peb-2	Mar-1	Mar-2	Apr-1	Apr-2	Mei-1	Mei-2	Jun-1	Jun-2	Jul-1	Jul-2	Ags-1	Ags-2	Sep-1	Sep-2	Okt-1	Okt-2	Nop-1	Nop-2	Des-1	Des-2	
2007	130	104	138	151	115	121	57	147	61	53	64	4	0	34	0	0	0	0	5	53	108	70	95	276	1569
2008	108	228	98	109	134	57	51	84	34	18	17	81	0	0	3	42	8	20	53	133	88	65	84	204	1405
2009	152	232	237	318	122	116	81	94	100	39	0	0	0	0	0	0	0	0	10	0	166	175	124	130	1949
2010	289	244	211	313	233	375	34	166	83	143	145	55	60	75	16	91	20	135	134	142	217	79	108	415	3756
2011	132	187	334	341	280	271	231	48	140	117	18	5	18	4	0	0	0	0	0	171	198	208	85	295	3083
2012	380	298	275	160	675	122	198	85	38	62	40	0	0	0	0	0	0	0	0	23	83	96	82	330	2753
2013	232	184	134	95	126	103	163	42	12	71	138	36	123	56	0	22	18	5	0	0	75	89	95	235	1721
2014	129	153	126	343	378	111	229	68	66	101	47	81	120	30	0	0	0	0	0	0	94	113	93	229	2511
2015	362	227	245	110	323	104	40	344	101	36	34	0	0	0	0	0	0	0	0	0	80	111	244	205	2511
2016	110	141	334	341	141	24	231	48	55	94	28	99	37	48	14	9	48	194	66	166	84	123	178	176	2716
Max	380	298	334	343	675	375	231	344	140	143	145	99	123	75	16	91	48	194	134	171	217	208	244	415	
Rerata	202	200	213	228	253	140	132	113	69	73	53	36	36	25	3	16	9	35	27	69	119	113	119	250	
Min	108	104	98	95	115	24	34	42	12	18	0	0	0	0	0	0	0	0	0	0	75	65	82	130	

Table 4. The Data of Rainfall from Grogol Station (Semimonthly) (2007-2016 mm)

Tahun	Januari		Pebruari		Maret		April		Mei		Juni		Juli		Agustus		September		Oktober		Nopember		Desember		Tahunan
	Jan-1	Jan-2	Peb-1	Peb-2	Mar-1	Mar-2	Apr-1	Apr-2	Mei-1	Mei-2	Jun-1	Jun-2	Jul-1	Jul-2	Ags-1	Ags-2	Sep-1	Sep-2	Okt-1	Okt-2	Nop-1	Nop-2	Des-1	Des-2	
2007	104	146	188	147	159	137	76	118	67	65	90	11	7	51	0	0	0	0	27	50	96	92	116	338	1935
2008	113	249	89	102	137	55	34	70	18	2	12	20	0	0	2	39	10	20	164	49	78	112	142	164	1471
2009	151	279	274	251	107	114	53	76	95	56	13	5	0	0	0	0	0	0	74	7	87	176	102	168	1943
2010	255	214	111	325	91	421	63	182	97	59	382	219	66	45	12	55	28	125	205	99	69	99	169	228	3619
2011	96	114	312	238	150	216	146	34	80	90	13	7	19	7	0	0	0	0	0	175	220	81	144	345	2425
2012	241	214	282	99	201	130	88	35	27	38	35	0	0	1	0	0	0	0	20	9	96	153	95	362	2071
2013	298	255	94	82	148	91	146	53	5	64	164	27	142	58	0	52	30	5	5	84	74	90	179	170	2208
2014	105	122	141	367	131	84	176	77	66	155	37	78	97	50	2	0	0	0	0	6	81	119	87	207	2166
2015	287	233	253	254	326	120	52	358	76	54	33	0	0	0	0	0	0	0	0	0	84	142	204	268	2685
2016	92	128	312	238	176	22	146	34	67	116	26	99	35	63	10	10	35	210	88	75	92	152	311	175	2675
Max	298	279	312	367	326	421	176	358	97	155	382	219	142	63	12	55	35	210	205	175	220	176	311	362	
Rerata	174	195	206	210	163	139	98	104	60	70	81	47	37	28	3	16	10	36	58	55	98	122	155	243	
Min	92	114	89	82	91	22	34	34	5	2	12	0	0	0	0	0	0	0	0	0	69	81	87	164	

Table 5. The Data of Rainfall from Traju Station (Semimonthly) (2007-2016 mm)

Tahun	Januari		Pebruari		Maret		April		Mei		Juni		Juli		Agustus		September		Oktober		Nopember		Desember		Tahunan
	Jan-1	Jan-2	Peb-1	Peb-2	Mar-1	Mar-2	Apr-1	Apr-2	Mei-1	Mei-2	Jun-1	Jun-2	Jul-1	Jul-2	Ags-1	Ags-2	Sep-1	Sep-2	Okt-1	Okt-2	Nop-1	Nop-2	Des-1	Des-2	
2007	224	166	421	265	115	146	163	215	113	143	189	0	49	37	0	0	0	0	36	44	148	127	97	293	2746
2008	146	231	256	284	108	56	64	88	6	12	0	5	0	0	0	22	7	0	67	15	85	81	156	103	713
2009	133	211	338	177	132	63	99	13	62	3	19	0	0	0	0	0	0	0	23	0	78	72	148	391	1614
2010	159	355	320	355	188	202	56	265	363	117	254	45	84	96	7	140	267	161	181	156	82	165	223	262	4503
2011	222	139	376	319	98	225	47	27	156	18	21	5	26	67	0	0	2	0	0	234	113	72	150	185	2590
2012	198	217	145	284	183	100	139	44	34	29	2	0	0	0	0	0	0	0	0	139	79	91	104	149	1681
2013	219	326	181	234	156	164	257	220	41	140	181	51	326	64	0	68	25	36	0	0	95	89	238	136	2880
2014	262	167	256	238	76	148	282	159	185	129	167	235	38	83	74	0	0	0	0	23	92	106	134	145	2918
2015	210	373	364	144	106	140	191	313	86	30	59	0	0	1	1	0	0	0	0	15	162	91	207	256	2935
2016	232	254	376	319	112	151	47	62	96	114	123	32	32	68	40	49	77	260	129	61	295	156	226	253	3676
Max	262	373	421	355	188	225	282	313	363	143	254	235	326	96	74	140	267	260	181	234	295	165	238	391	
Rerata	201	244	303	262	127	140	135	141	114	74	102	37	56	42	12	28	38	46	44	69	123	105	168	217	
Min	133	139	145	144	76	56	47	13	6	3	0	0	0	0	0	0	0	0	0	0	78	72	97	103	

Table 5. The Data of Rainfall from Pesayangan Station (Semimonthly) (2007-2016 mm)

Tahun	Januari		Pebruari		Maret		April		Mei		Juni		Juli		Agustus		September		Oktober		Nopember		Desember		Tahunan
	Jan-1	Jan-2	Peb-1	Peb-2	Mar-1	Mar-2	Apr-1	Apr-2	Mei-1	Mei-2	Jun-1	Jun-2	Jul-1	Jul-2	Ags-1	Ags-2	Sep-1	Sep-2	Okt-1	Okt-2	Nop-1	Nop-2	Des-1	Des-2	
2007	201	242	378	326	287	308	210	179	233	110	283	74	0	0	0	0	0	0	52	18	175	183	225	420	3643
2008	372	429	229	429	105	115	286	104	7	3	117	107	92	0	0	19	0	0	89	45	94	152	139	321	3254
2009	118	336	304	223	129	70	18	33	155	152	113	2	0	0	0	7	0	9	8	15	88	79	132	187	1430
2010	114	192	304	222	65	240	68	130	90	69	105	72	74	82	26	196	29	56	100	85	102	85	106	137	2468
2011	198	192	275	167	94	100	72	10	95	66	11	11	16	31	0	0	0	0	0	89	76	71	98	269	1596
2012	154	151	178	273	178	66	132	53	15	23	63	0	0	1	0	0	0	0	3	11	93	92	87	225	1404
2013	233	189	278	273	230	64	143	65	79	171	121	67	60	28	0	10	0	0	0	2	98	100	185	148	1935
2014	161	152	114	127	84	59	128	6	24	150	1	57	88	7	5	0	0	0	0	13	75	78	86	161	1542
2015	242	268	186	123	128	101	37	215	55	10	0	3	0	8	8	0	0	0	0	0	85	96	172	132	1699
2016	125	201	275	167	135	30	72	10	14	62	5	53	60	22	7	28	35	150	90	101	65	78	265	160	2126
Max	372	429	378	429	287	308	286	215	233	171	283	107	92	82	26	196	35	150	100	101	175	183	265	420	
Rerata	192	235	252	233	144	115	117	81	77	82	82	45	39	18	5	26	6	22	34	38	95	101	150	216	
Min	114	151	114	123	65	30	18	6	7	3	0	0	0	0	0	0	0	0	0	0	65	71	86	132	

8.3 POTENTIAL ANALYSIS OF WATER

Analysis of water potential there are two that is rain falling into rain gauge or also called rainfall and rain falling directly into the fields. To calculate water potential from rainfall data that is with half monthly rainfall multiplied by DTA area of each station. Then from the multiplication every five stations are added from januari to december in one year while to calculate the rain directly to the rice field that is with the rainfall data of pesayangan station multiplied by the width of rice field contained in Pesayangan is 12504 Ha. From both the data is cumulative by means of the amount added one by one, then made the graph.

8.3.1 Mainstay Debit

Table 6. Potential Calculations from Kemaron Station (wide : 237,5 km^2) (for example)

Tahun	Januari		Pebruari		Maret		April		Mei		Juni	
	Jan-1	Jan-2	Peb-1	Peb-2	Mar-1	Mar-2	Apr-1	Apr-2	Mei-1	Mei-2	Jun-1	Jun-2
2007	25,650,000	42,275,000	108,775,000	38,712,500	37,762,500	70,775,000	62,225,000	61,037,500	39,425,000	19,712,500	20,900,000	4,275,000
2008	59,137,500	21,375,000	113,287,500	37,287,500	80,512,500	44,650,000	14,962,500	16,387,500	5,462,500	1,900,000	2,375,000	712,500
2009	24,700,000	37,287,500	44,887,500	34,437,500	-	-	-	-	-	-	-	-
2010	106,400,000	118,750,000	101,650,000	63,887,500	68,637,500	53,675,000	22,800,000	57,237,500	71,487,500	29,687,500	46,312,500	19,237,500
2011	87,400,000	126,350,000	45,837,500	75,050,000	46,312,500	55,337,500	26,837,500	69,350,000	42,750,000	52,012,500	-	3,325,000
2012	81,700,000	75,287,500	35,150,000	130,862,500	123,500,000	23,750,000	90,250,000	57,475,000	38,000,000	23,750,000	2,375,000	950,000
2013	113,287,500	128,487,500	64,837,500	51,062,500	23,512,500	70,537,500	87,875,000	90,725,000	40,612,500	34,912,500	39,425,000	19,712,500
2014	22,087,500	149,862,500	103,787,500	52,250,000	28,737,500	58,900,000	65,075,000	57,237,500	33,487,500	55,337,500	9,975,000	44,175,000
2015	27,312,500	41,325,000	66,500,000	21,137,500	66,025,000	16,387,500	30,162,500	34,200,000	10,925,000	2,612,500	7,837,500	-
2016	21,137,500	49,400,000	45,837,500	75,050,000	60,562,500	28,975,000	26,837,500	69,350,000	31,350,000	43,937,500	33,725,000	36,812,500
Tahun	Juli		Agustus		September		Oktober		Nopember		Desember	
	Jul-1	Jul-2	Ags-1	Ags-2	Sep-1	Sep-2	Okt-1	Okt-2	Nop-1	Nop-2	Des-1	Des-2
2007	237,500	4,750,000	-	1,662,500	712,500	-	2,612,500	5,462,500	30,162,500	30,637,500	36,100,000	65,075,000
2008	-	-	237,500	2,375,000	2,375,000	-	42,037,500	43,225,000	96,187,500	42,750,000	42,037,500	55,812,500
2009	-	-	-	-	-	-	-	-	21,137,500	37,050,000	24,225,000	81,462,500
2010	19,712,500	29,450,000	31,825,000	58,900,000	63,412,500	47,975,000	49,637,500	87,637,500	40,137,500	34,437,500	107,112,500	109,250,000
2011	1,187,500	5,462,500	-	-	-	-	8,312,500	30,875,000	101,887,500	115,187,500	63,175,000	59,612,500
2012	-	1,662,500	-	-	-	-	1,900,000	37,050,000	45,600,000	75,525,000	75,287,500	50,112,500
2013	44,887,500	23,987,500	-	13,062,500	15,912,500	6,412,500	-	-	21,375,000	29,687,500	69,350,000	47,025,000
2014	16,150,000	14,012,500	30,637,500	2,612,500	-	-	-	16,150,000	23,512,500	38,712,500	46,550,000	41,562,500
2015	-	-	-	1,187,500	-	-	1,187,500	2,375,000	25,175,000	33,487,500	68,637,500	36,812,500
2016	11,875,000	39,900,000	11,162,500	3,800,000	56,287,500	91,437,500	18,525,000	15,200,000	42,275,000	51,775,000	42,750,000	21,375,000

Table 7. Potential of Calculations Table of Kaligung Watershed

Tahun	Januari		Pebruari		Maret		April		Mei		Juni	
	Jan-1	Jan-2	Peb-1	Peb-2	Mar-1	Mar-2	Apr-1	Apr-2	Mei-1	Mei-2	Jun-1	Jun-2
2007	104,613,750	115,781,250	233,362,500	137,718,750	110,209,375	145,718,750	113,512,500	143,965,625	84,240,625	62,993,750	81,328,125	3,925,000
2008	129,368,750	151,050,000	187,993,750	125,684,375	147,521,875	75,940,625	47,556,250	59,650,000	16,484,375	7,696,875	11,153,125	24,715,625
2009	101,368,750	167,310,938	190,993,750	170,734,375	63,596,875	52,700,000	38,993,750	34,484,375	48,590,625	21,706,250	7,703,125	837,500
2010	231,731,250	256,031,250	214,367,188	234,018,750	158,871,875	232,406,250	49,131,250	159,387,500	154,456,250	36,590,625	173,103,125	73,075,000
2011	165,177,813	207,549,938	222,646,875	231,265,625	144,756,250	179,018,750	106,931,250	88,687,500	108,146,875	95,156,250	8,921,875	6,446,875
2012	230,436,250	204,780,938	161,698,750	225,251,875	327,368,750	84,968,750	168,031,250	88,271,875	55,178,125	47,315,625	18,378,125	950,000
2013	244,446,875	255,534,375	139,572,188	122,420,625	100,356,250	129,968,750	183,078,125	138,634,375	51,546,875	33,184,375	121,534,375	40,159,375
2014	104,821,875	227,631,250	189,400,000	217,290,625	141,868,750	116,696,875	181,850,000	104,756,250	82,781,250	122,168,750	47,690,625	106,021,875
2015	183,450,000	182,462,500	211,100,000	106,559,375	203,112,500	78,453,125	72,896,875	210,365,625	57,108,125	22,904,688	27,962,500	84,375
2016	92,853,125	138,353,125	222,646,875	231,265,625	136,521,875	58,175,000	106,931,250	93,281,250	66,500,000	98,743,750	60,021,875	79,009,375
Tahun	Juli		Agustus		September		Oktober		Nopember		Desember	
	Jul-1	Jul-2	Ags-1	Ags-2	Sep-1	Sep-2	Okt-1	Okt-2	Nop-1	Nop-2	Des-1	Des-2
2007	7,762,500	24,800,000	-	1,662,500	712,500	-	14,081,250	30,818,750	92,459,375	81,703,125	93,471,875	226,806,250
2008	2,587,500	-	1,187,500	20,815,625	6,556,250	7,375,000	90,221,875	82,378,125	140,875,000	88,968,750	106,492,188	147,334,375
2009	-	-	-	196,875	-	253,125	16,931,250	1,515,625	82,736,458	113,409,375	89,650,000	191,915,625
2010	55,881,250	67,325,000	38,750,000	110,718,750	107,896,875	118,900,000	136,712,500	156,146,875	110,662,500	90,740,625	188,718,750	271,303,125
2011	11,843,750	17,071,875	-	-	262,500	-	8,312,500	127,771,875	195,306,250	183,490,625	126,181,250	208,039,063
2012	-	1,846,875	-	-	-	-	5,109,375	61,896,875	91,275,000	134,362,500	123,653,125	202,684,375
2013	137,687,500	54,137,500	-	35,068,750	27,706,250	12,981,250	781,250	13,181,250	64,100,000	77,156,250	153,946,875	145,537,500
2014	64,268,750	39,290,625	40,803,125	2,612,500	-	-	-	20,471,875	70,328,125	97,425,000	99,912,500	146,128,125
2015	-	356,250	356,250	1,187,500	-	-	1,187,500	4,343,750	78,901,042	93,906,250	184,368,750	159,562,500
2016	31,093,750	69,487,500	21,146,875	14,493,750	83,046,875	203,818,750	65,762,500	73,040,625	115,046,875	124,331,250	166,284,375	123,825,000

Table 8. Potential of Calculation Table of Rice Field (12504 Ha)

Tahun	Januari		Pebruari		Maret		April		Mei		Juni	
	Jan-1	Jan-2	Peb-1	Peb-2	Mar-1	Mar-2	Apr-1	Apr-2	Mei-1	Mei-2	Jun-1	Jun-2
2007	25,174,720	30,259,680	47,265,120	40,763,040	35,886,480	38,512,320	26,258,400	22,382,160	29,134,320	13,754,400	35,386,320	9,252,960
2008	46,514,880	53,642,160	28,634,160	53,642,160	13,129,200	14,379,600	35,761,440	13,004,160	875,280	375,120	14,629,680	13,379,280
2009	14,754,720	41,950,920	37,949,640	27,883,920	16,130,160	8,752,800	2,250,720	4,126,320	19,381,200	19,006,080	14,129,520	250,080
2010	14,254,560	24,007,680	37,949,640	27,758,880	8,127,600	30,009,600	8,502,720	16,255,200	11,253,600	8,627,760	13,129,200	9,002,880
2011	24,707,904	24,035,189	34,386,000	20,881,680	11,753,760	12,504,000	9,002,880	1,250,400	11,878,800	8,252,640	1,375,440	1,375,440
2012	19,306,176	18,893,544	22,307,136	34,185,936	22,257,120	8,252,640	16,505,280	6,627,120	1,875,600	2,875,920	7,877,520	-
2013	29,134,320	23,632,560	34,748,616	34,185,936	28,759,200	8,002,560	17,880,720	8,127,600	9,878,160	21,381,840	15,129,840	8,377,680
2014	20,131,440	19,006,080	14,254,560	15,880,080	10,503,360	7,377,360	16,005,120	750,240	3,000,960	18,756,000	125,040	7,127,280
2015	30,259,680	33,510,720	23,257,440	15,379,920	16,005,120	12,629,040	4,626,480	26,883,600	6,927,216	1,187,880	-	375,120
2016	15,630,000	25,133,040	34,386,000	20,881,680	16,880,400	3,751,200	9,002,880	1,250,400	1,750,560	7,752,480	625,200	6,627,120
Tahun	Juli		Agustus		September		Oktober		Nopember		Desember	
	Jul-1	Jul-2	Ags-1	Ags-2	Sep-1	Sep-2	Okt-1	Okt-2	Nop-1	Nop-2	Des-1	Des-2
2007	-	-	-	-	-	-	6,502,080	2,250,720	21,882,000	22,882,320	28,134,000	52,516,800
2008	11,503,680	-	-	2,375,760	-	-	11,128,560	5,626,800	11,753,760	19,006,080	17,380,560	40,137,840
2009	-	-	-	875,280	-	1,125,360	1,000,320	1,875,600	11,003,520	9,878,160	16,505,280	23,382,480
2010	9,252,960	10,253,280	3,251,040	24,507,840	3,626,160	7,002,240	12,504,000	10,628,400	12,754,080	10,628,400	13,254,240	17,130,480
2011	2,000,640	3,876,240	-	-	-	-	-	11,128,560	9,503,040	8,877,840	12,253,920	33,573,240
2012	-	125,040	-	-	-	-	375,120	1,375,440	11,628,720	11,503,680	10,878,480	28,134,000
2013	7,502,400	3,501,120	-	1,250,400	-	-	-	250,080	12,253,920	12,504,000	23,132,400	18,505,920
2014	11,003,520	875,280	625,200	-	-	-	-	1,625,520	9,378,000	9,753,120	10,753,440	20,131,440
2015	-	1,000,320	1,000,320	-	-	-	-	-	10,628,400	12,003,840	21,506,880	16,505,280
2016	7,502,400	2,750,880	875,280	3,501,120	4,376,400	18,756,000	11,253,600	12,629,040	8,127,600	9,753,120	33,135,600	20,006,400

Table 10. Potential of Calculation Table of Watershed and Irrigation Area

Tahun	Januari		Pebruari		Maret		April		Mei			
	Jan-1	Jan-2	Peb-1	Peb-2	Mar-1	Mar-2	Apr-1	Apr-2	Mei-1	Mei-2	Jun-1	Jun-2
2007	129,788,470	146,040,930	280,627,620	178,481,790	146,095,855	184,231,070	139,770,900	166,347,785	113,374,945	76,748,150	116,714,445	18,177,960
2008	175,883,630	204,692,160	216,627,910	179,326,535	160,651,075	90,320,225	83,317,690	72,654,160	17,359,655	8,071,995	25,782,805	38,094,905
2009	116,123,470	209,261,858	228,943,390	198,618,295	79,727,035	61,452,800	41,244,470	38,610,695	67,971,825	40,712,330	21,832,645	1,087,580
2010	245,985,810	280,038,930	252,316,828	261,777,630	166,999,475	262,415,850	57,633,970	175,642,700	165,709,850	95,218,385	186,232,325	82,077,880
2011	189,885,717	231,585,126	257,032,875	252,147,305	156,510,010	191,522,750	115,934,130	89,937,900	120,025,675	103,408,890	10,297,315	7,822,315
2012	249,742,426	223,674,482	184,005,886	259,437,811	349,625,870	93,221,390	184,536,530	94,898,995	57,053,725	50,191,545	26,255,645	950,000
2013	273,581,195	279,166,935	174,320,804	156,606,561	129,115,450	137,971,310	200,958,845	146,761,975	61,425,035	104,566,215	136,664,215	48,537,055
2014	124,953,315	246,637,330	203,654,560	233,170,705	152,372,110	124,074,235	197,855,120	105,506,490	85,782,210	140,924,750	47,815,665	113,149,155
2015	213,709,680	215,973,220	234,357,440	121,939,295	219,117,620	91,082,165	77,523,355	237,249,225	64,035,341	24,092,568	27,962,500	459,495
2016	108,483,125	163,486,165	257,032,875	252,147,305	153,402,275	61,926,200	115,934,130	94,531,650	68,250,560	106,496,230	60,647,075	85,636,495
Tahun	Juli		Agustus		September		Oktober		Nopember		Desember	
	Jul-1	Jul-2	Ags-1	Ags-2	Sep-1	Sep-2	Okt-1	Okt-2	Nop-1	Nop-2	Des-1	Des-2
2007	7,762,500	24,800,000	-	1,662,500	712,500	-	20,583,330	33,069,470	114,341,375	104,585,445	121,605,875	279,323,050
2008	14,091,180	-	1,187,500	23,191,385	6,556,250	7,375,000	101,350,435	88,004,925	152,628,760	107,974,830	123,872,748	187,472,215
2009	-	-	-	1,072,155	-	1,378,485	17,931,570	3,391,225	93,739,978	123,287,535	106,155,280	215,298,105
2010	65,134,210	77,578,280	42,001,040	135,226,590	111,523,035	125,902,240	149,216,500	166,775,275	123,416,580	101,369,025	201,972,990	288,433,605
2011	13,844,390	20,948,115	-	-	262,500	-	8,312,500	138,900,435	204,809,290	192,368,465	138,435,170	241,612,303
2012	-	1,971,915	-	-	-	-	5,484,495	63,272,315	102,903,720	145,866,180	134,531,605	230,818,375
2013	145,189,900	57,638,620	-	36,319,150	27,706,250	12,981,250	781,250	13,431,330	76,353,920	89,660,250	177,079,275	164,043,420
2014	75,272,270	40,165,905	41,428,325	2,612,500	-	-	-	22,097,395	79,706,125	107,178,120	110,665,940	166,259,565
2015	-	1,356,570	1,356,570	1,187,500	-	-	1,187,500	4,343,750	89,529,442	105,910,090	205,875,630	176,067,780
2016	38,596,150	72,238,380	22,022,155	17,994,870	87,423,275	222,574,750	77,016,100	85,669,665	123,174,475	134,084,370	199,419,975	143,831,400

Table 11. The Data of Debit Mainstay

No	Ranking	Januari		Pebruari		Maret		April		Mei		Juni	
		Jan-1	Jan-2	Peb-1	Peb-2	Mar-1	Mar-2	Apr-1	Apr-2	Mei-1	Mei-2	Jun-1	Jun-2
1	I	273,581,195	280,038,930	280,627,620	261,777,630	349,625,870	262,415,850	200,958,845	237,249,225	165,709,850	140,924,750	186,232,325	113,149,155
2	II	249,742,426	279,166,935	257,032,875	259,437,811	219,117,620	191,522,750	197,855,120	175,642,700	120,025,675	106,496,230	136,664,215	85,636,495
3	III	245,985,810	246,637,330	257,032,875	252,147,305	166,999,475	184,231,070	184,536,530	166,347,785	113,374,945	104,566,215	116,714,445	82,077,880
4	IV	213,709,680	231,585,126	252,316,828	252,147,305	160,651,075	137,971,310	139,770,900	146,761,975	85,782,210	103,408,890	60,647,075	48,537,055
5	V	189,885,717	223,674,482	234,357,440	233,170,705	156,510,010	124,074,235	115,934,130	105,506,490	68,250,560	95,218,385	47,815,665	38,094,905
6	VI	175,883,630	215,973,220	228,943,390	198,618,295	153,402,275	93,221,390	115,934,130	94,898,995	67,971,825	76,748,150	27,962,500	18,177,960
7	VII	129,788,470	209,261,858	216,627,910	179,326,535	152,372,110	91,082,165	83,317,690	94,531,650	64,035,341	50,191,545	26,255,645	7,822,315
8	VIII	124,953,315	204,692,160	203,654,560	178,481,790	146,095,855	90,320,225	77,523,355	89,937,900	61,425,035	40,712,330	25,782,805	1,087,580
9	IX	116,123,470	163,486,165	184,005,886	156,606,561	129,115,450	61,926,200	57,633,970	72,654,160	57,053,725	24,092,568	21,832,645	950,000
10	X	108,483,125	146,040,930	174,320,804	121,939,295	79,727,035	61,452,800	41,244,470	38,610,695	17,359,655	8,071,995	10,297,315	459,495
potensi 20%		141,502,739	172,840,530	195,582,167	149,906,962	133,706,802	101,645,410	69,145,680	78,338,401	47,029,712	34,642,546	45,484,317	22,997,427
No	Ranking	Juli		Agustus		September		Oktober		Nopember		Desember	
		Jul-1	Jul-2	Ags-1	Ags-2	Sep-1	Sep-2	Okt-1	Okt-2	Nop-1	Nop-2	Des-1	Des-2
1	I	145,189,900	77,578,280	42,001,040	135,226,590	111,523,035	222,574,750	149,216,500	166,775,275	204,809,290	192,368,465	205,875,630	288,433,605
2	II	75,272,270	72,238,380	41,428,325	36,319,150	87,423,275	125,902,240	101,350,435	138,900,435	152,628,760	145,866,180	201,972,990	279,323,050
3	III	65,134,210	57,638,620	22,022,155	23,191,385	27,706,250	12,981,250	77,016,100	88,004,925	123,416,580	134,084,370	199,419,975	241,612,303
4	IV	38,596,150	40,165,905	1,356,570	17,994,870	6,556,250	7,375,000	20,583,330	85,669,665	123,174,475	123,287,535	177,079,275	230,818,375
5	V	14,091,180	24,800,000	1,187,500	2,612,500	712,500	1,378,485	17,931,570	63,272,315	114,341,375	107,974,830	138,435,170	215,298,105
6	VI	13,844,390	20,948,115	-	1,662,500	262,500	-	8,312,500	33,069,470	102,903,720	107,178,120	134,531,605	187,472,215
7	VII	7,762,500	1,971,915	-	1,187,500	-	-	5,484,495	22,097,395	93,739,978	105,910,090	123,872,748	176,067,780
8	VIII	-	1,356,570	-	1,072,155	-	-	1,187,500	13,431,330	89,529,442	104,585,445	121,605,875	166,259,565
9	IX	-	-	-	-	-	-	781,250	4,343,750	79,706,125	101,369,025	110,665,940	164,043,420
10	X	-	-	-	-	-	-	-	3,391,225	76,353,920	89,660,250	106,155,280	143,831,400
potensi 20%		29,037,980	15,515,656	8,400,208	27,045,318	22,304,607	44,514,950	29,843,300	36,068,035	102,044,994	110,201,893	126,099,350	172,751,841

8.3.2 Debit Requirement

Initially calculated water requirement for ½ monthly based on planting area by way of planting area multiplied by coefficient of each subsequent cropping type to obtain water requirement at tertiary door that number multiplied by loss factor in tertiary channel that is 1,25. Then to get the number of water requirement on the secondary door, the above calculation results multiplied by the loss factor in the secondary channel is 1.10. Finally to get the number of water requirement on the door the number is multiplied by the loss factor in the primary channel of 1.05.

- Tertiary Water Requirement = CASH x 1.25
- Secondary Water Requirement = CASH x 1.10
- Primary Water Requirement = CASH x 1.05

Table 9. Comparison of Debit Requirement and Potential Debit

M³	MASA TANAM II							
	Maret		April		Mei		Juni	
	I	II	I	II	I	II	I	II
Data Debit Kebutuhan	28,075,481	28,075,481	23,396,234	23,396,234	18,716,988	18,716,988	11,698,117	11,698,117
Data Debit Potensi	133,706,802	101,645,410	69,145,680	78,338,401	47,029,712	34,642,546	45,484,317	22,997,427

M³	MASA TANAM I							
	November		Desember		Januari		Februari	
		II	I	II	I	II	I	II
Data Debit Kebutuhan	28,075,481	28,075,481	23,396,234	23,396,234	18,716,988	18,716,988	11,698,117	11,698,117
Data Debit Potensi	102,044,994	110,201,893	126,099,350	172,751,841	141,502,739	172,840,530	195,582,167	149,906,962

M³	MASA TANAM III							
	Juli		Agustus		September		Oktober	
	I	II	I	II	I	II	I	II
Data Debit Kebutuhan	19,653,286	19,653,286	16,377,738	16,377,738	13,102,191	13,102,191	8,188,869	8,188,869
Data Debit Potensi	29,037,980	15,515,656	8,400,208	27,045,318	22,304,607	44,514,950	29,843,300	36,068,035

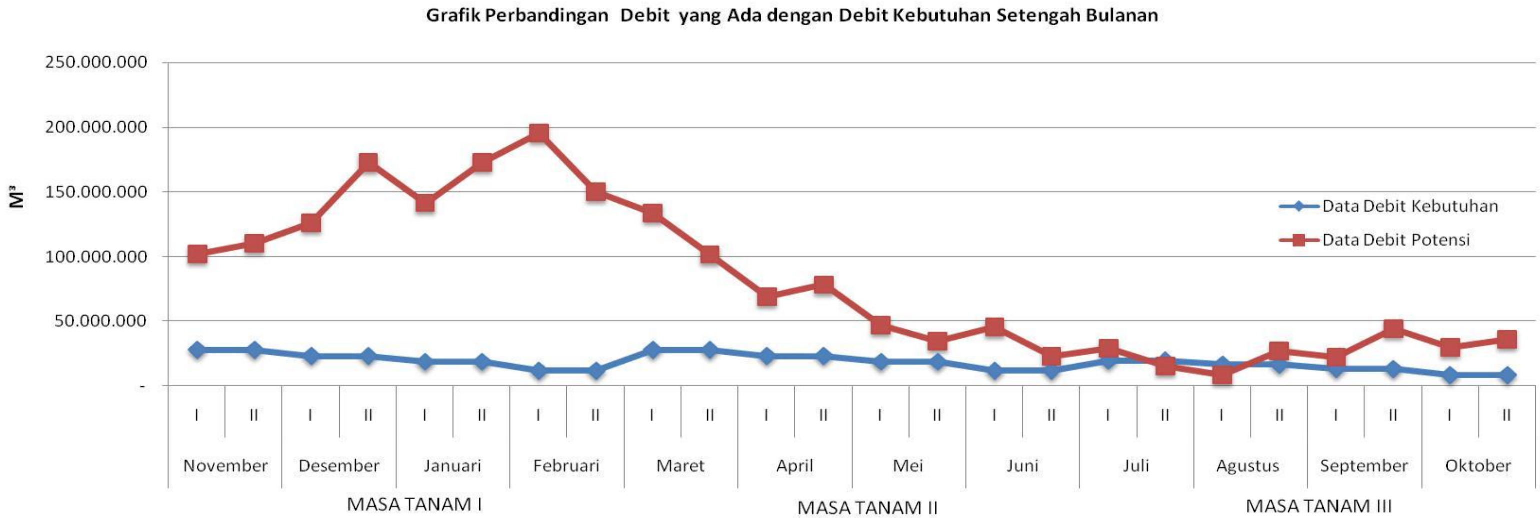

Figure 4. Comparison Chart Between Available Discharge with Half-monthly Requirement Discharge

8.4 ANALYSIS OF HYDROLOGY AND RAINFALL

In Rainfall Analysis which will be used is Gumbel Method, and Weduwen Method.

8.4.1 Gumbel Method Analysis

Table 10. Resume of Rainfall Rise Calculation Result (R) Gumbel Method

Periode Ulang	Stasiun					Rata-rata
	Kemaron	Lebaksiu	Grogol	Traju	Pesayangan	
R2	107	102	116	114	111	107
R5	135	123	154	154	147	135
R10	154	138	179	180	171	154
R25	178	155	210	213	202	178
R50	196	168	234	237	224	196
R100	214	181	257	261	246	214
Rata-rata						164

From the resume, in the average price of max rainfall from the five stations in use Thiesen method to get the rainfall region in each station on each specific repeat period. With an area of A = 765,625 km^2.

8.5 FLOOD DEBIT ANALYSIS PLAN

The design debit analysis should use the discharge data from the relevant river but since there is no debit data available, then to analyze the discharge plan will use rainfall data. Flood discharge planning analysis using Weduwen method analysis and HSS Nakayasu method. While the analysis of hourly rainfall using Monobe method.

8.5.1 Rain-Time Distribution According to Monobe

Table 11. Effective Hourly Rainfall

T (jam)	Distribusi Curah Hujan (%)	Hujan Efektif Dengan Kala Ulang (mm)					
		2	5	10	25	50	100
		107.000	135.000	154.000	178.000	196.000	214.000
1	55.032	58.88	74.29	84.75	97.96	107.86	117.77
2	14.304	15.31	19.31	22.03	25.46	28.04	30.61
3	10.034	10.74	13.55	15.45	17.86	19.67	21.47
4	7.988	8.55	10.78	12.30	14.22	15.66	17.09
5	6.746	7.22	9.11	10.39	12.01	13.22	14.44
6	5.8964	6.31	7.96	9.08	10.50	11.56	12.62

8.5.2 Metode Der Weduwen

Be discovered :

I	=	0,002
A	=	765,625
tr	=	27
β	=	0,81
q	=	2,4
α	=	0.54
TR	=	27
R2	=	107
R5	=	135
R10	=	154
R25	=	178
R50	=	196
R100	=	214

Completion :

Q	=	$\frac{\alpha \cdot \beta \cdot q \cdot A \cdot R}{240}$
Q2	=	$\frac{\alpha . \beta . q . A . R}{240} = \frac{0,54 x 0,81 x 2,4 x 765 x 107}{240} = 358$
Q5	=	$\frac{\alpha . \beta . q . A . R}{240} = \frac{0,54 x 0,81 x 2,4 x 765 x 135}{240} = 452$
Q10	=	$\frac{\alpha . \beta . q . A . R}{240} = \frac{0,54 x 0,81 x 2,4 x 765 x 154}{240} = 515$
Q25	=	$\frac{\alpha . \beta . q . A . R}{240} = \frac{0,54 x 0,81 x 2,4 x 765 x 178}{240} = 596$
Q50	=	$\frac{\alpha . \beta . q . A . R}{240} = \frac{0,54 x 0,81 x 2,4 x 765 x 196}{240} = 656$
Q100	=	$\frac{\alpha . \beta . q . A . R}{240} = \frac{0,54 x 0,81 x 2,4 x 765 x 214}{240} = 716$

Table 12. Flood Discharge Plan by Weduwen Method

Years	T (hour)	B	q (m3/sec/km2)	α	Qn (m3/sec)
2	**27**	**0,81**	**2,4**	**0,54**	**358**
5	**27**	**0,81**	**2,4**	**0,54**	**452**
10	**27**	**0,81**	**2,4**	**0,54**	**515**
25	**27**	**0,81**	**2,4**	**0,54**	**596**
50	**27**	**0,81**	**2,4**	**0,54**	**656**
100	**27**	**0,81**	**2,4**	**0,54**	**716**

8.5.3 Flood Debit Plan (HSS Nakayasu)

To get the flood discharge plan, then the up and down hydrograph arch is done in Table 4. The following:

Watershed area (A) = 765 km2 (Result of calculation).

Rever Length (L) 55.58 km (Results from BBWS map)

Table 13. Resume Debit Flood Hydrograf Nakayasu Plan

t	Qt	Q2	Q5	Q10	Q25	Q50	Q100
jam	m^3/det	m3/det	m3/det	m3/det	m3/det	m3/det	m3/det
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0203	1.1946	1.5073	1.7194	1.9873	2.1883	2.3893
2	0.1071	7.9442	10.0231	11.4337	13.2156	14.5520	15.8884
3	0.2834	24.0640	30.3611	34.6341	40.0317	44.0798	48.1279
4	0.5652	52.8283	66.6525	76.0332	87.8826	96.7696	105.6566
5	0.9655	97.2196	122.6603	139.9236	161.7298	178.0845	194.4392
5.07	1.0000	107.0001	135.0001	154.0001	178.0002	196.0002	214.0002
6	0.9273	99.2201	125.1843	142.8028	165.0578	181.7490	198.4403
7	0.8550	91.4846	115.4245	131.6694	152.1893	167.5792	182.9692
8	0.7883	84.3521	106.4256	121.4040	140.3241	154.5141	168.7042
9	0.7269	77.7757	98.1282	111.9389	129.3839	142.4677	155.5514
10	0.6702	71.7120	90.4778	103.2117	119.2967	131.3604	143.4241
11	0.6180	66.1211	83.4238	95.1650	109.9959	121.1190	132.2422
12	0.5698	60.9661	76.9198	87.7455	101.4202	111.6762	121.9321
13	0.5254	56.2129	70.9229	80.9046	93.5131	102.9695	112.4259
14	0.4844	51.8304	65.3934	74.5970	86.2225	94.9416	103.6607
15	0.4466	47.7895	60.2951	68.7811	79.5003	87.5396	95.5790
16	0.4118	44.0636	55.5943	63.4187	73.3021	80.7147	88.1273
17	0.3797	40.6283	51.2600	58.4743	67.5872	74.4219	81.2566
18	0.3501	37.4607	47.2636	53.9155	62.3179	68.6197	74.9215
19	0.3228	34.5402	43.5787	49.7120	57.4594	63.2698	69.0803
19.905	0.2999	32.0938	40.4922	46.1911	53.3897	58.7887	64.1877
20	0.2976	31.8473	40.1812	45.8363	52.9796	58.3371	63.6946
21	0.2744	29.3644	37.0485	42.2627	48.8491	53.7889	58.7287
22	0.2530	27.0750	34.1601	38.9678	45.0407	49.5953	54.1500
23	0.2333	24.9641	31.4968	35.9297	41.5291	45.7287	49.9283
24	0.2151	23.0179	29.0412	33.1285	38.2914	42.1635	46.0357
25	0.1983	21.2233	26.7771	30.5457	35.3060	38.8763	42.4466
26	0.1829	19.5686	24.6894	28.1642	32.5535	35.8454	39.1373
27	0.1686	18.0430	22.7645	25.9684	30.0155	33.0507	36.0860
27.622	0.1603	17.1547	21.6437	24.6899	28.5377	31.4235	34.3093
28	0.1555	16.6363	20.9897	23.9438	27.6754	30.4740	33.2726
29	0.1434	15.3393	19.3533	22.0771	25.5177	28.0981	30.6786
30	0.1322	14.1434	17.8444	20.3559	23.5282	25.9075	28.2868
31	0.1219	13.0407	16.4532	18.7689	21.6939	23.8876	26.0814
32	0.1124	12.0240	15.1705	17.3056	20.0026	22.0253	24.0480
33	0.1036	11.0866	13.9877	15.9564	18.4431	20.3081	22.1731
34	0.0955	10.2222	12.8972	14.7124	17.0052	18.7248	20.4444
35	0.0881	9.4253	11.8917	13.5653	15.6794	17.2650	18.8505
36	0.0812	8.6904	10.9646	12.5077	14.4570	15.9189	17.3809
37	0.0749	8.0129	10.1097	11.5326	13.3299	14.6778	16.0258
38	0.0690	7.3882	9.3215	10.6335	12.2906	13.5335	14.7764
39	0.0637	6.8122	8.5948	9.8044	11.3324	12.4784	13.6243
40	0.0587	6.2811	7.9247	9.0400	10.4489	11.5055	12.5621
41	0.0541	5.7914	7.3069	8.3352	9.6342	10.6085	11.5827
42	0.0499	5.3399	6.7372	7.6854	8.8831	9.7814	10.6797
42.155	0.0493	5.2731	6.6530	7.5893	8.7721	9.6591	10.5462
43	0.0460	2.2140	2.7934	3.1865	3.6831	4.0556	4.4280
44	0.0424	1.3920	1.7563	2.0035	2.3157	2.5499	2.7841
45	0.0391	0.8635	1.0895	1.2428	1.4365	1.5818	1.7270
46	0.0361	0.4879	0.6156	0.7022	0.8117	0.8937	0.9758
47	0.0333	0.2098	0.2647	0.3020	0.3491	0.3844	0.4196

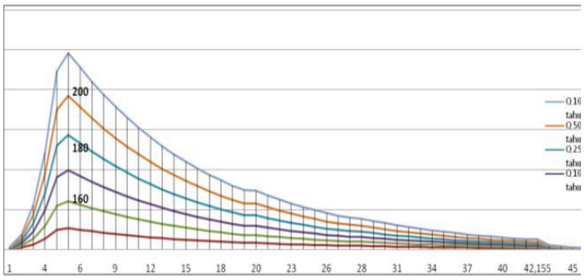

Figure 5. Chart of Nakayasu

9. CONCLUSIONS AND SUGGESTIONS

9.1 CONCLUSIONS

From the analysis of the analysis that has been done can be drawn several conclusions as follows:

1. Kaligung River Basin is 765,625 km^2.
2. From the above comparison results obtained the highest reliable debit occurred in February 195.582.167 m^3 and the lowest potential discharge in August of 8,400.208 m3.
3. The results of detailed rain records in the semi-monthly rainfall of the dry season run between May to October and the rainy season between November and April.
4. Modified cropping pattern for Tegal irrigation area three times
   - For Planting Season I (MT I) the need for water for rice crops with planted area of 12,504 hectares, the mainstay discharge is greater than the demand discharge then irrigation water needs can be fulfilled continuously.
   - For the Planting Season II (MT II) water needs for rice crops with planted area of 12,504 hectares.
   - For the Planting Season III (MT III) the need for water for rice crops with an area of 8.753 hectares of total area of 12,504 hectares due to potential discharge at the end of July until early August is insufficient.
   - The flood discharge calculation with method of the Nakayasu was Q_{25} = 187 m^3/second.

10. SUGGESTIONS

Based on the results of the analysis the author can provide suggestions as follows:

1. The availability of water potential from five rainfall stations should be optimized so that the intensity for maximum cultivation.
2. The result of cropping pattern analysis to be a reference or reference for the service
3. Further research is needed, so that the river hydrological analysis can be utilized more optimally
4. The data obtained should be checked whether it is in accordance with the actual conditions.

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