ISSN: 2223-9553
Volume 1, Issue 2, September 2011

OPTIMIZATION OF ELECTRICAL ENERGY AT BATUTEGI DAM, LAMPUNG PROVINCE OF INDONESIA

Anggara WWS
Department of Water Resources,
Faculty of Engineering,
Brawijaya University, Malang,
INDONESIA

Lily Montarcih
Department of Water Resources,
Faculty of Engineering,
Brawijaya University, Malang,
INDONESIA
lilymont2001@yahoo.com,

ABSTRACT

This paper studied optimization electrical energy. Site of study was at Batutegi Dam, Lampung Province of Indonesia. The methodology consisted of optimization energy using dynamic programming. Mathematically, dynamic programming was used to solve any kinds of non linear constraint and objective function. Results could be used as consideration of operating electrical power in this location.

Keywords: electrical energy, dynamic programming

INTRODUCTION

The issue of water resources estimation and use had long been of particular scientific importance, but now it acquired extremely acute social and political character (Shiklomadov et al., 2011). The issue was especially urgent in the context of considerable economics transformation and changed in river run off. This was due, on the other hand, to the increasing role of anthropogenic factors associated with water consumption by the population, industry, energy, and agriculture, and, on the other hand, to change to global and regional climate. Analysis of changes in the characteristics of water resources and their use with the consideration of possible economic trends in the country and climate conditions was used to forecast water use and water availability.

Droughts influenced the planning and design of water supply infrastructure and inflicted considerable economic and social damage worldwide. Their frequent and irregular occurrence had been a prime reason for the planning and construction of water resources infrastructure intended to increase the reliability of water supply in drought-prone areas. Compounding the task of water planning for drought abatement, present-day climate simulation capabilities did not permit reliable long-range forecasting (Loaiciga, 2005)

Watershed restoration efforts had sought to balance poverty alleviation against conservation, and local governance vs technical expertise. The potential for institutionalized mistakes in water planning by examining common guidelines for watershed managements were released by any government in the world. The daily lives of millions people in the world depended directly on functioning watersheds providing drinking water, irrigation, energy, groundwater recharge, and other usages. Mistakes in watershed prioritization and planning could have serious local ramifications. When such mistakes were institutionalized on a national scale, the results could be tragic (Bhalla et al., 2011).

ISSN: 2223-9553
Volume 1, Issue 2, September 2011

CONTEXT AND REVIEW OF LITERATURE

Hydro electrical power and energy

Generated power of hydro electrical power was analysis using the formula as follow (Arismunandar and Kuwahara, 1991):

$P = 9{,}81 \times Q \times H_{eff} \times Eff$……...…...…….(1)

Note
P = generated power (kW)
H = effective head (m)
H_{eff} = electrical generated discharge (m³/s)

$E = P \times 24 \times n$ ..... (2)

Note
E = energy (lWh)
P = power (kW)
n = number of days in a periode (hour)

Weibull Method (Montarcih, 2010)

$$P(Xm) = \frac{m}{N+1} \quad \text{……..} \quad (3)$$

Note
P(Xm) = probability of design rainfall
N = number of rainfall observed data.
m = rank of accident

Dynamic Programming (Soetopo and Montarcih, 2009)

Elements of dynamic programming was descibed as Figure 2

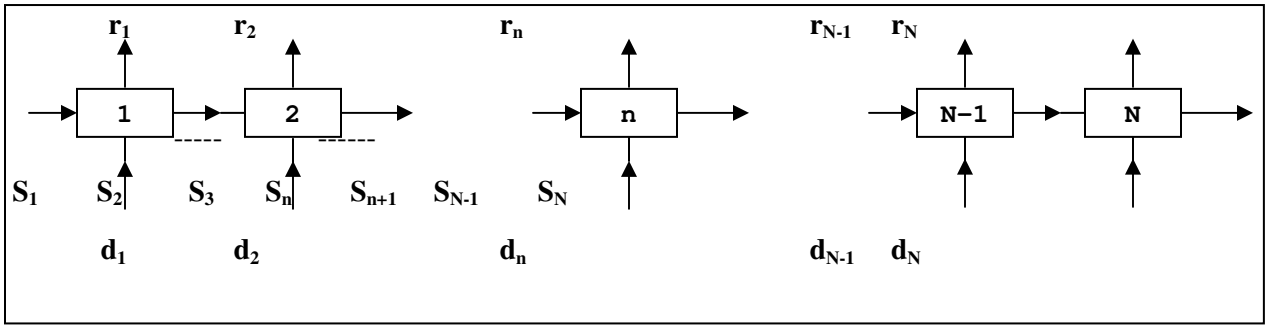

Figure 2 Elements of Dynamic Programming

ISSN: 2223-9553
Volume 1, Issue 2, September 2011

Formulation of forward recursive:

$$f_n^*(S_n) = \text{opt}_{dn}\,[r_n(S_n,d_n)\ O\ f_{n-1}^*(S_{n-1})] \quad \text{.....(4)}$$

Formulation of backward recursive:

$$f_n^*(S_n) = \text{opt}_{dn}\,[r_n(S_n,d_n)\ O\ f_{n+1}^*(S_{n+1})] \quad \text{..... (5)}$$

METHODS

Location of study was at Center Lampung Regency, Lampung Province of Indonesia.. Site of location was as Figure 1. The methodologies were conisted of 1) collection of data (discharge, electrical plant), 2) analysis of dependable discharge; 3) analysis of optimized electrical energy. Technical data of Batutegi Dam Was described as Table 1 below. Initial state of reservoir was as Table 2.

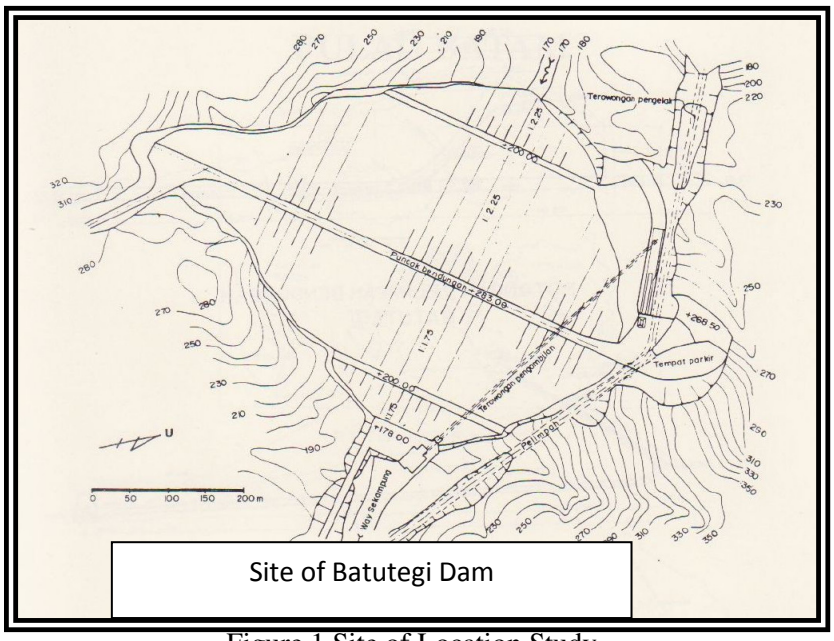

Figure 1 Site of Location Study

Table 1 Technical data of Batutegi Dam

No	Data of Batutegi reservoir	Volume	Unit
1	Area of still water	= 21	Km^2
2	Flood water level	= + 281.5	m
3	Normal water level	= + 274	m
4	The lowest water level	= + 226	m
5	Bruto capacity of reservoir	= 6,900,E+08	m^3
6	Minimum capacity of reservoir	= 9,000,E+07	m^3
7	Effective capacity of reservoir	= 6,000,E+08	m^3
8	Height of dam	= 120	m
9	Capacity of spillway	= 1,93	m^3/s
10	Capacity of turbine	= 29,76	MW
11	Effective head	= 90	m

ISSN: 2223-9553
Volume 1, Issue 2, September 2011

Table 2 Initial state of reseroir

0	(0% of effective reseroir)	90.000.000	m^3
1	(20% of effective reseroir))	192.000.000	m^3
2	(40% of effective reservoir))	294.000.000	m^3
3	(60% of effective reservoir)	396.000.000	m^3
4	(80% of effective reservoir)	498.000.000	m^3
5	(100% of effective reservoir)	600.000.000	m^3

FINDINGS AND DISCUSSIONS

Inflow used in this analysis was dependable discharge. Dependable discharge with 80% of probability was described as Table 3 below.

Table 3 Dependable discharge with 80% of probability

Month	Q (m^3/s)
Jan	7,9925
Feb	12,2995
Mar	15,1035
Apr	12,7735
May	12,97
Jun	6,7205
Jul	4,671
Aug	7,2095
Sep	4,138
Oct	2,9715
Nov	3,757
Dec	5,6575

Stages of dynamic programming in this case were months of the year. The simulation was carried out every month from Januari to December as described as Table 4 to 15 below'

Note for Table 4 to 15:

Tahap = stage
Saktif, Debit PLTA, Efisiensi, Energi = Saktive, hydropower discharge, efficiency, energy
Tamp awal = initial of reservoir, Tamp akhir = end of reservoir
Keputusan = decision
m^3/dt = m^3/s, sumber: perhitungan = source: analysis
Januari = Jan, Februari = Feb, Maret = Mar, April = Aprm Mei = May, Juni = Jun, Juli = Jul, Agustus = Aug, September = Sep, Oktober = Oct, Nopember = Nov, desember = Dec

ISSN: 2223-9553
Volume 1, Issue 2, September 2011

Table 4 Simulation of January

Tahap 1 (Januari) Inflow = 7,99 m^3/dtk

Saktif,Debit PLTA, Efisiensi, Energi																												
Tamp.	Tamp. Awal	Tampungan Akhir																										
Awal	+ inflow	90000000					192000000				294000000				396000000				498000000				600000000					
6,000,E+08	6,214,E+08	5,31,E+08	198,405	0,85	148743,99	4,29E+08	160,322	0,85	120193,6	3,27E+08	122,240	0,85	91643,187	2,25E+08	84,157	0,85	63092,784	1,23E+08	46,075	0,85	34542,38048	2,14E+07	7,993	0,85	5991,9773			
Maksimum					148743,99				120193,6				91643,187				63092,784				34542,38048				5991,9773			
Keputusan					6,00E+08				6,00E+08				6,00E+08				6,00E+08				6,00E+08				6,00E+08			

Sumber: Hasil Perhitungan

Table 5 Simulation of February

Tahap 2 (Februari) Inflow = 12,30 m^3/dtk

Saktif,Debit PLTA, Efisiensi, Energi																												
Tamp.	Tamp. Awal	Tampungan Akhir																										
Awal	+ inflow	90000000					192000000				294000000				396000000				498000000				600000000					
9,000,E+07	1,229,E+08	3,29,E+07	13,617	0,85	158952,88	-6,91E+07	-28,545	0,85	-21400,9	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	148743,99		
1,920,E+08	2,249,E+08	1,35,E+08	55,780	0,85	162011,86	3,29E+07	13,617	0,85	10208,89	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	120193,59		
2,940,E+08	3,269,E+08	2,37,E+08	97,943	0,85	165070,83	1,35E+08	55,780	0,85	41818,27	3,29E+07	13,617	0,85	10208,892	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	91643,19		
3,960,E+08	4,289,E+08	3,39,E+08	140,105	0,85	168129,8	2,37E+08	97,943	0,85	73427,64	1,35E+08	55,780	0,85	41818,267	3,29E+07	13,617	0,85	10208,892	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	63092,78		
4,980,E+08	5,309,E+08	4,41,E+08	182,268	0,85	171188,77	3,39E+08	140,105	0,85	105037	2,37E+08	97,943	0,85	73427,642	1,35E+08	55,780	0,85	41818,267	3,29E+07	13,617	0,85	10208,89249	0,00E+00	0,00	0,85	0	34542,38		
6,000,E+08	6,329,E+08	5,43,E+08	224,431	0,85	174247,74	4,41E+08	182,268	0,85	136646,4	3,39E+08	140,105	0,85	105037,02	2,37E+08	97,943	0,85	73427,642	1,35E+08	55,780	0,85	41818,26749	3,29E+07	13,617	0,85	10208,892	5991,98		
Maksimum					174247,74				136646,4				105037,02				73427,642				41818,26749				10208,892			
Keputusan					6,00E+08				6,00E+08				6,00E+08				6,00E+08				6,00E+08				6,00E+08			

Sumber: Hasil Perhitungan

Table 6 Simulation of March

Tahap 3 (Maret) Inflow = 15,10 m^3/dtk

Saktif,Debit PLTA, Efisiensi, Energi																												
Tamp.	Tamp. Awal	Tampungan Akhir																										
Awal	+ inflow	90000000					192000000				294000000				396000000				498000000				600000000					
9,000,E+07	1,305,E+08	4,05,E+07	15,104	0,85	185570,84	-8,15E+07	-22,974	0,85	-17227	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	174247,74		
1,920,E+08	2,325,E+08	1,42,E+08	53,186	0,85	176519,89	4,05E+07	15,104	0,85	11323,09	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	136646,39		
2,940,E+08	3,345,E+08	2,44,E+08	91,268	0,85	173460,92	1,42E+08	53,186	0,85	39873,5	4,05E+07	15,104	0,85	11323,094	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	105037,02		
3,960,E+08	4,365,E+08	3,46,E+08	129,351	0,85	170401,95	2,44E+08	91,268	0,85	68423,9	1,42E+08	53,186	0,85	39873,497	4,05E+07	15,104	0,85	11323,094	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	73427,64		
4,980,E+08	5,385,E+08	4,48,E+08	167,433	0,85	167342,97	3,46E+08	129,351	0,85	96974,3	2,44E+08	91,268	0,85	68423,9	1,42E+08	53,186	0,85	39873,497	4,05E+07	15,104	0,85	11323,09395	0,00E+00	0,00	0,85	0	41818,27		
6,000,E+08	6,405,E+08	5,50,E+08	205,516	0,85	164284	4,48E+08	167,433	0,85	125524,7	3,46E+08	129,351	0,85	96974,304	2,44E+08	91,268	0,85	68423,9	1,42E+08	53,186	0,85	39873,49718	4,05E+07	15,104	0,85	11323,094	10208,89		
Maksimum					185570,84				125524,7				96974,304				68423,9				39873,49718				11323,094			
Keputusan					9,00E+07				6,00E+08				6,00E+08				6,00E+08				6,00E+08				6,00E+08			

ISSN: 2223-9553
Volume 1, Issue 2, September 2011

Table 7 Simulation of April

Tahap 4 (April) Inflow = 12,77 m^3/dtk

Saktif,Debit PLTA, Efisiensi, Energi																									
Tamp.	Tamp. Awal	Tampungan Akhir																							
Awal	+ inflow	90000000					192000000				294000000				396000000				498000000				600000000				
9,000,E+07	1,231,E+08	3,31,E+07	12,774	0,85	195147,13	9,79E+07	25,574	0,85	19825	0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		185570,84
1,920,E+08	2,251,E+08	1,35,E+08	52,125	0,85	164603,08	3,31E+07	12,774	0,85	9576,293	0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		125524,71
2,940,E+08	3,271,E+08	2,37,E+08	91,477	0,85	165554,76	1,35E+08	52,125	0,85	39078,38	3,31E+07	12,774	0,85	9576,293	0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		98974,30
3,960,E+08	4,291,E+08	3,39,E+08	130,829	0,85	166506,44	2,37E+08	91,477	0,85	68580,46	1,35E+08	52,125	0,85	39078,376	3,31E+07	12,774	0,85	9576,293	0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		68423,90
4,980,E+08	5,311,E+08	4,41,E+08	170,181	0,85	167458,12	3,39E+08	130,829	0,85	98082,54	2,37E+08	91,477	0,85	68580,46	1,35E+08	52,125	0,85	39078,376	3,31E+07	12,774	0,85	9576,29295	0,00E+00	0,00	0,85		39073,50
6,000,E+08	6,331,E+08	5,43,E+08	209,533	0,85	168409,8	4,41E+08	170,181	0,85	127584,6	3,39E+08	130,829	0,85	98082,543	2,37E+08	91,477	0,85	68580,46	1,35E+08	52,125	0,85	39078,37628	3,31E+07	12,774	0,85	9576,293	11323,09
Maksimum					195147,13				127584,6				98082,543				68580,46				39078,37628				9576,293	
Keputusan					9,00E+07				6,00E+08				6,00E+08				6,00E+08				6,00E+08				6,00E+08	

Sumber: Hasil Perhitungan

Table 8 Simulation of May

Tahap 5 (Mei) Inflow = 12,97 m^3/dtk

Saktif,Debit PLTA, Efisiensi, Energi																									
Tamp.	Tamp. Awal	Tampungan Akhir																							
Awal	+ inflow	90000000					192000000				294000000				396000000				498000000				600000000				
9,000,E+07	1,247,E+08	3,47,E+07	12,970	0,85	204870,74	9,79E+07	25,712	0,85	19825	0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		195147,13
1,920,E+08	2,267,E+08	1,37,E+08	51,052	0,85	165858,64	3,47E+07	12,970	0,85	9723,609	0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		127584,63
2,940,E+08	3,287,E+08	2,39,E+08	89,135	0,85	164906,96	1,37E+08	51,052	0,85	38274,01	3,47E+07	12,970	0,85	9723,609	0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		98082,54
3,960,E+08	4,307,E+08	3,41,E+08	127,217	0,85	163955,28	2,39E+08	89,135	0,85	66824,42	1,37E+08	51,052	0,85	38274,012	3,47E+07	12,970	0,85	9723,609	0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		68580,46
4,980,E+08	5,327,E+08	4,43,E+08	165,300	0,85	163003,6	3,41E+08	127,217	0,85	95374,82	2,39E+08	89,135	0,85	66824,415	1,37E+08	51,052	0,85	38274,012	3,47E+07	12,970	0,85	9723,609	0,00E+00	0,00	0,85		39078,38
6,000,E+08	6,347,E+08	5,45,E+08	203,382	0,85	162051,92	4,43E+08	165,300	0,85	123925,2	3,41E+08	127,217	0,85	95374,819	2,39E+08	89,135	0,85	66824,415	1,37E+08	51,052	0,85	38274,01223	3,47E+07	12,970	0,85	9723,609	9576,29
Maksimum					204870,74				123925,2				95374,819				66824,415				38274,01223				9723,609	
Keputusan					9,00E+07				6,00E+08				6,00E+08				6,00E+08				6,00E+08				6,00E+08	

Sumber: Hasil Perhitungan

Table 9 Simulation of June

Tahap 6 (Juni) Inflow = 6,72 m^3/dtk

Saktif,Debit PLTA, Efisiensi, Energi																									
Tamp.	Tamp. Awal	Tampungan Akhir																							
Awal	+ inflow	90000000					192000000				294000000				396000000				498000000				600000000				
9,000,E+07	1,074,E+08	1,74,E+07	6,721	0,85	209909,1	0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		204870,74
1,920,E+08	2,094,E+08	1,19,E+08	46,072	0,85	158465,66	1,74E+07	6,721	0,85	5038,359	0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		123925,22
2,940,E+08	3,114,E+08	2,21,E+08	85,424	0,85	159417,34	1,19E+08	46,072	0,85	34540,44	1,74E+07	6,721	0,85	5038,3589	0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		95374,82
3,960,E+08	4,134,E+08	3,23,E+08	124,776	0,85	160369,02	2,21E+08	85,424	0,85	64042,53	1,19E+08	46,072	0,85	34540,442	1,74E+07	6,721	0,85	5038,3589	0,00E+00	0,00	0,85		0,00E+00	0,00	0,85		66824,42
4,980,E+08	5,154,E+08	4,25,E+08	164,128	0,85	161320,7	3,23E+08	124,776	0,85	93544,61	2,21E+08	85,424	0,85	64042,526	1,19E+08	46,072	0,85	34540,442	1,74E+07	6,721	0,85	5038,35885	0,00E+00	0,00	0,85		38274,01
6,000,E+08	6,174,E+08	5,27,E+08	203,480	0,85	162272,38	4,25E+08	164,128	0,85	123046,7	3,23E+08	124,776	0,85	93544,609	2,21E+08	85,424	0,85	64042,526	1,19E+08	46,072	0,85	34540,44218	1,74E+07	6,721	0,85	5038,3589	9723,61
Maksimum					209909,1				123046,7				93544,609				64042,526				34540,44218				5038,3589	
Keputusan					9,00E+07				6,00E+08				6,00E+08				6,00E+08				6,00E+08				6,00E+08	

Sumber: Hasil Perhitungan

ISSN: 2223-9553
Volume 1, Issue 2, September 2011

Table 10 Simulation of July

Tahap 7 (Juli) Inflow = 4,67 m^3/dtk

Saktif,Debit PLTA, Efisiensi, Energi																									
Tamp.	Tamp. Awal	Tampungan Akhir																							
Awal	+ inflow	90000000					192000000				294000000				396000000				498000000				600000000				
9,00E+07	1,02E+08	1,25E+07	4,671	0,85	213410,95	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	209909,10
1,92E+08	2,04E+08	1,15E+08	42,753	0,85	155098,94	1,25E+07	4,671	0,85	3501,849	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	123046,69
2,94E+08	3,06E+08	2,17E+08	80,836	0,85	154147,26	1,15E+08	42,753	0,85	32052,25	1,25E+07	4,671	0,85	3501,8487	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	93544,61
3,96E+08	4,08E+08	3,19E+08	118,918	0,85	153195,58	2,17E+08	80,836	0,85	60602,66	1,15E+08	42,753	0,85	32052,252	1,25E+07	4,671	0,85	3501,8487	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	64042,53
4,98E+08	5,10E+08	4,21E+08	157,001	0,85	152243,9	3,19E+08	118,918	0,85	89153,06	2,17E+08	80,836	0,85	60602,655	1,15E+08	42,753	0,85	32052,252	1,25E+07	4,671	0,85	3501,8487	0,00E+00	0,00	0,85	0,00	34540,44
6,00E+08	6,12E+08	5,23E+08	195,083	0,85	151292,22	4,21E+08	157,001	0,85	117703,5	3,19E+08	118,918	0,85	89153,058	2,17E+08	80,836	0,85	60602,655	1,15E+08	42,753	0,85	32052,25193	1,25E+07	4,671	0,85	3501,8487	5038,36
Maksimum					213410,95				117703,5				89153,058				60602,655				32052,25193				3501,8487	
Keputusan					9,00E+07				6,00E+08				6,00E+08				6,00E+08				6,00E+08				6,00E+08	

Table 11 Simulation of August

Tahap 8 (Agustus) Inflow = 7,21 m^3/dtk

Saktif,Debit PLTA, Efisiensi, Energi																									
Tamp.	Tamp. Awal	Tampungan Akhir																							
Awal	+ inflow	90000000					192000000				294000000				396000000				498000000				600000000				
9,00E+07	1,09E+08	1,93E+07	7,210	0,85	218815,91	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	213410,95
1,92E+08	2,11E+08	1,21E+08	45,292	0,85	247366,31	1,93E+07	7,210	0,85	5404,962	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	213410,95
2,94E+08	3,13E+08	2,23E+08	83,374	0,85	151658,83	1,21E+08	45,292	0,85	33955,37	1,93E+07	7,210	0,85	5404,9622	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	89153,06
3,96E+08	4,15E+08	3,25E+08	121,457	0,85	151658,83	2,23E+08	83,374	0,85	62505,77	1,21E+08	45,292	0,85	33955,365	1,93E+07	7,210	0,85	5404,9622	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	60602,66
4,98E+08	5,17E+08	4,27E+08	159,539	0,85	151658,83	3,25E+08	121,457	0,85	91056,17	2,23E+08	83,374	0,85	62505,769	1,21E+08	45,292	0,85	33955,365	1,93E+07	7,210	0,85	5404,96215	0,00E+00	0,00	0,85	0,00	32052,25
6,00E+08	6,19E+08	5,29E+08	197,622	0,85	151658,83	4,27E+08	159,539	0,85	119606,6	3,25E+08	121,457	0,85	91056,172	2,23E+08	83,374	0,85	62505,769	1,21E+08	45,292	0,85	33955,36538	1,93E+07	7,209	0,85	5404,9621	3501,85
Maksimum					247366,31				119606,6				91056,172				62505,769				33955,36538				5404,9621	
Keputusan					1,92E+08				6,00E+08				6,00E+08				6,00E+08				6,00E+08				6,00E+08	

Sumber: Hasil Perhitungan

Table 12 Simulation of September

Tahap 9 (September) Inflow = 4,14 m^3/dtk

Saktif,Debit PLTA, Efisiensi, Energi																									
Tamp.	Tamp. Awal	Tampungan Akhir																							
Awal	+ inflow	90000000					192000000				294000000				396000000				498000000				600000000				
9,00E+07	1,01E+08	1,07E+07	4,138	0,85	250468,57	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	247366,31
1,92E+08	2,03E+08	1,13E+08	43,490	0,85	152210,92	1,07E+07	4,138	0,85	3102,259	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	119606,58
2,94E+08	3,04E+08	2,15E+08	82,842	0,85	153162,6	1,13E+08	43,490	0,85	32604,34	1,07E+07	4,138	0,85	3102,2586	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	91056,17
3,96E+08	4,07E+08	3,17E+08	122,194	0,85	154114,28	2,15E+08	82,842	0,85	62106,43	1,13E+08	43,490	0,85	32604,342	1,07E+07	4,138	0,85	3102,2586	0,00E+00	0,00	0,85	0,00	0,00E+00	0,00	0,85	0,00	62505,77
4,98E+08	5,09E+08	4,19E+08	161,545	0,85	155065,96	3,17E+08	122,194	0,85	91608,51	2,15E+08	82,842	0,85	62106,425	1,13E+08	43,490	0,85	32604,342	1,07E+07	4,138	0,85	3102,2586	0,00E+00	0,00	0,85	0,00	33955,37
6,00E+08	6,10E+08	5,21E+08	200,897	0,85	156017,64	4,19E+08	161,545	0,85	121110,6	3,17E+08	122,194	0,85	91608,509	2,15E+08	82,842	0,85	62106,425	1,13E+08	43,490	0,85	32604,34193	1,07E+07	4,138	0,85	3102,2586	5404,96
Maksimum					250468,57				121110,6				91608,509				62106,425				32604,34193				3102,259	
Keputusan					9,00E+07				6,00E+08				6,00E+08				6,00E+08				6,00E+08				6,00E+08	

Sumber: Hasil Perhitungan

ISSN: 2223-9553
Volume 1, Issue 2, September 2011

Table 13 Simulation of October

Tahap 10 (Oktober) Inflow = **2,97** m^3/dtk

Saktif,Debit PLTA, Efisiensi, Energi																											
Tamp.	Tamp. Awal	Tampungan Akhir																									
Awal	+ inflow	90000000					192000000				294000000				396000000				498000000				600000000				
9,000,E+07	9,796,E+07	7,96,E+06	2,972	0,85	252696,31	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	250468,57
1,920,E+08	2,000,E+08	1,10,E+08	41,054	0,85	151888,73	7,96E+06	2,972	0,85	2227,734	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	121110,59
2,940,E+08	3,020,E+08	2,12,E+08	79,136	0,85	150937,05	1,10E+08	41,054	0,85	30778,14	7,96E+06	2,972	0,85	2227,7336	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	91608,51
3,960,E+08	4,040,E+08	3,14,E+08	117,219	0,85	149985,37	2,12E+08	79,136	0,85	59328,54	1,10E+08	41,054	0,85	30778,137	7,96E+06	2,972	0,85	2227,7336	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	62106,43
4,980,E+08	5,060,E+08	4,16,E+08	155,301	0,85	149033,69	3,14E+08	117,219	0,85	87878,94	2,12E+08	79,136	0,85	59328,54	1,10E+08	41,054	0,85	30778,137	7,96E+06	2,972	0,85	2227,73355	0,00E+00	0,00	0,85	0	32604,34
6,000,E+08	6,080,E+08	5,18,E+08	193,384	0,85	148082,01	4,16E+08	155,301	0,85	116429,3	3,14E+08	117,219	0,85	87878,943	2,12E+08	79,136	0,85	59328,54	1,10E+08	41,054	0,85	30778,13678	7,96E+06	2,972	0,85	2227,7336	3102,26
Maksimum					252696,31				116429,3				87878,943				59328,54				30778,13678				2227,734	
Keputusan					9,00E+07				6,00E+08				6,00E+08				6,00E+08				6,00E+08				6,00E+08	

Sumber: Hasil Perhitungan

Table 14 Simulation of November

Tahap 11 (November) Inflow = **3,76** m^3/dtk

Saktif,Debit PLTA, Efisiensi, Energi																											
Tamp.	Tamp. Awal	Tampungan Akhir																									
Awal	+ inflow	90000000					192000000				294000000				396000000				498000000				600000000				
9,000,E+07	9,974,E+07	9,74,E+06	3,757	0,85	255512,93	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	252696,31
1,920,E+08	2,017,E+08	1,12,E+08	43,109	0,85	148748,05	9,74E+06	3,757	0,85	2816,623	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	116429,35
2,940,E+08	3,037,E+08	2,14,E+08	82,461	0,85	149699,73	1,12E+08	43,109	0,85	32318,71	9,74E+06	3,757	0,85	2816,6229	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	87878,94
3,960,E+08	4,057,E+08	3,16,E+08	121,813	0,85	150651,41	2,14E+08	82,461	0,85	61820,79	1,12E+08	43,109	0,85	32318,706	9,74E+06	3,757	0,85	2816,6229	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	59328,54
4,980,E+08	5,077,E+08	4,18,E+08	161,164	0,85	151603,09	3,16E+08	121,813	0,85	91322,87	2,14E+08	82,461	0,85	61820,79	1,12E+08	43,109	0,85	32318,706	9,74E+06	3,757	0,85	2816,6229	0,00E+00	0,00	0,85	0	30778,14
6,000,E+08	6,097,E+08	5,20,E+08	200,516	0,85	152554,77	4,18E+08	161,164	0,85	120625	3,16E+08	121,813	0,85	91322,873	2,14E+08	82,461	0,85	61820,79	1,12E+08	43,109	0,85	32318,70623	9,74E+06	3,757	0,85	2816,6229	2227,73
Maksimum					255512,93				120625				91322,873				61820,79				32318,70623				2816,623	
Keputusan					9,00E+07				6,00E+08				6,00E+08				6,00E+08				6,00E+08				6,00E+08	

Sumber: Hasil Perhitungan

Table 15 Simulation of December

Tahap 12 (Desember) Inflow = **5,66** m^3/dtk

Saktif,Debit PLTA, Efisiensi, Energi																											
Tamp.	Tamp. Awal	Tampungan Akhir																									
Awal	+ inflow	90000000					192000000				294000000				396000000				498000000				600000000				
9,000,E+07	1,052,E+08	1,52,E+07	5,658	0,85	259754,36	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	255512,93
1,920,E+08	2,072,E+08	1,17,E+08	43,740	0,85	153616,79	1,52E+07	5,658	0,85	4241,428	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	120824,95
2,940,E+08	3,092,E+08	2,19,E+08	81,822	0,85	152665,11	1,17E+08	43,740	0,85	32791,83	1,52E+07	5,658	0,85	4241,4278	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	91322,87
3,960,E+08	4,112,E+08	3,21,E+08	119,905	0,85	151713,43	2,19E+08	81,822	0,85	61342,23	1,17E+08	43,740	0,85	32791,831	1,52E+07	5,658	0,85	4241,4278	0,00E+00	0,00	0,85	0	0,00E+00	0,00	0,85	0	61820,79
4,980,E+08	5,132,E+08	4,23,E+08	157,987	0,85	150761,75	3,21E+08	119,905	0,85	89892,64	2,19E+08	81,822	0,85	61342,234	1,17E+08	43,740	0,85	32791,831	1,52E+07	5,658	0,85	4241,42775	0,00E+00	0,00	0,85	0	32318,71
6,000,E+08	6,152,E+08	5,25,E+08	196,070	0,85	149810,07	4,23E+08	157,987	0,85	118443	3,21E+08	119,905	0,85	89892,637	2,19E+08	81,822	0,85	61342,234	1,17E+08	43,740	0,85	32791,83098	1,52E+07	5,658	0,85	4241,4278	2816,62
Maksimum					259754,36				118443				89892,637				61342,234				32791,83098				4241,4278	
Keputusan					9,00E+07				6,00E+08				6,00E+08				6,00E+08				6,00E+08				6,00E+08	

Sumber: Hasil Perhitungan

ISSN: 2223-9553
Volume 1, Issue 2, September 2011

Electrical energy from January to December at each initial level of reservoir was described as Table 16 below

Table 16 Electrical energy at each initial level of reservoir

No	Month	Initial level of reservoir (m^3)					
		90000000	19200000	294000000	396000000	498000000	600000000
		Electriical energy (kWh)					
1	Jani	148743,99	120193,5902	91643,1869	63092,7837	34542,38048	5991,97725
2	Feb	174247,7447	136646,3925	105037,017	73427,6425	41818,26749	10208,89249
3	Mar	185570,8387	125524,7069	96974,3036	68423,9004	39873,49718	11323,09395
4	Apr	195147,1316	127584,6263	98082,543	68580,4596	39078,37628	9576,29295
5	May	204870,7406	123925,2219	95374,8187	66824,4155	38274,01223	9723,609
6	Jun	209909,0995	123046,6922	93544,6089	64042,5255	34540,44218	5038,35885
7	Jul	213410,9482	117703,4616	89153,0584	60602,6552	32052,25193	3501,8487
8	Aug	247366,3136	119606,5751	91056,1718	62505,7686	33955,36538	5404,96215
9	Sep	250468,5722	121110,5919	91608,5086	62106,4253	32604,34193	3102,2586
10	Oct	252696,3057	116429,3465	87878,9432	59328,54	30778,13678	2227,73355
11	Nov	255512,9286	120824,9562	91322,8729	61820,7896	32318,70623	2816,6229
12	Dec	259754,3564	118443,0407	89892,6374	61342,2342	32791,83098	4241,42775
	Max Energiy	259754,3564	136646,3925	105037,017	73427,6425	41818,26749	11323,09395

CONCLUSION

Based on analysis as aboved, it was conclused that maximum electrical energy was as follow:

1. At initial level of 90,000,000 m^3 = 259,754.3564 kWh (December}
2. At initial level of 19,200,000 m^3 = 136,646.3925 kWh (February)
3. At initial level of 294,000,000 m^3 = 105,037.0170 kWh (February)
4. At initial level of 396,000,000 m^3 = 73,427.6425 kWh (February)
5. At initial level of 498,000,000 m^3 = 41,818.6279 kWh (February)
6. At initial level of 600,000,000 m^3 = 11,323.09395 kWh (March)

REFERENCES

Shiklomadov, I.A.; Babkiu, V.I.; and Balouishu;kov, Zh.A. (2011) Water Resources, Their Use, and Water Availability in Rusia: Current Estimates and Forecasts. *Journal of Water Resources* (38) no. 2, p 139-148

Loaiciga, Hugo A (2005) On the Probability of Droughts: The Compound Renewal Model. *Journal of Water Resources Research*, Vol. 41, p 1-8

Bhalla, R.S.; Pelkey, N.W.; and Prasad, K.V.D. (2011) Application of GIS for Evaluation and Design of Watershed Guidelines, *Journal of Water Resource Manage*, 25: 113-140

Arismunandar, A and Kuwahara, A (1991) *Teknik Tenaga Listrik, Jilid I,* cetakan keenam. PT Pradnya Paramita, Jakarta.

Montarcih, Lily. 2010. *Hidrologi Praktis*. CV Lubuk Agung. Bandung

Soetopo, Widandi & Montarcih, Lily. 2009. Manajemen Air Lanjut. CV Citra Malang. Indonesia. 111 pages