Riverflow Characteristics Analysis for Water Resources Development and Management in Lower Myanmar

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1. Introduction

In Ngamoeyeik project of Lower Myanmar, the reservoir is supplying its storage water for only summer paddy cultivation in dry season. The area is already limited by the storage, and will furthermore decrease when the reservoir supplies to city water demand. Due to our preceding study on a paddy cropping season for the project through the regional rainfall analysis from the viewpoint of water resources management, the reservoir is feasible to expand its benefit also on the traditional rain-fed paddies by shifting a transplanting at the earlier season, thus it can avoid a damage of transplanted rice plants from flood inundation (Maung Maung Naing et al., 2003). However, a further water resources system in the project as shown in **Fig.1** has been developed. Therefore, we continue our study to evaluate a stability and effectiveness of water use in this water resources system.

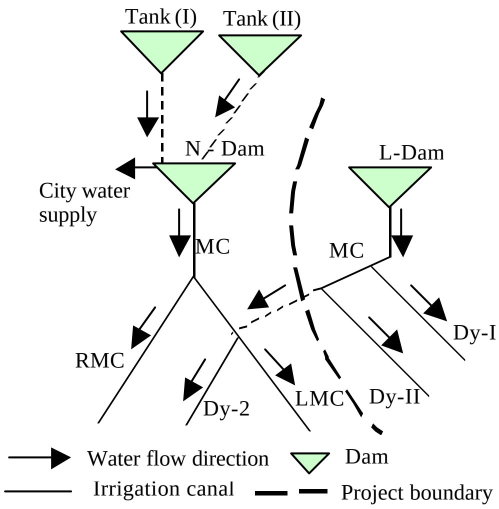

Fig.1 Schematic diagram of water resources development in Ngamoeyeik project.

2. Objectives

A research is necessary to decide (1) when the main reservoir should start its overflow to lessen a flood inundation on downstream area, (2) when the reservoirs should start their increasing storage for dry season water supply, (3) how many hectares with rainy paddies are possible at earlier transplanting, and what is a maximum allowable area with summer paddies in dry season by the system, even fulfilling the city water demand. To answer the above questions, long streamflow data are needed. The research aims to analyse the characteristics of streamflow from the viewpoint of applicability of Thomas-Fiering Method on streamflow synthesis.

3. Analysis of Streamflow Synthesis

Thomas-Fiering Method is applied for an analysis of streamflow synthesis. The characteristics of a streamflow are one of the interesting subjects for the reservoir operation planning. Due to insufficiency of the observed length in streamflow data, we synthesized Ngamoeyeik streamflow from observed data (1982-1992) by ***Thomas-Fiering Method*** (Maass et al., 1962). The synthesized flow data is given by

$$Q_i = \overline{Q}_i + b_i(Q_{i-1} - \overline{Q}_{i-1}) + ts_i(1 - r_i^2)^{\frac{1}{2}}, \text{ ----------------------------------- } \quad (1)$$

where Q_i (m^3/s) is the synthesized discharge at the *i*th period, reckoned from the start of the synthesized sequence; $\overline{Q}_i$ and $\overline{Q}_{i-1}$ are the observed mean 10-day discharge at the respective period; and b_i is the regression coefficient of Q_i from Q_{i-1}; and s_i is the standard deviation of Q_i; and r_i is the correlation coefficient between Q_{i-1} and Q_i; and t is a random normal deviate with zero mean and unit variance. Here, t is distributed by ***Box and Muller*** method (Wakimoto, 1970). The statistical parameters in observed flow data were used in synthesis of the flow. Preservation of the statistical parameters in observed flow data will not connote statistical agreement of synthesized ones (Satoh et al., 1995). The flow of 10-day total discharge was computed in each period for synthesized sequence. In our synthesis, a lag-one model is chose by 10-day flow discharge (Fiering et al., 1971). N.C Matalas found that more elaborate models involving lags of two or more did not give significantly better results (Maass et al., 1962). The flow was synthesized by normal or logarithmic transformation according to the flow distribution in each period. For the logarithmic transformation, the transformed flow, q (m^3/s), is given by

$$q = \text{Log}\,(Q - b), \text{ ------------------------ } \quad (2)$$

where Q is the observed flow discharge (m^3/s), and b (m^3/s) is the minimum value of streamflow for each period, which is computed by ***Iwai Method*** (Type II) (Iwai et al., 1970).

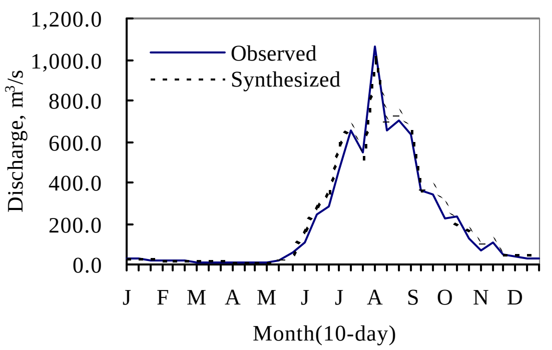

Fig.2 Average 10-day streamflow discharge in Ngamoeyeik creek.

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4. Results and Discussion

When the untransformed flows are normally synthesized, negative values often occur in the synthesized sequence, and this gives unreliable fit to the observed flow. The application of logarithmic transformation would give for a better fit. However, due to the distribution analysis, we found that (1) in dry season the flow has a normal distribution from December 21 to the end of April; (2) in wet season the flow has a lognormal distribution from the beginning of May to December 20. But, during rainy season, the flow sometime changes to a normal distribution. The statistical parameters of the 10-day streamflow are given in **Table 1**. Based on this condition, we synthesized the flow sequence by changing normal or lognormal distribution during one-year cycle. This result has given a good fit in flow distribution as well as in average flow (**Figs.2-4**). In synthesized sequence, extreme value sometime occurred, but the flow of synthesized one is identical of observed one at the same probability. We also found that when the observed data length is too short, a

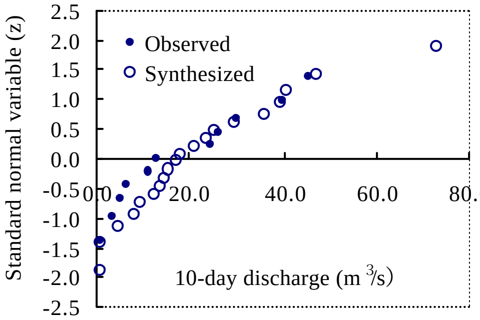

Fig.3 Distribution functions for observed and synthesized 10-day flow discharge in Ngamoeyeik creek, Feb 1-10.

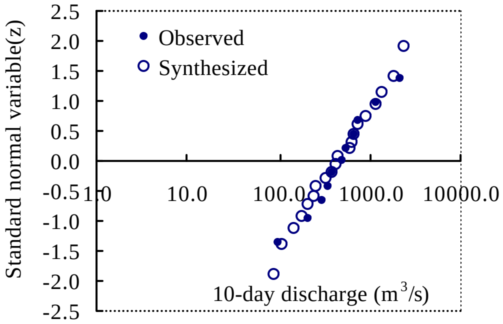

Fig.4 Distribution functions for observed and synthesized 10-day flow discharge in Ngamoeyeik creek, Jul 11-20.

Table 1 Statistical parameters of 10-day streamflow in Ngamoeyeik Creek

Period	m	N & LN	σ	r	β_1	β_0
Jan 1-10	26.48	N	19.10	0.70	0.44	14.71
11-20	25.04	N	17.19	0.95	0.86	2.34
21-31	21.38	N	15.42	0.98	0.88	-0.53
Feb 1-10	18.81	N	15.33	0.96	0.96	-1.70
11-20	16.97	N	14.26	1.00	0.93	-0.44
21-28	16.37	N	14.15	0.99	0.99	-0.35
Mar 1-10	14.52	N	12.92	0.97	0.89	-0.05
11-20	13.21	N	12.19	0.96	0.91	0.01
21-31	11.79	N	10.83	0.98	0.87	0.33
Apr 1-10	9.43	N	8.39	0.91	0.70	1.13
11-20	10.09	N	9.50	0.98	1.12	-0.43
21-30	8.72	N	8.10	0.90	0.77	0.94
May 1-10	11.10	LN	12.01	0.00	0.00	0.79
11-20	17.55	LN	15.35	0.54	0.68	0.32
21-31	62.89	LN	110.96	0.87	0.77	0.73
Jun 1-10	107.48	LN	98.43	0.44	0.39	1.29
11-20	244.20	LN	294.66	0.74	0.74	0.79
21-30	287.23	LN	204.00	0.85	0.73	0.75
Jul 1-10	463.10	LN	349.17	0.01	0.01	2.49
11-20	655.84	LN	596.31	0.46	0.39	1.70
21-31	542.07	N	254.64	0.24	0.10	474.67
Aug 1-10	1061.58	LN	1398.54	0.61	0.82	0.70
11-20	657.85	N	378.44	-0.09	-0.03	684.44
21-31	706.19	LN	373.30	0.52	0.29	1.94
Sep 1-10	631.06	LN	464.70	-0.09	-0.08	2.89
11-20	360.04	LN	197.24	0.32	0.34	1.51
21-30	340.19	LN	166.51	0.57	0.64	0.88
Oct 1-10	224.30	LN	102.13	0.48	0.44	1.19
11-20	237.65	LN	202.19	-0.03	-0.04	2.31
21-31	129.88	LN	73.85	0.27	0.30	1.31
Nov 1-10	71.65	LN	42.90	0.45	0.52	0.63
11-20	107.54	LN	99.68	0.27	0.30	1.31
21-30	44.85	LN	27.22	0.69	0.46	0.71
Dec 1-10	36.52	LN	30.18	0.79	1.35	-0.73
11-20	33.85	LN	31.41	0.99	1.06	-0.14
21-31	34.08	N	27.37	0.92	0.80	6.98

m : mean observed flow (m^3/s), σ: standard deviation (m^3/s)
r : correlation coefficient, β_0 & β_1 : regression coefficients
N : normal distribution, LN : lognormal distribution

reasonable choice of b is difficult in Iwai Method. In the case, regional streamflow characteristics and information will support to choose b for a reliably better result of synthesized one.

5. Conclusions

(1) The characteristics of streamflow in Ngamoeyeik creek can be divided mainly into two: one is a normal distribution in dry season; and another is a lognormal distribution in wet season. But, the flow sometime changes from a lognormal distribution to a normal distribution during rainy season.

(2) In synthesized streamflow sequence by Thomas-Fiering Method, the result is more realistic in logarithmic transformation analysis than in untransformed analysis.

(3) The synthesized flow discharge is can be used in our main purposes for reservoir operation planning even fulfilling sufficient length of flow data.

References

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