USE OF HISTORICAL DATA IN FLOOD-FREQUENCY ANALYSIS

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ABSTRACT. It is presented an assessment of several flood frequency procedures for the estimation of the 10,000 years flood which takes into account historical information, as for example when one knows the maximum flow in a period of 100 years. Monte Carlo experiments are employed. The conclusion favors the use of the exponential distribution.

1. INTRODUCTION

The spillway design flood for dams can be calculated through flood frequency analysis, which is a set of procedures to estimate x(T), the flow which will be exceeded in any year with probability 1/T. For major hydraulic structures T is chosen to be as large as 10,000 years. The most usual approach to estimate x(T) is to fit a probability distribution F(.) to the annual maximum flow series. Due to the short length of these series (usually less than 50 years), as compared with the required return period, these estimators have large sample variation. Research on this area has been directed to find out which is the best fitting distribution and which estimation procedure should be employed. Special consideration ought to be given to the case when historical information is available, as for example when one knows the maximum flow in a period of 100 years and the streamgage record is only 10 years long. In this paper it is presented an assessment of several flood frequency procedures which take into account the historical information. Monte Carlo experiments are employed. Special attention is given to the estimators of the ten thousand years flow. Similar investigations can be found in Tasker and Thomas (1978), Condie and Lee (1982), Cohn (1984) and Hosking and Wallis (1986).

The experiment is performed using a set of twelve Wakeby parents chosen to represent typical brazilian annual flood data. For each one of them a major sequence of 100,000 independent values is generated and then sequentially split into sequences with h elements: n of these elements simulate gauge data and (h-n) elements simulate the

V. P. Singh (ed.), Hydrologic Frequency Modeling, 487–497.

2. THE MONTE-CARLO EXPERIMENT

The experiments were designed to test the procedures in a set of conditions:

a) Historical period (h): 50, 100 and 150 years.
b) Record length (n): 5, 10, 25 and 50 years.
c) Parent distribution: Twelve conditions were tested, using Wakeby distributions. Figure 1 illustrates the position of each of these parents in a kurtosis versus skewness plane.

It is also included in Figure 1 points that correspond to annual maximum flow sequences for different regions in Brazil. Table II presents the parameters and the first four moments for each of the twelve parents and presents some of the quantiles.

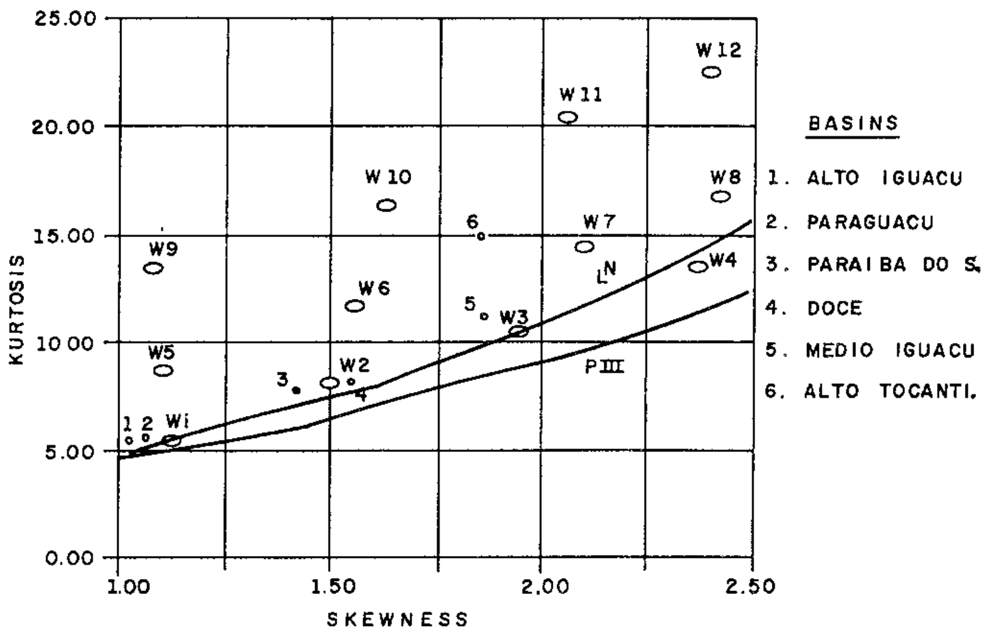

FIGURE 1. SKEWNESS AND KURTOSIS OF THE WAKEBY DISTRIBUTIONS

3. THE RESULTS

The method which gives the minimum MAE for each condition is presented in Table III, where it is also given the correspondent MAE value. It was also calculated an efficiency coefficient for each method given by the ratio between the minimum MAE along the methods and the MAE of the considered method. Table IV presents the mean of this coefficients obtained through the twelve parents for each method and pair (h,n).

TABLE II: THE TWELVE WAKEBY DISTRIBUTION USED AS PARENT DISTRIBUTIONS

Wakeby	a	b	c	d	m	E(X)	Std.Var.(X)	Skew(X)	Kurt(X)	x(T) T=1000	x(T) T=10000
W - 1	0.55	2.00	8.24	0.04	0.29	1.00	0.49	1.12	5.46	3.46	4.51
W - 2	0.49	2.00	3.45	0.09	0.33	1.00	0.49	1.50	8.13	3.79	5.27
W - 3	0.32	1.50	3.80	0.09	0.43	1.00	0.49	1.95	10.52	4.03	5.66
W - 4	0.14	1.50	4.19	0.09	0.50	1.00	0.49	2.37	13.03	4.25	6.05
W - 5	0.89	1.50	0.89	0.19	0.25	1.00	0.49	1.11	8.76	3.56	5.37
W - 6	0.65	4.00	1.96	0.14	0.16	1.00	0.49	1.56	11.87	4.01	5.97
W - 7	0.42	2.00	2.08	0.14	0.38	1.00	0.49	2.10	14.37	4.19	6.27
W - 8	0.31	1.50	2.18	0.14	0.46	1.00	0.49	2.42	16.42	4.32	6.51
W - 9	0.93	4.00	1.06	0.19	0.00	1.00	0.49	1.07	13.50	3.81	5.97
W - 10	0.73	2.50	1.13	0.19	0.22	1.00	0.49	1.63	16.32	4.02	6.32
W - 11	0.60	2.00	1.20	0.19	0.32	1.00	0.49	2.05	20.36	4.18	6.63
W - 12	0.53	1.15	1.22	0.19	0.43	1.00	0.49	2.39	22.58	4.27	6.76

Note: A Wakeby distribution is described by $X = m + a(1 - (1 - U)^{b}) - c(1 - (1 - U)^{-d})$ where U is a uniform (0,1) random variable.

TABLE IV: MEAN EFFICIENCY COEFFICIENT

H	N	EPR	EPR*	GUR	GUR*	LP3R	P3R	GEVR	EPM	EPM*	GUM	GUM*	LP3M	P3M	GEVM
150.	50.	0.63	0.70	0.45	0.44	0.29	0.35	0.33	0.69	0.82	0.46	0.47	0.36	0.46	0.41
150.	25.	0.59	0.71	0.45	0.44	0.23	0.33	0.31	0.68	0.88	0.47	0.49	0.33	0.43	0.43
150.	10.	0.66	0.76	0.54	0.54	0.18	0.39	0.36	0.75	0.96	0.57	0.71	0.37	0.55	0.55
150.	5.	0.61	0.69	0.53	0.53	0.12	0.40	0.38	0.71	0.99	0.58	0.84	0.38	0.62	0.62
100.	50.	0.64	0.71	0.46	0.46	0.30	0.35	0.34	0.71	0.80	0.48	0.48	0.36	0.40	0.39
100.	25.	0.59	0.71	0.45	0.45	0.24	0.34	0.32	0.69	0.88	0.48	0.49	0.34	0.42	0.41
100.	10.	0.65	0.77	0.54	0.54	0.20	0.40	0.37	0.77	0.95	0.58	0.67	0.37	0.55	0.54
100.	5.	0.64	0.71	0.57	0.57	0.14	0.43	0.42	0.78	0.99	0.64	0.84	0.41	0.65	0.65
50.	50.	0.73	0.77	0.51	0.51	0.33	0.39	0.37	0.73	0.77	0.51	0.51	0.33	0.39	0.37
50.	25.	0.65	0.74	0.49	0.49	0.26	0.36	0.34	0.72	0.88	0.52	0.52	0.32	0.41	0.39
50.	10.	0.64	0.78	0.54	0.55	0.19	0.40	0.37	0.79	0.94	0.60	0.64	0.36	0.51	0.49
50.	5.	0.69	0.76	0.61	0.60	0.12	0.46	0.44	0.86	0.99	0.69	0.80	0.36	0.65	0.64
25.	25.	0.74	0.82	0.56	0.56	0.29	0.40	0.37	0.74	0.82	0.56	0.56	0.29	0.40	0.37
10.	10.	0.80	0.90	0.66	0.67	0.22	0.47	0.44	0.80	0.90	0.66	0.67	0.22	0.47	0.44
5.	5.	0.86	0.95	0.76	0.76	0.17	0.57	0.54	0.86	0.95	0.76	0.76	0.17	0.57	0.54

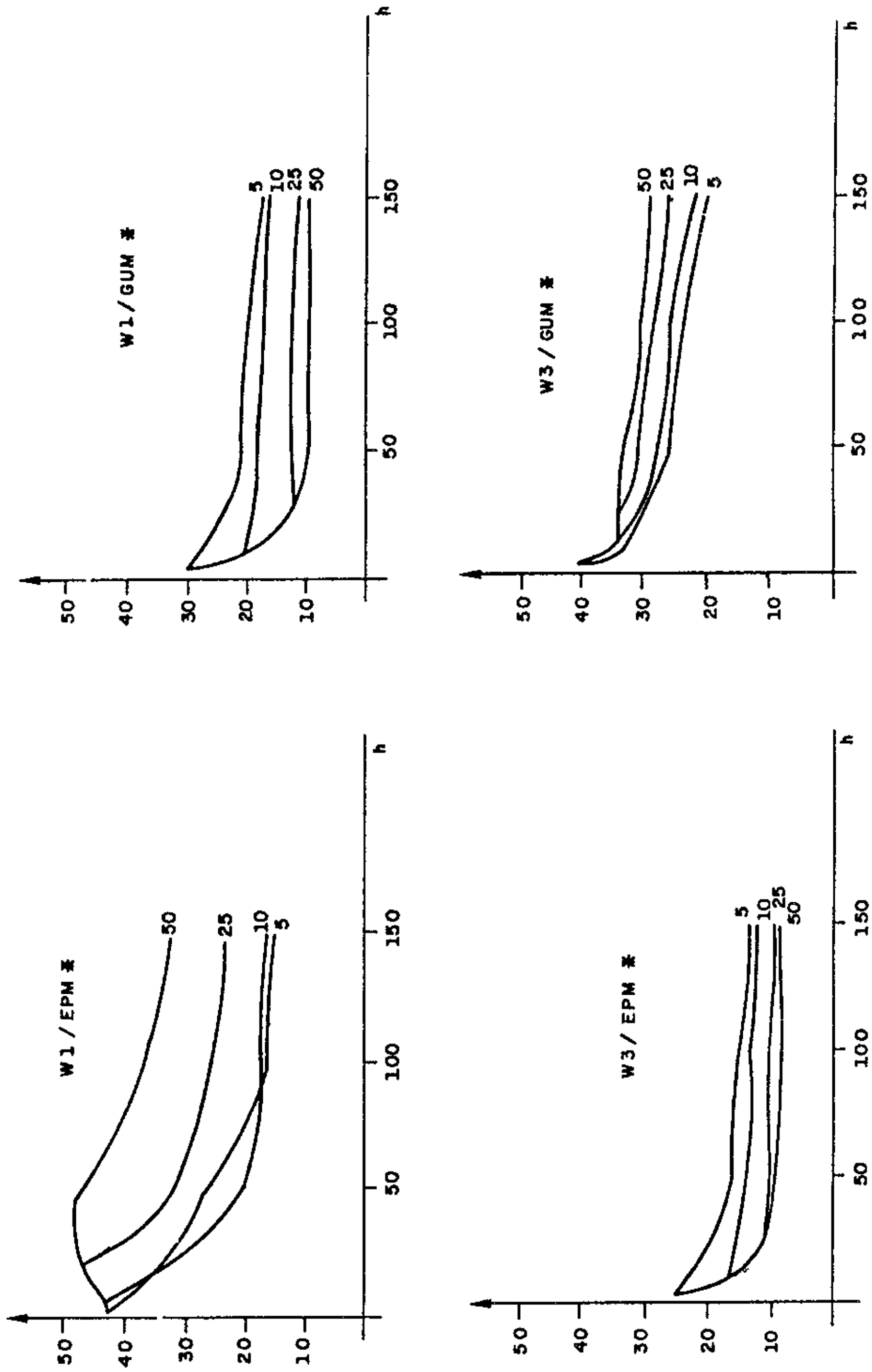

FIGURE 2. MAE FOR W - 1 AND W - 3

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