ON STATISTICAL ANALYSIS OF FLOOD FLOWS

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It is not intended to discuss the various formulae for estimation of extreme discharges or the "for and against" because there is not yet a method or a formula which would relieve the engineer of the responsibility of adopting the "correct" value. In this note a few results are presented which may be of general interest.

Several records of annual flood maxima were studied by the extreme value theory, better known as the Gumbel method.

In Fig.1 the mean lines of the estimated annual flood are plotted for:

(a) Manawatu River at Fitzherbert Bridge, Palmerston North, 32 years of continuous record (to and incl.1958).
(b) Waipaoa River at Kanakanaia Bridge near Te Karaka, Poverty Bay, 29 years of continuous record.
(c) Waimakariri River at the Gorge Bridge, 30 years of continuous record.
(d) Clutha River at Balclutha, 21 years of continuous record.

The analysis yielded:

(a) $Q = 49,618 + 25,228y$

Standard deviation $S_x = 28,238$ cusecs

(b) $Q = 31,280 + 29,109\ y$

Standard deviation $S_x = 32,270$ cusecs

(c) $Q = 61,439 + 27,468\ y$

Standard deviation $S_x = 30,555$ cusecs

(d) $Q = 51,552 + 19,729\ y$

Standard deviation $S_x = 21,100$ cusecs

The recorded points closely follow the calculated mean line with all points being well inside the control curves.

The record of annual maximum floods for the Waikato River at Ngaruawahia (downstream of the confluence with Waipa) was treated in similar manner. Firstly the continuous record from 1924 -1940, i.e. prior to the control of Lake Taupo outflow, was analysed. The observed points follow the calculated mean line very well indeed. Remarkable is the very small value of dispersion, $S_x = 3,450$ cusecs.

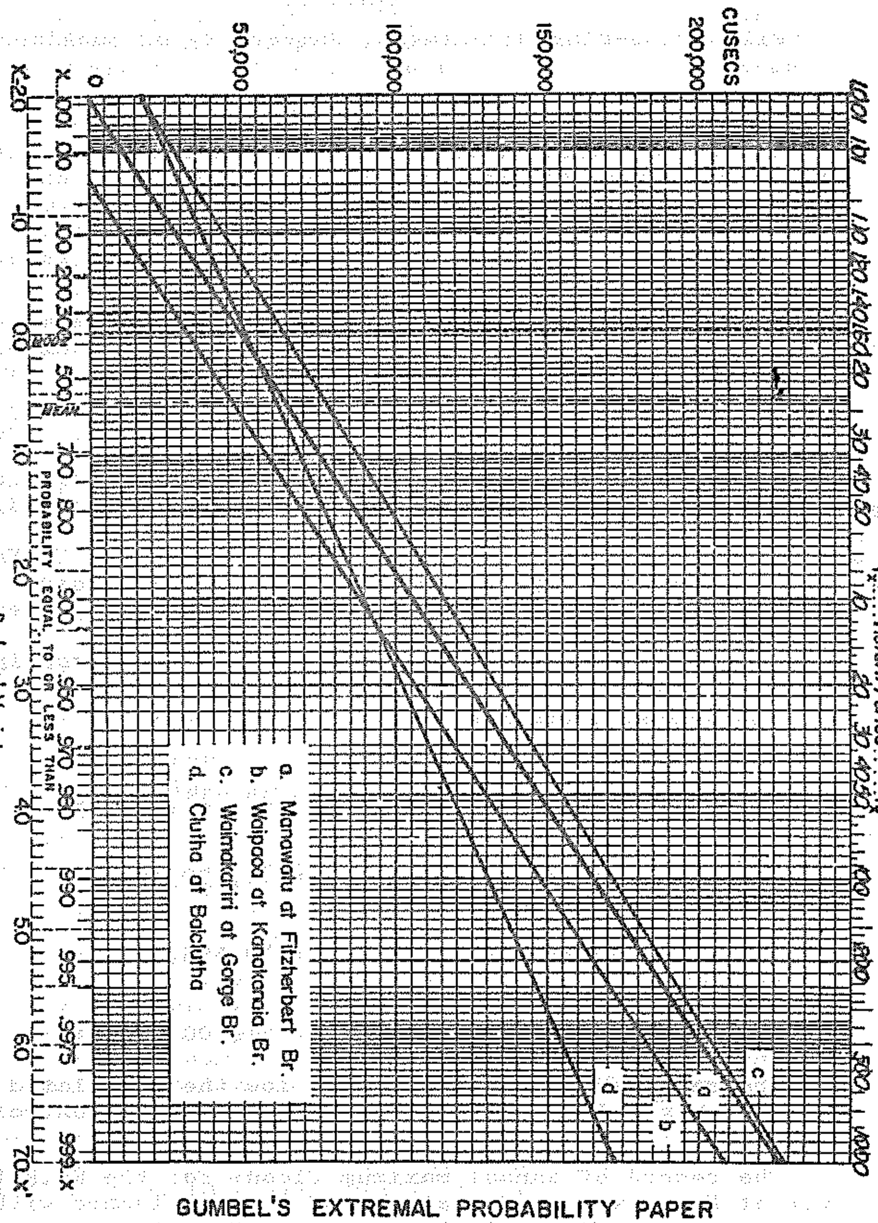

FIG. I Mean Estimated Flood Discharges of Manawatu, Waipaoa, Waimakariri and Clutha Rivers by the Gumbel Method

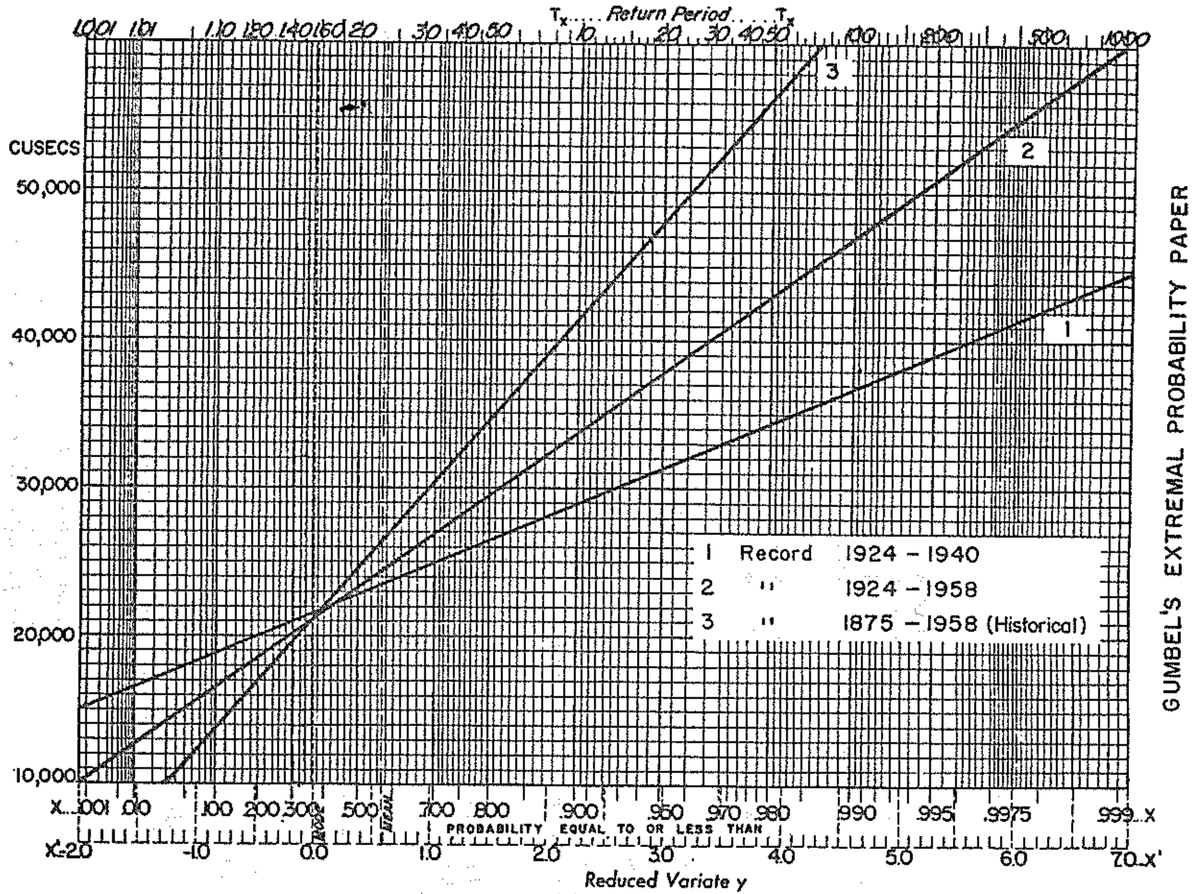

FIG. 2 Different Flood Estimates for the Waikato River

Next the continuous record from 1924-58 was analysed. Here the calculated mean line is of very poor fit to the data. The data follows the general direction of the above short record up to a return period of 20 years, but the observation for the largest flood, of 1958, plots more than 20,000 cusecs above the penultimate observation. Consequently, the analytically fitted line is away from all the observed points.

Finally, the same record was analysed after taking into account the historical record for the years 1875 and 1907 (Method is shown in U.S. Geological Survey Water Supply Paper 1543-A). Again the fit is very poor, similar to the record of 1924-58, with the extreme floods standing clear on their own.

The calculated mean lines are shown on Fig.2. The individual points of observed data have been omitted.

The analysis yielded:

(1) Record 1924-40: $Q = 21,615 + 3,317\ y$, $S_x = 3,450$ cus.
(2) Record 1924-58: $Q = 21,152 + 5,668\ y$, $S_x = 6,396$ cus.
(3) Record 1875-58: $Q = 21,227 + 9,085\ y$, $S_x = 10,301$ cus.
(Historical)

It is seen that the fitted mean lines show very widely differing magnitudes for the extreme floods. According to the short record a 50,000 cusecs flood would have a return period of more than 2,000 years. Yet the records show three floods in excess of this magnitude in less than a century. The probability of this occurring by chance is very remote indeed.

Now, one could suggest that the flows of the Waikato do not follow the extreme value distribution and one should look for another basic distribution.

However, the most important point emerging from this example is that one should not accept the estimates obtained from short records unless these estimates can be substantiated by historical or other evidence.