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ALGORITHM FOR ADJUSTING STREAM STAGE RECORDS[a]

Discussion by Donald L. Chery, Jr.

DONALD L. CHERY, JR.,[3] A. M. ASCE.—Indeed, estimations are a part of processing stream-stage records. In fact, the writer's experience with records collected at the Southwest Watershed Research Center (SWWRC) make him dubious that "Most of the time these stage recorders perform their function accurately and without failure." Perhaps these instruments operate more reliably where they receive close attention, but for some flow-stage records from remote stations being processed by the SWWRC, the entire recording system (including recording instrument, intake to stilling well, sedimentation complications, service and supervision) has had its defects. Table 1 is a selected example of the amount of estimation in the runoff records for a 246-acre watershed near Albuquerque, N.M. with 32 yr of record. The amount of estimation for 10 different yr is representative of that required in data from remote stations where flows carry tremendous sediment loads that plug flow-recording apparatus. Included in the sample are the years with the most and least amounts of estimation and some average years. Obviously, estimation is a significant part of processing flow-stage records from such remote locations and should be given serious and objective consideration as the authors propose.

The authors' statements that "estimation or corrections can be drawn directly on the (analog) chart" recording, and that "digital recorders provide data in a form suitable for automated data processing" may be misleading. While it is true that digital data may be processed more readily or directly on the computer, this does not preclude converting the analog record to a digital record (by using a chart reader for instance) and then using automatic data processing and objective data correction procedures. These latter procedures are used in processing the runoff records of the SWWRC.

The point that with so many agencies processing hydrologic data, there must be many procedures for making estimates, but it is difficult "to find specific and detailed analyses of these methods" is worth some discussion. If all the various estimation procedures were published, the literature could well contain a surfeit of descriptions of very limited application. It is more important that the computer tabulation annotate any internal objective estimates, and the basic data files provide for comments or descriptions of any judgment estimates that are then passed by the data processing procedures to the final tabulations. The data processing procedures of the SWWRC have such provisions, and any staff member using these records has in-the-system references to the estimation procedures.

[a] March, 1971, by William C. Mills and Willard M. Snyder (Proc. Paper 7955).

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These have been preliminary remarks to comments on the estimation procedures discussed by the authors. Typical estimation problems for SWWRC data almost never allow so much information as a beginning and end point, with beginning and end slopes, plus possibly an intermediate point on which to base an estimate. Most of the estimation problems are either a stilling well intake plugging on the recession of a flow or being plugged for the entire flow. There also are a few other minor problems such as clock stopping, pen running out of ink, or only inking part of the time, pen not being placed on the chart, etc. The two major deficient record situations are amendable to gross estimates.

The record that has an intake plug on the recession can have a standard recession applied at a point where it is judged that the intake plugged. The standard recession or recessions have been determined for each watershed and documented in file reports. The computer processing applies the standard recession. Sometimes the judgment of where to start the estimate is not the best, as indicated by the first estimate in Fig. 5. However, a new point can be

TABLE 1.—SELECTED EXAMPLES OF AMOUNT OF ESTIMATION IN RUNOFF RECORDS

Year (1)	Number of known events (2)	Number of known events with no record (3)	Estimated volume, as a percentage (4)	Estimated duration, as a percentage (5)
1939	7	0	1.6	17.4
1941	20	0	9.9	50.3
1942	10	0	68.8	42.8
1947	7	0	11.5	69.0
1950	6	0	26.6	81.0
1952	5	0	28.5	74.4
1956	3	0	42.4	89.4
1959	10	1	40.0	77.9
1964	9	3	7.5	67.2
1968	2	0	25.0	74.2

selected and the tabulation rerun to obtain a better estimate as shown by the second estimate of Fig. 5.

A record that had the intake plugged during the entire time can be reconstituted in a very gross way, especially if a maximum water depth has been measured. When such estimates are made, they can be explained with notes placed in the digital basic data file.

Very infrequently, the records of SWWRC have recording lacunae such as considered by the authors. Such lapses in the recording are called gaps and no attempt is made to estimate or tabulate through the gap unless it is an obvious recessional situation such as shown in Fig. 1. More often gaps in the recording occur when, without the actual measurement, there is no idea what the response of the watershed system was (similar to the situation shown in Fig. 3). This point leads the writer to emphasize the authors' point that "the polynomial techniques are not recommended for estimating missing records" and to question their general usefulness for "an erroneously recorded hydrograph."

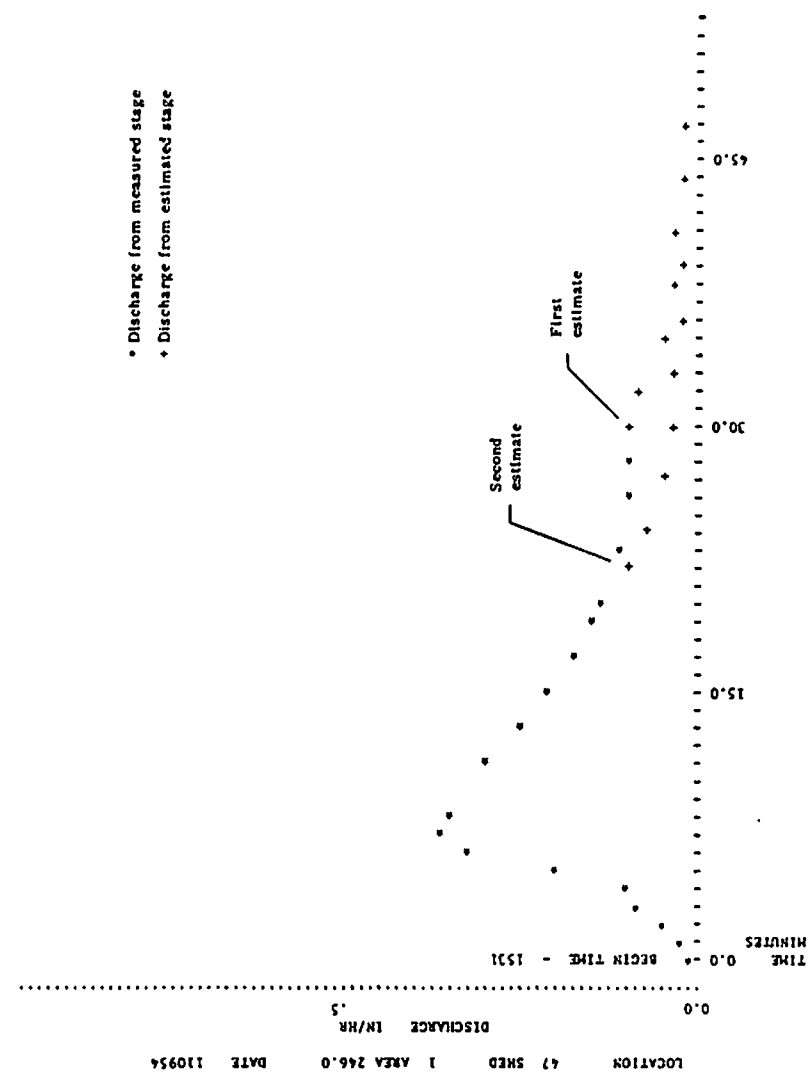

FIG. 5.—COPY OF COMPUTER PLOTTING OF RUNOFF DISCHARGE TABULATIONS SHOWING TWO STARTING POSITIONS OF APPLYING A STANDARD RECESSION

Further, note that the estimation procedure discussed does not consider the input (rainfall) experienced by the watershed system. As the discussion is about records from well-measured systems, the ultimate in estimation procedures will be the development of verified mathematical transfer relations that model the watershed and then use the input (rainfall) information to generate estimates constrained by whatever limited outflow information was obtained. It is rather obvious that these transfer relations must be developed from data containing no or very little (and of a restricted type) estimation. What also may be obvious, but is not universally practiced, is that all estimates placed in basic data files must be so noted. Estimates in the SWWRC basic data files are indicated as estimates and when other automatic data processing is done with the data, they can be recognized as estimates. (For instance, the computer plottings in Fig. 5 could be prepared to plot measured data points and • and estimated data points as +.)

NUMERICAL ANALYSIS OF FREE SURFACE SEEPAGE PROBLEMS[a]

Discussion by L. T. Isaacs and K. G. Mills

L. T. ISAACS[5] AND K. G. MILLS.[6]—The authors have presented a numerical technique which will be widely used for the analysis of free surface seepage problems. It needs, therefore, to be examined for computational efficiency and applicability to field conditions. The writers have also developed finite element programs to analyze steady seepage and drawndown in zoned earth dams using the same assumptions as the authors. Triangular elements were used in these programs and for geometric adjustment of the seepage field only those elements adjacent to the moving boundary were modified, while the remainder of the finite element mesh was left unaltered. This has the advantage that only the contributions of the modified elements to the overall stiffness matrix need be calculated instead of generating a new mesh and completely reforming the overall stiffness matrix when the geometry is changed. Another advantage is that, if an iterative method is used for the solution of the set of equations, Eq. 8, the set of nodal values of the piezometric head h calculated before the geometry is altered is a good initial approximation for the solution of the equations after the geometry is changed and a significant saving in computer time is obtained.

[a] March, 1971, by Peter W. France, Chandrakant J. Parekh, John C. Peters and Cedric Taylor (Proc. Paper 7959).

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