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Dynamic Behavior Model of Ephemeral Stream[a]

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As the authors point out in their introduction, sediment transport by ephemeral streams in the Southwestern United States is an important problem. Moreover, these sediment transport formulas have been evaluated with only a handful of good field measurements (16,17). Therefore, a thorough investigation with the facilities at the Walnut Gulch Experimental Watershed would contribute valuable knowledge of sediment transport, representing higher flow velocities and presumably higher sediment discharge rates than occur in more other parts of the country.

There are two parts of the authors' study—one dealing with sediment discharge rating prediction and the other dealing with overall sediment movement and trends of aggradation/degradation under a given pattern of flows. The second part is quite dependent on the first, since the hydrologic model is accepted a priori. The discussion of this paper is made in three parts: (1) The sediment transport model; (2) the stream hydraulic relations; and (3) general considerations.

Sediment Transport Model.—The authors adopt, without justification, the semi-empirical formula of Laursen (5). It is pertinent to note the caution expressed by Laursen in the presentation of his formula, developed from extensive flume experiments:

> . . . it should be kept in mind that the relationships are basically empirical and hence can be used with confidence only within the ranges of conditions for which they have been tested against actual measurements.

Of the three streams Laursen used to test his formula, the one with largest mean sediment size (d_{50} = 0.9 mm) showed the poorest prediction of the three, and the more serious bias was for the largest discharges, 40 cfs-60 cfs, which were far less than those reported for Walnut Gulch. Graf (16) also found the formula had predictive bias. Given this background, the use of the Laursen relationship for Walnut Gulch is unacceptable without some evaluation. Specifically, the ratio of size composition of moving sediment to size composition of bed material, as shown in Fig. 8, should be carefully studied. The authors indicate that many depth-integrated samples were taken at Flume 7, but the sediment size distribution for these data is not presented, nor is the method of sampling described. Thus, the crucial assumption of the Laursen formula is left untested.

[a] May, 1975, by Kenneth G. Renard and Emmett M. Laursen (Proc. Paper 11315).

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The only means by which the applicability of the Laursen formula to Walnut Gulch may be assessed is through the sediment discharge ratings of Figs. 12 and 14. Many samples were taken of between-flow bed material (Figs. 6 and 13), for use in the Laursen formula, and a range of distributions is reported

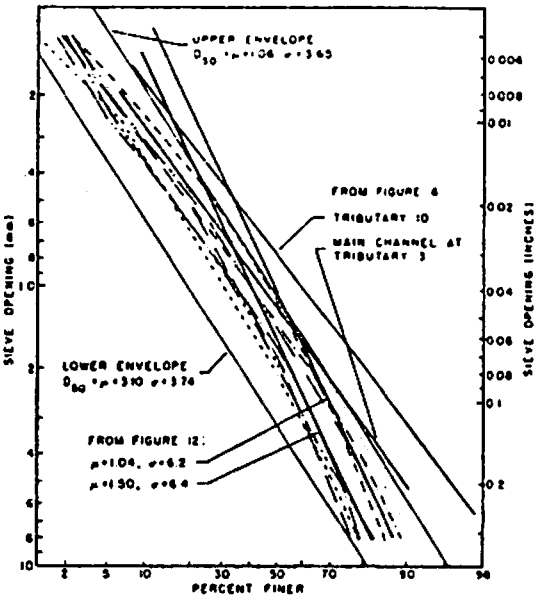

FIG. 17.—Composite Plot of Data from Figs. 6 and 13, Plus Data Used in Fig. 12

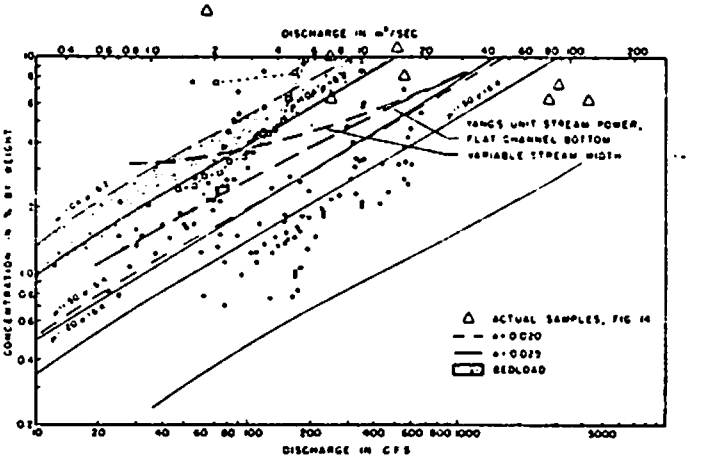

FIG. 18.—Composite Plot of Data from Figs. 12 and 14

in Fig. 13. Although the sediment concentration data for a given water discharge varies over nearly an order of magnitude, the data are not identified so that the distribution can be associated with a preceeding or following flow event.

Does the scatter of Fig. 13 partly explain the scatter of Fig. 12?

Fig. 17 compares bed material size distribution from the authors' Figs. 6 and 13 with some of the distributions used in simulations shown in Figs. 12 and 14. The data suggests a smaller mean sediment size, μ, in tributaries and in upstream reaches of the main channel. The sediment sample at Flume 6 reportedly has twice the variance, σ, as that found (downstream) at Flume 1. Is this a significant trend or a sampling variance? Why was the value of σ measured at Flume 1 doubled in the simulations of Fig. 12? Importantly, little verification of the Laursen or any other formula can be obtained with the scattered and unassociated data shown.

The experimental data shown as peak flow values of Fig. 14(*a*) have less scatter, yet again there is a question concerning these data. For comparison, they may be transformed from cubic feet per second of sediment to concentration in percent by weight and plotted with the data from Fig. 12. This is shown here in Fig. 18. The apparent trend of this peak data is counter to the rating relations from Laursen, and to the main body of data in Fig. 12.

The illustrated sample variability of bed material distributions and the difficulty the authors had in successfully using them in the Laursen formula leads the writers to suggest a sediment discharge model independent of bed material measurements. Yang (18) presented a method to predict total sediment load based on "unit stream power"—velocity times slope. By using the coefficients directly from Yang's composite regression equation (Yang's Eq. 13) and assuming a flat bed channel, the line on Fig. 18 is produced. This seems easily as accurate a fit to the data of Fig. 14(*a*) and Fig. 12 as the Laursen relation, and more direct as well.

Stream Hydraulics Assumptions.—The authors used a steady-state or, at most, kinematic rather than a dynamic model. Steady-state sediment transport conditions are assumed at all discharge levels. If the peak flow anomaly noted previously is real and related either to hydraulic wave dynamics or to variation of sediment rating with rising and falling stages, as the authors suggested, the writers suggest that the "dynamics" of the ephemeral stream have not been truly examined.

In fact, another possible explanation for the sediment relation to be steeper in Fig. 14(*a*) (or less steep in Fig. 12) than that indicated by the synthetic data is that the alluvial bed is not actually "flat," but has a continuously varying width to depth relation, and thus a different velocity versus area relation than that assumed by the authors.

General Considerations.—The authors use a regression-based empirical method to generate 10 yr of flow for upstream and tributary inflows to a reach between two flumes at the lower end of the Walnut Gulch Watershed. Sediment distribution (μ,σ) reportedly representing a sample at the upstream end, is used in Laursen's transport formula to simulate overall sediment balance, and to conclude that the *reach* is near equilibrium. Since the sediment size distribution at the lower end of the reach is apparently different, as previously shown, the sediment distribution used cannot be considered representative of the reach.

In the light of these omissions, as well as the preceding discussion concerning the Laursen sediment transport formula and hydraulic assumptions concerning the alluvial bed, it seems that the *dynamics* of sediment transport have not been well explored in this study. The writers cannot agree with the authors' conclusion that the model "agrees closely" with sampled data. It is not clear

to which data the authors are referring in their statement that the "runoff-sediment generating scheme" agreed with limited field data. The only results shown for the combined model are those of Fig. 16, which are only compared with the assumption of equilibrium. The results of Fig. 15 are from the Diskin-Lane model alone, and those of Fig. 14 are independent of a runoff-generating scheme. Finally, in considering the above and the authors' explanation that 70 yr ago the stream channel was very much different, it is difficult to find reason for concluding that the stream reach studied is in "equilibrium."

Appendix.—References

16. Graf, H. P., *Hydraulics of Sediment Transport*, McGraw-Hill Book Co., Inc., New York, N.Y., 1971, 513 p.
17. Vanoni, V. A., Brooks, N. H., and Kennedy, J. F., "Lecture Notes on Sediment Transportation and Channel Stability," *Report KH-R-1*, W. M. Keck Laboratory of Hydraulics and Water Resources, California Institute of Technology, Pasadena, Calif., 1960, 140 p.
18. Yang, C. T., "Unit Stream Power and Sediment Transport," *Journal of the Hydraulics Division*, ASCE, Vol. 98, No. HY10, Oct., 1972, pp. 1805-1826.

Legal Perspective on Water Quality Management*

Errata

The following corrections should be made to the original paper:

Page 596, first paragraph, line 6: Should read "Act" instead of "ACT"
Page 597, second paragraph, line 6: Should read "input" instead of "imput"
Page 599, second paragraph, line 3: Should read "Adjustment" instead of "Admustment"
Page 601, Ref. 12: Should read "§1904-A(1) and (6)" instead of "§1904-A(1) and (a)"

*May, 1975, by Douglas R. Blazey (Proc. Paper 11320).