Numerical Simulation of Degradation of Alluvial Channel Beds[a]

Discussion by Jinn-Chuang Yang[3]

Numerical modeling of sediment transport in alluvial channels has been extensively studied for the past decade. A number of models have been developed for the corresponding specific problems. However, as the authors pointed out, most of the papers do not discuss the effect of Δt and Δx on the simulation results. Based on the bed-perturbation celerity relation proposed by de Vries and the use of a simple sediment-transport predictor, the authors have derived Eqs. 21 and 24 for determining the most appropriate Δt and Δx to avoid the numerical instability.

Nevertheless, as far as the nonuniform sediment transport is concerned, the bed perturbation is induced not only by the bed-level change but also by the variation of the composition of bed material. In view of Eqs. 21 and 24, the time and space steps Δt and Δx are related to the Froude number, mean flow velocity, and sediment concentration. It is obvious that the perturbation caused by the nonuniformity of the bed material is not considered. Therefore, strictly speaking, Eqs. 21 and 24 should only be valid for the uniform sand transport model. In addition, the relations derived are based on the simple power law relation, Eq. 20, for a sediment discharge predictor, which is not consistent with Eq. 4. Therefore, the use of Eqs. 21 and 24 may give the wrong indication of Δt and Δx selection.

The necessity of appropriately selecting Δt and Δx is resulted from the explicit scheme used by the authors for the sediment continuity equation. One can probably use the implicit scheme such as Preissmann's four-point scheme, which is unconditionally stable, to avoid the Courant-number constraint. Although the existence of multiple time (or length) scales may lead to an instability problem, with the careful choice of space weighting factor one need not worry about the instability caused by an unsuitable choice of Δt and Δx (24).

Appendix. Reference

24. Lyn, D. A. (1987). "Unsteady sediment-transport modelling." *J. Hydr. Engrg.*, ASCE, 113(1), 1–15.

Closure by Inbo Park[4] and Subhash C. Jain,[5] Member, ASCE

One of the primary reasons for imposing constraints on time and space steps was to eliminate the dependence on the space step of the bed elevation changes at the upstream node. Different procedures have been proposed by other investigators. Holly et al. (25) introduced the concept of a buffer reach

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of length $\beta\Delta x$ ($\beta < 1$) within the upstream reach and assumed that local degradation due to unbalance between the imposed and transported load occurs in the buffer reach. The length of the buffer reach corresponds to the distance traveled by a bed perturbation in one time step. A relation similar to Eq. 22 was used by Shen and Lu (1986).

The effect of the sediment size distribution on bed perturbation has been considered indirectly through sediment concentration, which depends on the sediment size distribution.

Appendix. References

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26. Shen, H. W., and Lu, J. Y. (1986). "Modelling of aggradation." *Proc. 3rd Int. Symp. on River Sedimentation,* Univ. of Mississippi, Jackson, Miss., 226–234.

Dimensionless S-Graphs for Urban Watersheds[a]

Discussion by Arie Ben-Zvi,[3] Affiliate, ASCE

The authors conclude, from a data sample analysis, that the time-area diagram is a good representation for the S-graph and therefore either function may be applied to improve a design based upon the other function. The writer recalls that Watkins (1956) has shown, from an analysis of another data sample, that the time-area concentration curve and the instantaneous unit hydrograph are similar to each other. These graphs are the time derivatives of the graphs applied by the authors. Linsley et al. (1949) consider the time-area concentration curve and the instantaneous unit hydrograph as being proportional to each other. Bernard (1935) considered the unit hydrograph as being proportional to the area contributing the runoff. The Committee On Floods ("Report" 1930) explained the existence of a characteristic curve for a watershed through the time-area contributions. By theoretical reasoning the writer (Ben-Zvi 1974) has shown that if these graphs exist for a watershed they should be equal to each other. These cited works allow us to generalize the conclusions of the authors.

Yet, it should be kept in mind that the discussed linear functions provide only a simplified description of the hydrologic process (Nash 1958). The writer believes that it is worthwhile to apply for a watershed a family of linear functions rather than a unique one (Ben-Zvi 1974). Two alternative methods for the composition of this family are proposed by Becker and Kundzewicz (1987).

[a]July, 1987, Vol. 113, No. 7, by Richard H. McCuen and Theodore V. Hromadka II (Paper 21653).

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