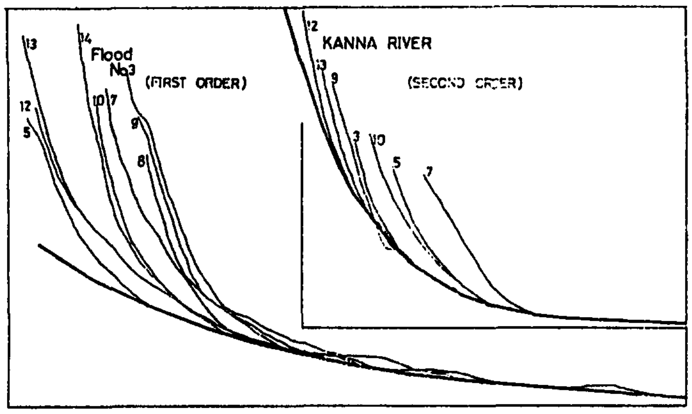

FIG. 13. Standard Recession's Curve in Kannagawa River (Kikkawa et al. 1979)

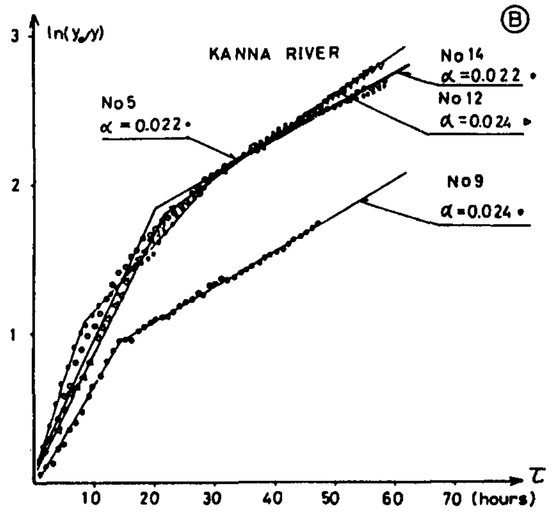

FIG. 14. Semilogarithmic Plot of Hydrograph (Mikio and Masahiko 1984)

Please give the discusser's comment or replay about the previously mentioned points.

APPENDIX. REFERENCES

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Closure by Kazumasa Mizumura[3]

The writer is thankful to T. Kumekawa for his interest in the paper. His discussion consists of two parts. The first one is that the slopes of each component in the hydrographs of the Kannagawa River are not constant in semilog plots. The second is that the inflection points between two components are not the same for different floods.

The answers to the two aforementioned questions come from the interpretation of the mechanism of the runoff process. The recession coefficients k_g for the ground-water flow are the same for the different floods [see Fig. 7(a)]. This suggests that the ground-water flow is produced from the whole area of the watershed for different floods after water infiltrates into the land. However, the recession coefficients k_o for the overland flow are not always constant for different floods [see Fig. 7(a)]. The inflection points are also not the same for different floods. This is explained by the fact that the recession coefficients for the subsurface and overland flow are not always the same for different floods. The discusser's problems are mainly considered to be caused by the locations where the overland flow appears in the watershed. This comes from the concept of the partial area sources. Thus, these problems are related with meteorological conditions such as spatial distribution of rainfalls in the watershed, time-varying characteristics of rainfalls, seasonal changes of vegetations, land development, etc., although the mechanism of runoff process is the same. Since the main purpose of the author's study is proof of the linearity of the rainfall and runoff process, and the introduction of a simple runoff prediction model, the previously mentioned points are not essential to this study. This study may not give all the answers in the prediction models. If a prediction model takes account of detailed points in the rainfall and runoff process, it overlooks the essence of the mechanism in the runoff process. Thus, this prediction model assumes that the distribution of rainfall is uniform in the unit time and space. The difference in the rainfall distributions more remarkably influences overland flow than ground-water flow as we know. The other conditions that make the rainfall and runoff process complex are simplified as much as possible.

Since papers or local journals that are written in special languages, such as Japanese, are not easily available to researchers all over the world, the writer did not consider them.

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Finite-Element Model for High-Velocity Channels[a]

Discussion by P. M. Steffler[3] and F. E. Hicks,[4] Associate Members, ASCE

The authors have presented a two-dimensional depth averaged shallow flow model based on a novel implementation of the Petrov-Galerkin finite-element method. The key contribution, in the view of the discussers, is the specification of the upwinding matrices in (11). The proposed formulation is shown to work well for some interesting test cases and removes a significant obstacle to the wider application of the finite-element method in hydraulic engineering.

The discussers are unconvinced, however, concerning the utility of the proposed shock detection scheme. Unlike most finite difference shock capturing schemes, the Petrov-Galerkin upwinding process is consistently applied to all terms in the

[a]October 1995, Vol. 121, No. 10, by R. C. Berger and R. L. Stockstill (Paper 7146).

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J. Hydraul. Eng. 1997.123:581-582.

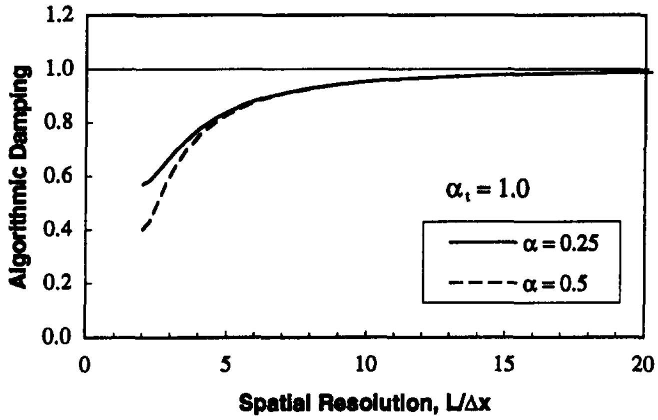

FIG. 5. Amplitude Accuracy of Petrov-Galerkin Scheme for Solution of Linearized St. Venant Equations, $C_s = 0.5$

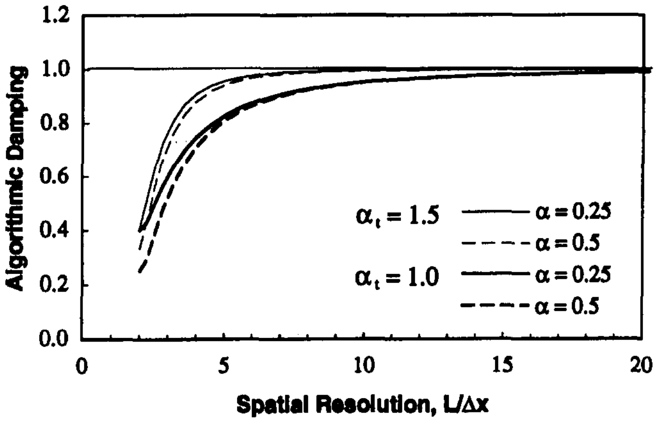

FIG. 6. Amplitude Accuracy of Petrov-Galerkin Scheme for Solution of Convective Transport Equation, $C_s = 0.5$

governing equation and does not degrade the overall order of accuracy of the discrete approximation. The dissipation provided is highly selective and actually not very sensitive to the magnitude of the upwinding coefficient, except for the very shortest solution wavelengths. In the presence of jumps a value of $\alpha = 0.5$, as recommended by the authors, is clearly desirable. However, in the discussers' experience (primarily one-dimensional and limited two-dimensional), there is little reason to reduce this value in smooth areas and to bother with shock detection.

The effect of α has not been studied extensively, except for optimization of phase accuracy (Froehlich 1985). For the purpose of this discussion, the discussers have undertaken a highly simplified Fourier analysis of the Petrov-Galerkin scheme. The simplifications begin with considering one-dimensional flow, neglecting friction and bed slope terms, and linearizing the remaining terms in the St. Venant equations. The results of this analysis include the algorithmic damping, defined as the ratio of the amplitude of a harmonic wave train after and before a single time step, as a function of spatial resolution (nondimensional wavelength). The effect of α on damping is shown in Fig. 5 for the case of $C_s = 0.5$ and $\alpha_t = 1.0$, the implicit time stepping scheme. The effect of changing α from 0.25 to 0.5 is small, and for wavelengths greater than $5\Delta x$, negligible.

For the higher order, three time level scheme proposed, a further simplification was made to make the analysis tractable. Instead of the St. Venant equations, a simple convective transport equation

$$\frac{\partial h}{\partial t} + U\frac{\partial h}{\partial x} = 0 \tag{26}$$

is considered. The results of this analysis are shown in Fig. 6. The $\alpha_t = 1.0$ case is redone, with results comparable to those in Fig. 5. The $\alpha_t = 1.5$ case shows considerably less damping, but again, very little effect of changing α.

Of course, the results of the Fourier analysis are only indicative, given the high degree of simplification involved. A more definitive approach would be to have actual simulation results showing the effect of varying the upwinding coefficient on smooth flow regions.

Closure by R. C. Berger[5] and R. L. Stockstill,[6] Members, ASCE

The writers would like to thank the discussers for their interest and valuable insights. They make a good point in that the use of a single test function produces a "consistency" that results in good precision even at relatively low resolution. This is true even when using the maximum "upwinding" of $\alpha = 0.50$. The discussers suggest simply applying the maximum upwinding ($\alpha = 0.50$) everywhere rather than using the shock detection mechanism, whereby the maximum upwinding could be applied in the rough regions and a lower value (say $\alpha = 0.25$) could be used in the smoother regions. From our experience the computed water surface elevations in smooth regions are insensitive to a range of αs.

The use of this shock detection is relatively inexpensive, computationally, and relies only on information within an element. Because it does not use neighboring information, the method is well-suited to an unstructured approach. The detection mechanism can be regarded independently from the stabilization scheme, so that the detection scheme itself can be applied with other stabilization methods.

Sand-Dune Geometry of Large Rivers during Floods[a]

Discussion by Mario L. Amsler[3] and Marcelo H. García,[4] Member, ASCE

In 1968 a 2.4-km long tunnel was built across the Paraná River, Argentina, to provide a traffic connection between the Provinces of Santa Fé and Entre Ríos. The tunnel was constructed in a trench that was backfilled with the original bed material. To offer sufficient protection against uplifting of the tunnel, a minimum cover thickness of 3 m above the tunnel was required. Further attention was then paid to sand dunes

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[a]September 1995, Vol. 121, No. 9, by Pierre Y. Julien and Gerrit J. Klaassen (Paper 7923).

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