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DISCUSSION

Proc. Paper 11209

Rainfall Excess Model from Soil Water Flow Theory[a]

Closure by Roger E. Smith,[4] A. M. ASCE and Donald L. Chery, Jr.,[5] M. ASCE

The writers thank Chen for his attention to our paper. We regret the apparent misunderstandings implied by his comments, which may have resulted in part from our rather brief explanation of the simple, but not easily understood, parametric model.

In some of his comments Chen does not completely consider explicit portions of the paper. Our appendix substantiates the mathematical validity of the relations given by Eq. 15 which he questions. Furthermore, Eq. 7 is precisely the solution to Eq. 15 and no "integral equation" is involved. Chen correctly points out, of course, the implied condition for Eqs. 4 and 7, i.e., $t_* \geq t_{p*}$ or equivalently, $Q_* \geq Q_{p*}$.

Chen's Eq. 16 is a correct partial transformation, introducing time as an independent variable, but curiously calculating Q_*. The writers suggest that, if time is the desired independent variable, Eq. 4 is a far more efficient form to use for infiltration rate decay. Our paper introduced Q (storage) as a variable for interest in conceptual modeling.

Chen's comments on the variation of t_p with θ_i indicate that he failed to appreciate the intended point regarding use of Eq. 9, which does *not* imply independence of t_p and θ_i. On the contrary, from the results shown in Ref. 7, this relation very closely incorporates all the effects of variation in initial condition θ_i, but in converting to real (dimensional) time, $t_p = t_{p*} T_o$, and the variation of θ_i is incorporated in the variation of T_o, according to Eq. 9.

Chen then chooses the limiting condition, $\theta_i = \theta_o$, to criticize the definition of T_o in Eq. 9. Perhaps the limit, $\theta_i > \theta_o$, should have been made explicit. At any rate, there is little need for redefinition as he proposes in Eq. 20 since there would be no need for an infiltration equation for a completely saturated soil. Chen indicates that the parameter, Q_{o*}, may be regarded as having no "physical" meaning. This is not a disadvantage, since it is determined from other soil parameters at the time of ponding, t_p. It does not take negative values, nor does t_{o*} ever become negative. Eq. 14 of Ref. 7 demonstrated for ponding ($r_* \rightarrow \infty$), $t_{o*} \rightarrow 0$ as $t_{p*} \rightarrow 0$. The same applies to Q_{o*}.

Furthermore, the writers are concerned that Chen, as a potential model user, feels that determining these parameters is prohibitively difficult. The general logical correspondence of the parameters with soil type is stressed more in Ref. 7. The range of variation of α is quite small; f_∞ is a basic and measurable (or estimable from records of rainfall and runoff) parameter for most infiltration

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[a] September, 1973, by Roger E. Smith and Donald L. Chery, Jr. (Proc. Paper 9990).

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equations; and D varies logically with soil type (small for sands and large for clays) (7). The information to date indicates confident estimability to a certain accuracy on this crude basis alone. The value of B also varies consistently with soil type. As to the relationship between B and β, which Chen does not accept, the range of β is again limited. The relationship in Fig. 6 is a pattern observed in simulations to data (7). If other accurate infiltration tests or simulation tests so indicate, this relation could and should be modified or replaced.

Chen's characterization of the use of this model as requiring "parameters for all possible combinations of factors . . . and then store(ing) their values" is an incorrect representation of the use of this model. The four parameters are constants for a soil for all rainfall and initial soil water θ_i conditions (variables as opposed to parameters) as was shown in Ref. 7.

Finally, Chen's objection to the writer's lack of consideration of surface depth is specious with respect to watershed surface flow simulation. In Fig.

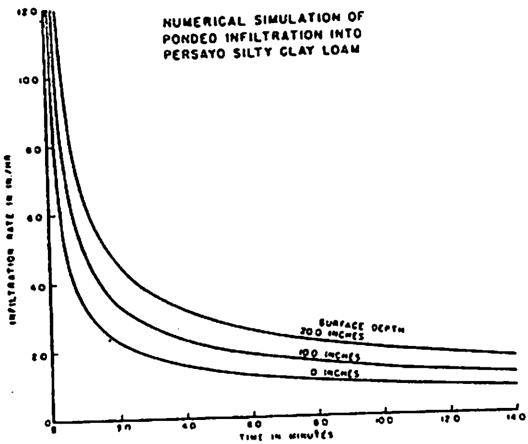

FIG. 14.—Example of Effective Surface Depth on Infiltration Rate under Ponded Conditions (1 in. = 25.4 mm)

14, we show the numerical simulation of infiltration under two very large depths. Since surface depths under rainfall do not begin until *after* much of the infiltration has occurred ($t > t_p$) and especially since such depths are on the order, at maximum, of a few millimeters, this figure shows graphically that the corresponding order of effect on f may be 0.01 in. (0.25 mm/hr). This would, of course, be different for simulating loss in an ephemeral stream channel.

In another statement, Chen seems not to recognize the point of the problem when he says that the parametric model seems to have little advantage over the complete numerical soil column simulations. The writers have presented a parametric model faithful to porous media hydraulics with a minimum of parameters. Their model is able to account for random rainfall patterns and to predict ponding time and is many times faster than numerical solution of the underlying differential equations of porous media flow. Elaborating on the potential value of such a model in watershed research and design should be unnecessary.

Of course, no single infiltration model is best. In selecting a model for any purpose, a hydrologist should consider space and time scale of interest. The number (and determinability) of parameters or complexity of model generally should achieve a corresponding accuracy. The writers suggest that this infiltration model has merit in its versatility and parameter efficiently on single-event scale simulation problems.

Errata.—The following corrections should be made to the original paper.

Page 1339, line 1: Should read "Eq. 1" instead of "Eq. 7"
Page 1342, line 10: Should read "Fig. 6" instead of "Fig. 5"

Sedimentation in Mangla Reservoir[a]

Closure by Roman W. Szechowycz,[4] F. ASCE and M. Mohsin Qureshi,[5] M. ASCE

The writers wish to thank Thomas for his valuable comments on the paper and agree with his suggestions to increase the life of the reservoir and to provide additional storage by: (1) Raising the main and subsidiary dams; and (2) creating off-river storage. However, the paper was written to present, to the fellow professional engineers, a method to predict the rate of storage depletion and to estimate the economic life of the storage reservoirs. It will be worthwhile investigating the new reservoirs using the technique described in the paper.

Errata.—The following corrections should be made to the original paper:

Page 1551, line 11: $10^9 m^3 = km^3$ should be deleted.
Page 1553, paragraph 2, line 2: Should read ($112 \times 10^6 m^3$) instead of (112,000 km^3)
Page 1555, paragraph 2, line 5: Should read ($11.8 \times 10^9 kg$) instead of ($11.8 < 10^9 kg$)
Page 1555, paragraph 2, line 7: Should read ($231.3 \times 10^9 kg$) instead of ($231.3 < 10^9 kg$)
Page 1555, paragraph 2, line 9: Should read ($91.55 \times 10^9 kg$) instead of ($91.55 < 10^9 kg$)
Page 1555, paragraph 3, line 3: Should read ($1.25 \times 10^9 kg$) instead of ($1.25 < 10^9 kg$)

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[a]September, 1973, by Roman W. Szechowycz and M. Mohsin Qureshi (Proc. Paper 10033).
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