Comment on 'Distributed Numerical Model for Estimating Runoff and Sediment Discharge of Ungaged Rivers, 2, Model Development' by S. I. Solomon and S. K. Gupta

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In their paper, *Solomon and Gupta* [1977] presented a distributed numerical model for estimating runoff and sediment discharge of ungaged rivers. The authors did a commendable job of keeping the model simple, a main feature distinguishing their work from similar models like the Stanford Watershed Model [*Crawford and Linsley*, 1966], pesticide transport and runoff model [*Crawford and Donigian*, 1973], nonpoint pollution model [*Donigian and Crawford*, 1976], and Actmo, an agricultural chemical transport model [*Frere et al.*, 1975]. In the above models, although considerable effort has been expended toward detailed mathematical modeling of various hydrologic processes, much less attention has been focused on the development of reliable prediction models for defining land use changes on ungaged areas. A minimum number of calibration parameters are needed in Solomon and Gupta's model. For example, only three parameters, *FA*, *UPOF*, and *Pg*, are needed in calibrating the water balance component of the hydrologic simulation. The model, with its minimum emphasis on subsurface flow, would be particularly adaptable for characterizing nonpoint source (NPS) pollution from land areas. Since the NPS model is concerned primarily with the surface wash-off of pollutants, overland flow is the key transport mechanism to be simulated.

One of the principal shortcomings of the model is that it does not take into account the snowmelt process. But snowmelt is a major component in continuous hydrologic simulation in many parts of the continental United States and Canada. The authors, however, attempted to include the snow accumulation by including the parameter a in (5). Since no simulations were reported for the winter months and snowmelt conditions, it is not clear how the model would perform in those situations.

The authors used *Holtan*'s [1971] model to estimate the infiltration component of the water balance. Holtan's model has been widely used because of the relative ease with which the input parameters can be estimated. A major difficulty in applying Holtan's equation is the evaluation of the soil depth on which to base S_{a1} in (8) of the authors' paper. As was suggested by *Holtan* [1971], the authors apparently assumed the soil depth to be the surface layer or the A horizon of the soil. *Huggins and Monke* [1966] found that this soil depth (referred to as the control depth in their work) was highly dependent on both the surface condition, such as crusting, and the cultural practices used in preparing the seed bed. *Skaggs et al.* [1969], in an experimental evaluation of Green and Ampt's, Horton's, Philip's, and Holtan's equation, found that for fallow soils the control depth is generally much less (with a mean of 97 mm) than the A horizon depth (178–254 mm for the soils in their study). As was reported by *Skaggs et al.* [1969], parameter n varied drastically between the wet and dry runs. This wide variation was attributed to differences in the control depth and could be reduced by using the alternate form of Holtan's equation, as proposed by *Huggins and Monke* [1966]:

$$f = D\left(\frac{S-F}{TP}\right)^n + f_c \qquad (1)$$

where TP is the product of total porosity and the effective depth to the impeding strata. Since the quantity inside the parentheses in (1) never exceeds unity, the constant D represents the maximum possible increase in infiltration rate over the steady state rate f_c. However, either form of the equation requires that $F = S$ before the predicted infiltration rate becomes constant. Therefore it is necessary that the control depth (soil depth) be estimated accurately to obtain reliable predictions using Holtan's equation.

The sediment model employed by the authors is very similar to the conceptual model presented by *Meyer and Wischmeier* [1969]. A particular disadvantage of this approach is that several model calibration parameters *SDR*, *SDF*, *STR*, and *STF* are needed. Such calibration parameters override influences of the topographic features, crop cover and management factor, and supporting practice factor, such as contouring, terracing, and strip-cropping. Researchers have recently made significant progress in separating rainfall-induced (interrill) erosion from runoff-induced (rill) erosion [*Foster and Meyer*, 1972]. Foster and Meyer derived the closed form soil erosion equation, which utilized the four basic subprocesses described by Solomon and Gupta and their interactions. Erosion by water from upland areas was mathematically described by an equation of mass continuity and an interrelationship between the detachment by runoff and the sediment load was assumed. *Kuh et al.* [1976] employed Foster and Meyer's closed form soil loss equation and described a two-dimensional erosion model which predicts both the total amount of erosion from a watershed and the areal distribution of erosion and sediment deposition. The two-dimensional erosion model divides the watershed into grids similar to the technique employed by the authors. Procedures were developed for evaluating the rainfall detachment capacity, runoff detachment capacity, transport capacity, effective rainfall width, and effective runoff width for input into the closed form soil loss equation. The end result was a map showing erosion or deposition in each grid on the watershed. Isoerodent lines were then drawn showing areas of erosion and deposition on the watershed. The two-dimensional erosion model did a better job of predicting erosion from individual storms than the universal soil loss equation (USLE). Over the 8-year period the USLE estimated slightly more than twice the measured erosion, whereas the two-di-

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mensional erosion model estimated only 1% more erosion than was actually measured. Such an erosion model is particularly attractive, since unlike the authors' model the two-dimensional erosion model needs no calibration. But even without any calibration, there was excellent agreement between measured and calculated values.

It would be interesting to know the computation time for the authors' model, including both calibration and production runs. This would allow comparison of their computer time with other available models.

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