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Comments on 'Derivation of an Equation of Infiltration' by H. J. Morel-Seytoux and J. Khanji

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Although their title was somewhat inappropriately chosen, *Morel-Seytoux and Khanji* [1974] have thoroughly analyzed this rather elegant approximate model [*Green and Ampt*, 1911] for surface infiltration of ponded water into a porous medium. The mathematical development of an expression for weighted driving pressure H_c is revealing and generally unassailable; however, there appears to be room for question with respect to the utility and perspective of the method. At the request of Morel-Seytoux the writer submits the following comments for consideration.

In their paper, the authors do not, of course, 'derive' an equation of infiltration. Rather, they have presented a development intended to provide a methodology for calculating the term representing capillary potential across the wetting front in the Green and Ampt approximate model for surface infiltration. Unfortunately, they exaggerated several accomplishments. For example, there is no real 'curtain of mystery' surrounding the parameters; Green and Ampt explained what each represented in terms of their simplified concept of water movement, and these have not been challenged seriously. The distinction may be made between a 'pure' empirical model, which seeks only to describe input-output relations, and a model which significantly simplifies the physics of the system and represents exactly the performance of this simpler system. The Green-Ampt model exemplifies this latter approach and is not strictly 'empirical.' The authors also clearly exaggerate when they state that the Green and Ampt model would have been forgotten except for *Bouwer* [1964]. In addition, it is difficult to accept their claim that the parameter H_c in (21) has now been given a 'precise physical meaning.' Mathematical definition does not impart physical meaning. Is there indeed a 'physical meaning' in an integration of the $k_r(\Theta)$ curve, not to mention the integration of a function of this curve?

Interestingly, the paper does not compare any infiltration curves from the methods discussed. The writer's experience verifies Morel-Seytoux's claim that the *Mein and Larson* [1973] calculation of S_{av} generally underpredicts infiltration [*Smith*, 1973]. Morel-Seytoux and Khanji also refer to bias in the Mein and Larson model, which overpredicts at large times and underpredicts at small times. This phenomenon is apparently inherent in their assumption of a time invariant moving profile shape, which is apparently the effective assumption in (22). In fact, capillarity and gravity are not 'neglected,' since there would be no flow under these conditions. The W used in (24) and (25) is not defined but must be $\int_0^t i\,dt$. The mathematical assumption seems to be that v is independent of Θ, thus an invariant profile front shape. In a commentary on the work of Mein and Larson the writer [*Smith*, 1973] demonstrated the resulting bias in comparison to numerical solutions of the Richards equation. Significantly, correction of the bias in H_b (S_{av}) by Morel-Seytoux's β will not affect this bias in curve shape.

The practicing hydrologist will recognize this work as an example of mathematical overkill. For what purpose would one invest the extensive (expensive) laboratory time and effort necessary to determine, in turn, $k_{rw}(\Theta)$, $k_{ra}(\Theta)$, K_θ, and $P_w(\Theta)$ in order to then calculate the parameters of an approximate infiltration equation? A major part of the value of approximation or of simple models lies in utility (estimability?) when the detailed porous media properties cannot be found. This is an especially important consideration in the light of experimental errors and in view of variability and uncertainty of soil properties. The authors' discussion of the variation of β with soil type seems a tacit recognition that for utility, β must be able to be estimated from soil 'type.'

Another sobering consideration is the fact that no matter how refined our estimate of the two parameters in this equation, it has applicability to only one boundary and initial condition; the important case of rainfall infiltration cannot be treated in this approximation. This commentary is, of course, intended to emphasize the dimensions of the underlying hydrologic problem rather than to detract from the analysis of Morel-Seytoux and Khanji.

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