Some Considerations on Space and Time Scale in the Modeling of Two-dimensional Unsaturad Infiltration Processes

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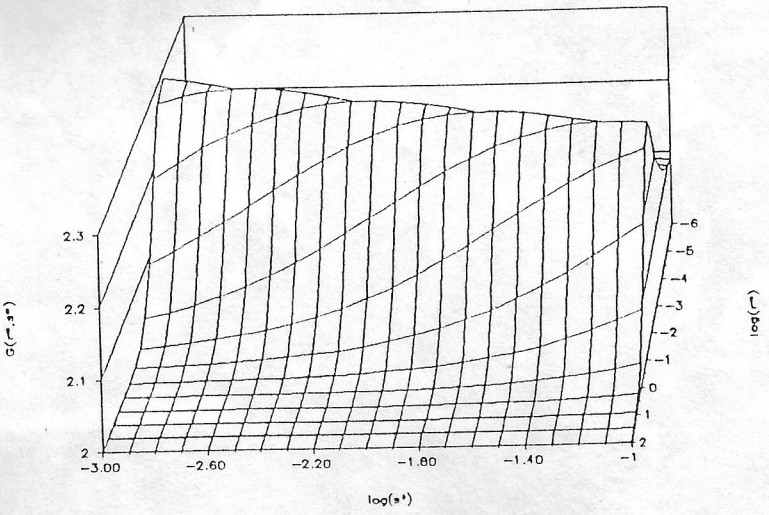
Multiple scale problems are involved in the analisys of infiltration processes. A simplyfied 2-D capillary-tube infiltration model (Menduni & Rosso, 1988) is used to establish the essential parameters defining space and time scales for two dimensional infiltration models at the field scale.

Despite of some very rough assumptions (e.g. stepwise function is used to describe saturation, hydraulic conductivity and pressure drop at pore air-water interfaces are assumed to be uniform for the medium at the REV scale) the present analysis shows how essential information can be gathered by a simple approach on the time and space scale of infiltration flow, at least for the early stages of the process.

Among different parameters currently used to describe the state of the air-solid-water system, the ratio of the flow boundary local radius of curvature, r, and the capillary head, h_c it is shown to play a major role to determine the scale requirements of the model.
Accordingly, the local slope of the dimensionless wetting lentgh of advance s_* on the double logarithmic plane, $G = d(\log(t_*))/d(\log(s_*))$ it is shown to be a function of ratio s_*/r_* only whith t_* denoting the dimensionless time and $r_* = r/h_c$.



This function is plotted in the above figure. One can observe that a region can be identified where 1-D behavior is predominant (i.e. for $s_*/r_* < .1$ corresponding with $G \approx 2$) while 2-D behavior occurs when $s_*/r_* > .1$, but it fully developes only for $s_*/r_* \approx 10$.