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This Week's Citation Classic

Philip J R. Theory of infiltration. *Advan. Hydrosci.* **5**:215-96, 1969.
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The article describes the physical basis of the modern analysis of water movement in unsaturated soils, with special reference to infiltration. The general flow equation (a nonlinear Fokker-Planck equation) is developed, methods of solution are described, solutions are presented, and their physical significance is discussed. [The *SCI*® indicates that this paper has been cited over 145 times since 1969.]

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"A very large fraction of precipitation (or irrigation water) reaching the land surface moves through *unsaturated* soil during the subsequent processes of infiltration, drainage, absorption of soil-water by plants, and evaporation. Understanding these processes is central to hydrological studies by water resource engineers, agronomists, and ecologists.

"In the early 1950s, when I began research in this field, these processes were poorly understood. Each had its own folkloric explanation, and no unified physically based quantitative predictive theory existed. The soil physicists L.A. Richards[1] (US) and E.C. Childs[2] (England) had perceived that Darcy's law for unsaturated media, together with the measurable dependence of the chemical potential of the soil-water on its concentration, yielded a flow equation. This is, in general, a nonlinear Fokker-Planck equation, and I developed methods of solving this equation and showed that the solution agreed with the (hitherto unexplained) experiments. It was thus demonstrated that the various hydrological processes represented solutions of the general equation subject to appropriate initial and boundary conditions. My most detailed studies were of *infiltration,* the process whereby water at its surface soaks into soil.

"Why has this article been much cited? First, it is a review which gives a concentrated, connected account of a program of work reported in some 30 papers over the period 1954-1968. So it tends to get cited as an act of *economy.* Secondly, the article was *timely.* Engineering hydrologists took little notice of this work before the *Advances in Hydroscience* article appeared. Till then the topic seemed to be thought fit only for soil physicists with mathematical tendencies.

"Awards and honours? This work has, I assume, contributed to my getting several: the David Rivett Medal (1966); elected Fellow of the Australian Academy of Science (1967); elected Fellow of the Royal Society of London (1974); and the Lyle Medal of the Australian Academy of Science (1981).

"New terminology? *Sorptivity* is a measurable physical quantity, and expresses the capacity of a porous medium for capillary uptake of a liquid. I used the term from 1957, but it was not widely accepted until after the *Advances in Hydroscience* article.

"Relevant later reviews? My papers entitled 'Flow in porous media' relate the work to conventional fluid mechanics and review the generalization to embrace flow and volume change in swelling soils and porous media.[3,4] 'Recent progress in the solution of nonlinear diffusion equations' describes further work on solving nonlinear Fokker-Planck and diffusion equations.[5] 'Macroscopic analysis of the behaviour of colloidal suspensions' reviews the application to colloidal suspensions, which represent simply a special (if dilute) class of swelling media.[6] It must be added that this mode of analysis remains at present largely unknown to colloid chemists."

1. **Richards L A.** Capillary conduction of liquids through porous mediums. *Physics* **1**:318-33, 1931.
2. **Chllds E C & Collis-George N.** The permeability of porous materials. *Proc. Roy. Soc. London A* **201**:805-13, 1950.
3. **Philip J R.** Flow in porous media. *Annu. Rev. Fluid Mech.* **2**:177-204, 1970.
4. ..... Flow in porous media. (Becker E & Mikhailov G K, eds.) *Theoretical and applied mechanics.* Berlin: Springer, 1973. p. 279-94.
5. ..... Recent progress in the solution of nonlinear diffusion equations. *Soil Sci.* **117**:257-64, 1974.
6. **Philip J R & Smiles D E.** Macroscopic analysis of the behaviour of colloidal suspensions. *Advan. Colloid Interface Sci.* In press, 1981.