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This Week's Citation Classic

Nielsen D R, Biggar J W & Erh K T. Spatial variability of field-measured soil-water properties. *Hilgardia* **42**:215-59, 1973.
[Department of Water Science and Engineering, University of California, Davis, CA]

Infiltration and redistribution of soil-water following an irrigation was studied in a 150-hectare agricultural field in the Central Valley of California. Statistical analyses of variations of soil-water properties with soil depth throughout the field identified the reliability of measurements and mathematical simulations of soil-water behavior. [The *SCI*® indicates that this paper has been cited in over 130 publications since 1973.]

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"In California in the 1950s, with water being transported from the north to irrigate hundreds of thousands of newly farmed areas of land to the south, questions of nonpermissible levels of nitrate and pesticides, and of excess levels of salines in drainage waters, were being raised. To understand how these constituents were to be retained or leached through the Central Valley floor, we first needed to understand how water moved in agricultural fields, through the vadose (water-unsaturated) zone and into the groundwater. The late John T. Maletic, chief soil scientist of the US Bureau of Reclamation, recognized our dilemma, and funded a modest two-year proposal by Biggar and myself on the condition that we mentioned nitrate in the title! Between us, we understood that it would not be possible to complete in a limit of two years the objective of the proposal in relation to water much less nitrate behavior. Our two-year report to the Bureau attests to our tacit understanding, but with additional piecemeal funding from other organizations including the US Department of Agriculture, we completed in five years the first phase of our final report on water (this publication). The final phase regarding nitrate leaching was completed in another three years.[1]

"Although our experiment did not provide any new theories or academic innovations, it offered dozens of undergraduate and graduate students as well as technicians and postdoctoral fellows an opportunity to experience the practical aspects of soil-physics research. The instrumentation was simple and handmade, with success depending upon large numbers of observations taken hourly, day and night, for several months throughout the initial two-year period. Laboratory analyses initiated concomitantly required an additional two-year effort. The logistics for conducting the work were complicated by the fact that the field was located 200 miles from our campus. Erh, a student who later earned his PhD on a study unrelated to this publication, contributed the computer programs and elements of some of the statistical analyses. We acknowledge not only his contribution but those of all our colleagues mentioned anonymously above, for without their commitment, the publication would not exist.

"We believe that this article has become a *Citation Classic* because it was the first publication to provide a comprehensive set of statistical parameters describing field-measured soil-water properties over a mapping unit containing only one soil series. It provides insights for two kinds of researchers—a) the modeler who makes computer simulations of soil-water behavior with inadequate knowledge of the appropriate range of values manifested by a soil-water parameter, and b) the experimentalist who arbitrarily selects the number and location of observations in a field without a quantitative appreciation of the spatial variation of the soil-water parameter. These considerations have been incorporated into reviews dealing with the measurement of nitrogen in agricultural lands[2] as well as movement and retention of water and solutes in the vadose zone.[3] And, at least in part, we believe that this article helped to focus the attention of our colleagues toward the continued development of a technology to measure field soils with the establishment of a Working Croup of the International Soil Science Society bearing the title. Analysis of Spatial and Temporal Variability of Field Soil Properties."

1. **Biggar J W & Nielsen D R.** Spatial variability of the leaching characteristics of a field soil. *Water Resour. Res.* **12**:78-84, 1976.
2. **Nielsen D R, Biggar J W & Wierenga P J.** Nitrogen transport processes in soil. (Stevenson F J, ed.) *Nitrogen in agricultural soils.* Madison, WI: American Society of Agronomy, 1982. p. 423-48.
3. **Nielsen D R** & **Biggar J W.** Implications of the vadose zone to water-resource management. (Geophysics Study Committee, National Research Council) *Scientific basis of water-resource management.* Washington, DC: National Academy Press, 1982. p. 41-50.