Deep Unsaturated-Zone Recharge to the High Plains Aquifer

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The Darcy method, environmental tracers (chloride, tritium, and atrazine), and numerical simulations were used to estimate deep unsaturated-zone recharge to the High Plains aquifer in southwestern Kansas. These techniques integrate data over different time scales, thereby providing information on the temporal variability in recharge. Recharge estimates were made on the basis of physical, hydraulic, and chemical data collected from throughout the unsaturated zone at a rangeland site, where the depth to water was about 160 feet; and at two irrigated fields, where the depth to water was about 150 feet. Irrigation first began at these two sites in about 1956. The fields were furrow irrigated until 1990, when they were switched to sprinkler irrigation.

Recharge under current (2000-01) moisture conditions, estimated using the Darcy method, was 0.004 to 0.01 inch/year at the rangeland site, 0.1 inch/year at the first irrigated site, and 0.02 to 0.04 inch/year at the second irrigated site. These results indicate that irrigated fields were a relatively important source of recharge to the aquifer. Chloride mass-balance calculations indicated that recharge at the rangeland site over the last several hundred years was larger (0.2 to 0.6 inch/year) than under current moisture conditions. This difference may result from changes in climate or vegetation in southwestern Kansas over the last several hundred years. Tritium and atrazine tracers and numerical simulations indicated that recharge under the irrigated fields during the period of furrow irrigation was larger (7.5 to 8 inches/year) than under current moisture conditions. This large reduction in recharge after furrow irrigation was stopped indicated that tritium and agricultural chemicals present in the deep unsaturated zone and ground water must have been transported primarily during the period of furrow irrigation. This reduction in chemical flux to the aquifer may eventually result in a decrease in concentrations of agricultural chemicals in ground water.